Using Intentional Analysis to Model Knowledge Management Requirements in Communities of Practice

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Abstract. This working document presents a Knowledge Management (KM) fictitious scenario to be modeled using Intentional Analysis in order to guide us on choosing the appropriate Information System support for the given situation. In this scenario, a newcomer in a knowledge organization decides to join an existing Community of Practice (CoP) in order to share knowledge and adjust to his new working environment. The preliminary idea suggests that Tropos is used for the Intentional Analysis, allowing us to elicit the requirements for a KM system, followed by the use of Agent-Object-Relationship Modeling Language (AORML) on the architectural and detailed design phases of software development. Aside of this primary goal, we also intend to point out needs of extending the expressiveness of the current Intentional analysis modeling language we are using and to check where the methodology could be improved in order to make it more usable. This is the first version of this working document, which we aim to constantly update with our new findings resulting of progress in the analysis.

1. Introduction

Research on KM systems and practices have evolved substantially in the past 30 years, coming from top-down approaches enforced by the organization management to bottom-up strategies, allowing the employees to take most of the decisions regarding knowledge exchange. The first Knowledge Management Systems (KMSs) were *centrally based* and followed a *top-down design approach*. The organization managers, supported by knowledge engineers, collected and structured the contents of an organizational memory as a finished product at design time (before the organizational memory was deployed) and then disseminated the product, expecting employees to use it and update it [12]. Employees often claimed that the knowledge stored in the repository was detached from their real working practices. This led to the development of *evolutionary methods*, which prescribe that the basic KM platform is initially developed and evolve proactively in an on-going fashion [16]. However, as most of the initiatives are still based on building central repositories and portals, issues of trust and motivation often lead to dissatisfaction [7,20]. Workers resist on sharing knowledge, since they do not know who is going to access it and what is going to be done with it.

Currently, organizations have realized that workers have their own natural way to share knowledge. They usually gather in groups, based on similar interests, personal

affinity and trust. These groups are commonly known as *Communities of Practice (CoPs)*. According to Brown, mentioned by Verna [1], CoPs are peers in the execution of **real work**. What holds them together is a common sense of purpose and a real need to know what each other knows." The use of CoPs in KM (both in businesses and in educational settings) has been motivated by the assumption that knowledge cannot be separated from the communities that create it, use it, and transform it. Etienne Wenger indicate that such environments are especially suitable for organizations' newcomers, who can learn the common procedures and working practices by informally collaborating with others. With time, the newcomer can become a fully integrated and active member of the community.

It is important to note that such communities cannot be forcibly created, but they may be fostered, by acquiring from the organization the means to grow and mature within working settings [8,14]. Dignum and van Eeden [8] emphasize the importance of setting up real targets to CoPs, guaranteeing that their value for the organization be concretely perceived and measured. In addition to that, fostering also includes creating the conditions for a community to emerge, both giving social and technological support for it. In the *social dimension*, community members can, for instance, be rewarded and remembered. As for the *technological support*, it is important to note that an appropriate infrastructure needs to be provided to facilitate knowledge sharing. In this work, both the social and the technological dimensions are considered, though the latter is our main focus. Deciding which Information System (IS) could enable CoP creation and management becomes a critical issue, which requires a deep understanding of the organization, taking into consideration both common and the individual goals of its workers.

The effectiveness of applying Intentional Analysis to model the organization stakeholders, along with their goals and mutual dependencies for goal achievement has been described in [18]. The referred work applies such analysis methodology in order to elicit Distributed Knowledge Management needs. Along this line, we propose to use Intentional analysis to elicit the requirements of an IS to support Knowledge Management processes within a CoP. This analysis may be the input to a **system design phase**, leading finally to the implementation of an adequate IS, or to a **technology evaluation activity**, in case the use of already available applications is preferable. Moreover, Intentional analysis could be useful for maintenance activities, and in particular for the so called *"corrective"* and *"perfective" maintenance activities* [13] that are performed to modify the system after it has been delivered, according to particular needs and preferences of the stakeholders (in other words, supporting the already mentioned evolutionary methods for KM systems' development).

This document presents a Knowledge Management (KM) Scenario to be modeled using Intentional analysis, guiding us on choosing the appropriate IS support for the given situation. The preliminary idea suggests that Tropos is used for the Intentional analysis, allowing us to elicit the requirements for a KM system (Tropos' early and late requirements phases), followed by the use of Agent-Object-Relationship Modeling Language (AORML) on the architectural and detailed design phases of software development. Aside this primary goal, we also intend to point out needs of extending the expressiveness of the current Intentional analysis modeling language, besides checking

how the methodology could be improved in order to make it more adequate for the proposed goals.

The remaining of this document is structured as follows: section 2 presents a fictitious scenario created according to the available KM literature to serve as the basis of our analysis, along with some research questions (subsection 2.1); in section 3, the reader will find some results of our ongoing work using Intentional analysis to model the scenario, after a brief presentation of the Intentional analysis methodology. Moreover, subsection 3.3 points out some directions for proceeding with our modeling efforts; in section 4, we explain how existing applications may be considered, allowing us to analyze diverse possibilities of technological support for CoPs; section 5 presents some insights on how the concepts of intentional analysis can be mapped to AORML constructs, supporting the architectural and detailed design; and, finally, section 6 presents our preliminary conclusions and discusses our research agenda for the future.

2. Fictitious Scenario Knowledge Management in CoPs

In order to support our work, pursuing the focuses already mentioned in section 1, we used a fictitious scenario. Although not a real case study, this scenario was carefully tailored, taking into consideration available literature [1,2,8,11,23] and the authors' past experiences regarding CoPs [8,15,18]. Here follows the scenario description.

> "Luca starts working in BHI Software Company. He is a programmer with 10 years of experience. As a newcomer at BHI, he needs to adjust to the organization's work practices. This involves adapting to the work style of his working team and immediate supervisor, and also includes learning about the company's policies and management directives. As a knowledge organization, BHI considers Luca not only a new "hand at work", but as part of the company's intellectual capital. He is a new knowledge source for the organization, capable of providing his team (as well as the whole company) with innovation and positive changes.
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> Aiming at providing its workers with a rich environment for knowledge sharing, BHI Management fosters the development of Communities of Practice (CoPs) across the organization. These communities are self-organizing groups whose members share interests and goals, or perform similar tasks within the organization. They are not necessarily from the same working team or division, and their members are dispersed across the 10 branches of BHI. The CoPs play an important role in allowing newcomers to get acquainted with their new working environment, naturally learning about products, projects, specific domains, and procedures.
>
> Though the communities are self-organizing systems, there is a special sector within the company to support them, called the Knowledge Management Division (KMD). One of the main objectives of this division is supporting the CoP on pursuing explicit targets related to the organization's goals. This allows the community members to feel important as a group for the organization at the same time that the CoP's value is more concretely measurable from the Management's point of view. Besides this, the KMD provides new communities with guidance towards their creation and maturing, assists the community's leadership, and monitors the CoP's activities, granting incentives for those that stand out,

contributing to the organization as a whole. These incentives include promoting events for the community, granting specific members with financial support for courses, and fostering a higher visibility of communities and members. Finally, this division also provides information about the active CoPs that are open for new membership, in order to facilitate the integration of newcomers in the organization.

After consulting the KMD, Luca decides to join an ongoing CoP organized around the eCommerce domain, called ECom. He has a particular interest for the subject and would like to learn more about it, while also contributing to the colleagues with his own past experience. He meets Julia, one of ECom's leaders, who now assumes the role of introducing Luca to the other members and getting him acquainted with the main processes that guide the community's functioning. It's important to note that ECom's leaders have an important role in motivating Luca, as well as the other members, on sharing knowledge. Especially when business processes are tight and answering some questions or making one's knowledge available will get very little priority. Besides, it may not be very clear for Luca what he will get in return for his willingness to contribute to the CoP members. External incentives, provided by the KMD, along with internal disposition related to Luca's personality and character play an important role here. On the other hand, having appropriate Information System tools may also strongly contribute to his will towards knowledge sharing.

ECom is now active for 5 years, so it holds a big community memory. This memory is composed of *knowledge artifacts* elaborated by the CoPs' members and *messages* they have exchanged throughout the community's lifetime. A knowledge artifact can be any resource produced or stored by the CoP members (e.g. reports, manuals, meeting audio-recordings, etc) while a message refers to a communication construct, used to mediate dialogue and discussion, such as interactions mediated by email or video-conferencing. Luca will start his learning process by having access to the community memory, besides interacting with other members. This should help him integrate into the community, slowly becoming an active member of ECom, by contributing with his own points of view and previous knowledge on the area."

2.1. Research Questions

Table 1 presents the research questions pursued in this work. These questions have been elicited in the earliest stage of our work and should be refined throughout our work.

Table 1: Proposed Research Questions

Focus on Eliciting IS Requirements
Newcomer's Perspective
RQ01: How to contribute for the newcomer's unintentional learning process while participating of the CoP?
RQ02: How to facilitate the newcomer's integration, becoming an active member of the CoP?
RQ03: How to assist the community member's to share knowledge and organize the community memory?
CoP's Perspective
RQ04: How to assist the community's leadership in helping new members adjust to the work within the community?
RQ05: How to support the monitoring of CoP's activities?
KM Division Perspective
RQ06: How to support the work of the Knowledge Management Division in collecting data about the CoP in order to perform its functions of providing guidance and incentives to the CoP and information to newcomers?
Methodological Focus
RQ07: How can Intentional Analysis support explicitly modeling the rationale of a particular organization when fostering CoPs?
RQ08: How can AORML be used to provide a more smooth transition from the early/late requirements analysis of Tropos to the architectural/detailed design of CoP supporting IS development?

Table 1 organizes our research questions, taking different focuses and perspectives. Our main focus, at this moment, has been *"Eliciting IS Requirements"*, taking the *"Newcomer's perspective"*(RQs 01-03). Besides, we have also preliminarily targeted RQ07. Emphasis on the other questions will depend on how this work will evolve and which directions it will take.

3. Intentional Analysis of the Proposed Scenario

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 they need to be shaped to respond to the specific needs of the organizational environment. Many systems 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 ISs, there are well-established techniques and methods for system development and management [13]. Of particular interest are methods for requirements elicitation and analysis, aimed at matching organizational needs with technical capabilities and system qualities. 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 [19]. 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 ISs, and opens up many more ways to leverage information technologies to augment human and organizational capabilities and performances.

Given the richness and complexity of real-life organizational setting and the availability of distributed system technology, 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 KM and social organizations.

This motivated the proposals of novel methodologies for requirements analysis based on an organizational perspective [10] and extending approaches that were originally proposed in Agent-Oriented Software Engineering [5]. Applying agents as a *metaphor* on system development is not new and has been observed in [17]. However, especially in KM domains, agents seem to be an interesting construct to represent not only artificial beings, but also the users and the organizations involved in a given scenario [9]. This allows the requirement engineer or analyst to understand, before modeling the KM system itself, how knowledge flows within the organization, supporting decisions regarding **'why'** and **'how'** knowledge management processes should be supported [18].

There are at least two reasons to use agents as a metaphor to model KM settings: a) the agent mindset fit well with concepts that are suitable for modeling the needs of so called "knowledge workers"; b) the adoption of such common set of concepts is crucial to allow the understanding or the influence that the social organization model has (or has to have) on the functionality and objectives of the eventual agent-based application. In other words, agent related 'mentalistic' concepts such as goals [18], beliefs, commitments and claims [22,15] may be useful on analyzing the needs of an organization towards KM, also providing the means for reaching appropriate technologic solutions.

In [18], the authors propose a methodology for analyzing KM requirements based on Intentional analysis, claiming that, in order to develop effective KM solutions, it is necessary to analyze the intentional dimension of the organizational setting, i.e. the interests, intents, and strategic relationships among the actors of the organization. Their methodology is based on the use of the **i* framework**, which models the organization as a set of actors, goals, 'soft goals', dependencies, tasks and resources.

Intentional analysis allows us to model complex relationships among social actors in terms of their interests and intents and of the strategic relationship 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 (Yu 1997) supports intentional analysis through actor and goal modelling and provides an intuitive diagrammatic representation of these models. The intentional elements in i*are goal, task, softgoal, and resource:

- a goal is a condition or state of affairs in the world that the stakeholders would like to achieve;
- a task specifies a particular way of doing something, a particular course of action;
- a softgoal is used to represent how a state of affair should be reached (that is it has no clear-cut definition and/or criteria as to whether it is satisfied);
- a resource is an (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 diagram*, a graph whose nodes represent actors (circles) and whose arcs represent dependencies (a couple of arrows linked by its dependum). In i* an actor's goal (or task) 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 re_ning a goal structure.

3.1. A First Strategic Dependency Model

We have elaborated a first i* Strategic Dependency (SD) model of the scenario, by directly taking into consideration the text presented in section 2. Though Intentional Analysis has been previously applied only in real case studies, we are now using it to model a fictitious scenario. Though, our SD model considers the general relationship/dependencies between the actors of the scenario in an ideal situation. Figure 1 depicts this diagram, modeling the relationship between the actors of the scenario, taking a general point of view.

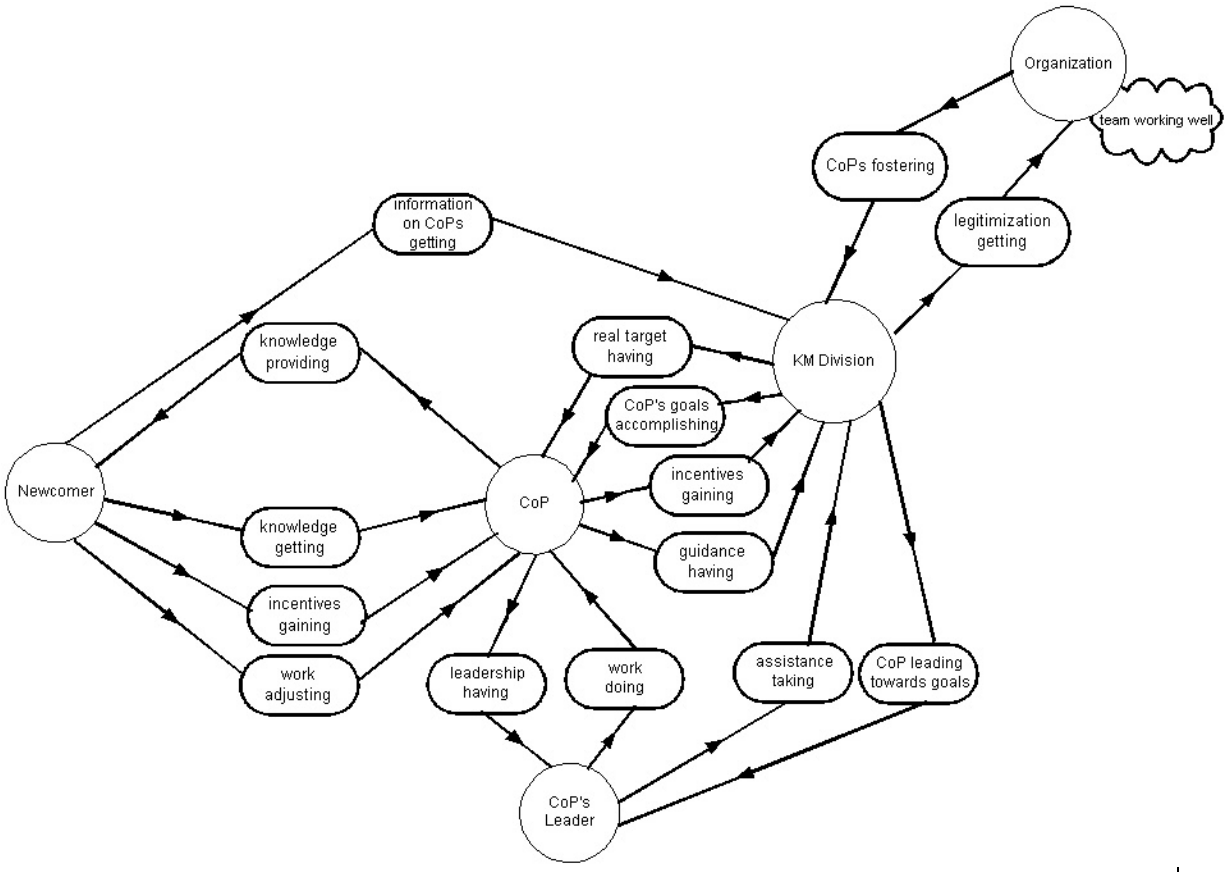

Fig. 1. A first Strategic Dependency (SD) i* model showing the general relationship between the actors involved in the scenario[1]

The model of Fig. 1 shows the main actors of the environment (depicted as circles), taken directly from the scenario description. These actors are Newcomer, CoP, CoP Leader, KM Unit, and Organization. Next to this, the goals of these actors have been identified (both softgoals and goals) and the dependencies on other actors to satisfy such goals have been represented.

We start from the actor Organization, which represents the BHI organization top management. The Organization has an initial general softgoal of having the organization's team working well, both in terms of products' and procedures' quality and also regarding the promotion of good relationship among the workers. This softgoal leads the organization to CoPs fostering[2], delegating this goal to the Knowledge Management Division (KM Division actor). In return, the KM Division depends on the Organization to be legitimized for playing the specific role of motivating and supporting

[1] Here, we are using a slightly different notation than the original i* notation, adapted for Topos.

[2] A dependency between two actors towards one specific *goal A* indicates that the *dependee* commits to *goal A*, which was initially only aimed by the *depender*. In order to characterize this mutual commitment, the English participle is sometimes used in goal's nomination. For instance, we could express this goal as CoP fostered. Here, however, we prefer to use the gerund form, as we think this suggests *a continuation in time*. In other words, CoP fostering represents better the fact that this is a goal sustained through an unspecified time period by both the Organization and the KM Division, instead of being pursued by such actors in a discrete point in time.

Knowledge Management practices (goal legitimization getting). The initial Organization's softgoal, leading to its main goal of supporting CoPs, generates all other goal dependencies between the remaining actors in the scenario.

Taking, for instance, the pair of actors Newcomer and CoP, we note that there are goal dependencies in both directions. The Newcomer depends on the CoP to get new knowledge, to gain external incentives or motivation in order to share his/her own knowledge, and to adjust into his new work setting and practices within the organization (goals knowledge getting, incentives gaining and work adjusting). On the other hand, the CoP aims at taking contributions from the Newcomer's own knowledge and experience (goal knowledge providing, here seen in the Newcomer's perspective, i.e. the Newcomer provides knowledge to the CoP). This mutual dependency characterizes what Intentional analysis names *"sustainable relationship"*, i.e. a relationship in which two actors depend on each other to achieve one or more of their own goals. Sustainable relationships indicate that there is some kind of balance between the two actors, thus helping them achieve personal goals. On the other hand, if there are dependencies only from one side, this indicates an vulnerability by this dependee actor towards the depender [24], which should be corrected in order to guarantee that both actors are committed to each other. Analyzing the different strengths between each dependency [24] can also indicate if a specific situation needs to be balanced. Besides analyzing the direct dependencies between two actors, balance can also come as a result of a dependency chain. For instance, though there is no direct goal dependency from the KM Division to the Newcomer, balance between the two actors is achieved by the propagation goal dependencies between Newcomer and CoP to KM Division. As an example, the goal incentive gaining between the Newcomer and CoP is propagated by the latter to the KM Division. This means that in order to motivate the Newcomer on sharing knowledge, the CoP relies on the KM Division's providing external incentives, such as promoting events for the community, granting specific members with financial support for courses, and fostering a higher visibility of communities and members.

Our goal is that this model can be used, in a very general way, to analyze the dependencies between the actors of a KM setting and be compared to what happens in real situations. In other words, by comparing an analysis made for a particular case study, taking into consideration the specificities of such setting, we could compare it with this model in order to find inconsistencies between ideal situation and practices, possibly, providing us with inspirations on how such problem could be solved. Moreover, this first general model can then be refined in Strategic Rationale (SR) models, showing a particular perspective of one or more actors, depending on the intentions and particular characteristics of an organizational.

3.2. The Newcomer's Perspective: a Strategic Rationale Model

Figure 2 presents a Strategic Rationale (SR) i* model, from the Newcomer's perspective.

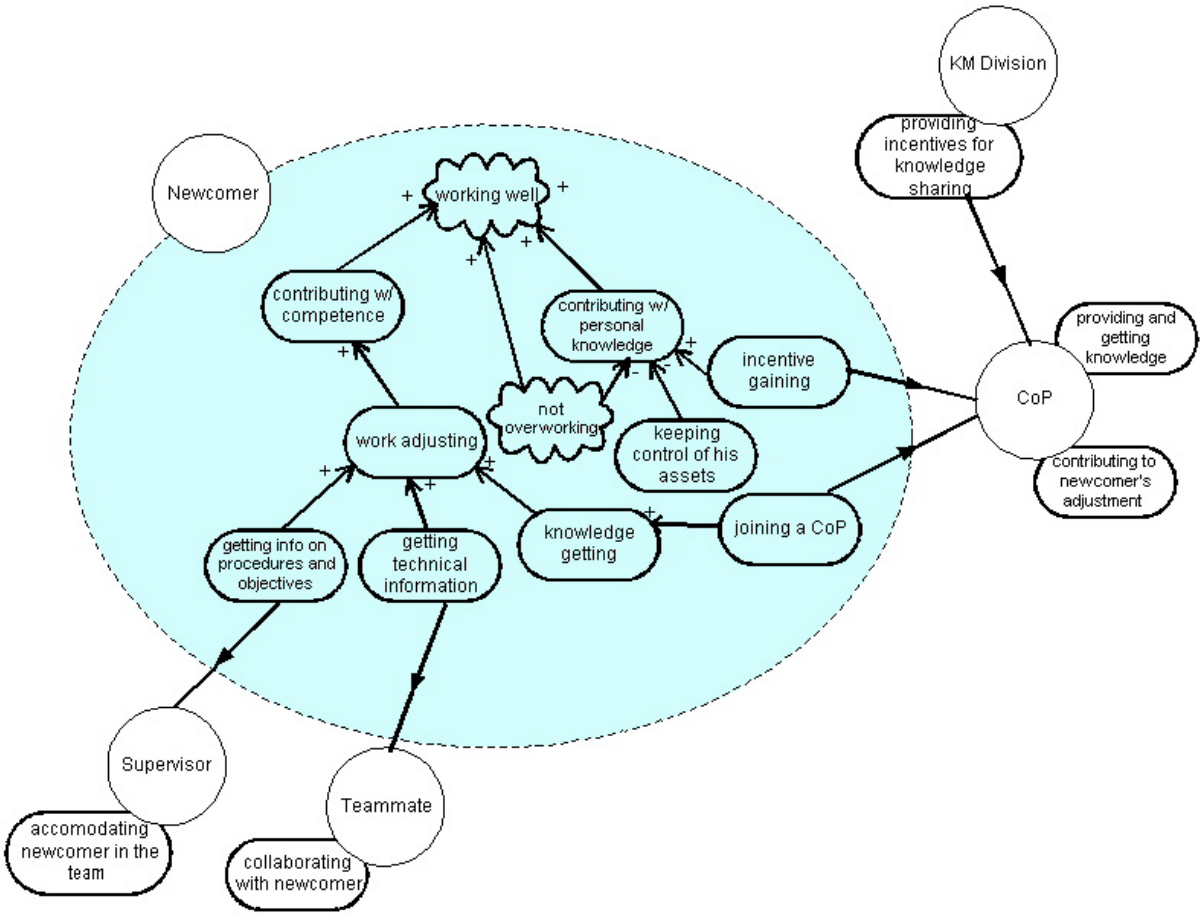

Fig. 2. Intentional Analysis on the Newcomer's perspectives with the use of Strategic Rationale (SR) model[3].

Although coherent with the previous model (Fig. 1), the model of Fig.2 shows a more detailed analysis of the Newcomer's goals (note the actor's perspective balloon) and presents the goals of the other actors in the Newcomer's point of view.

The Newcomer's most general goal is the softgoal "working well", i.e. he aims at doing his work efficiently, while also feeling good about himself and about the organization as a whole. In order to accomplish this, he aims at "contributing with his competence" and "contributing with personal knowledge", gained in previous personal and professional experiences. Going deeper in the analysis of the Newcomer's goal of "contributing with personal knowledge", we realize that there is one goal which contributes positively to it ("incentive gaining") while there are two other that contribute negatively towards it ("not overworking" and "keeping control of his assets"). The "incentive gaining" goal, as already mentioned in section 3.1, refers to receiving external incentives from the CoP in order to share knowledge. Of course, other internal motivation, such as personal will to collaborate, curiosity, and personal competencies

[3] In this diagram, we are using a "shortcut" when representing the dependencies between the goals of the Newcomer and the other actors of the scenario. The original i* notation prescribes that a *dependum* (goal, resource, or plan) is represented between the Newcomer and each *dependee* (the *dependum* is external to the Newcomer's actor). Here, instead, we do not represent such *dependums* yet.

such as networking and interpersonal communication abilities [14] will contribute for the Newcomer's will to share knowledge. On the other hand, the two mentioned goals that are mentioned as negatively contributing to knowledge sharing are common problems already noted by the KM community [7,18,20]. As most of the initiatives related to KM systems are still based on building central repositories and portals, issues of trust ("keeping control of his assets" goal) and motivation ("not overworking" goal) often lead to dissatisfaction. Workers resist on sharing knowledge, since they do not know who is going to access it and what is going to be done with it. Besides, they often see the task of feeding a centralized KM system as an overwork and a burden.

Let's now analyze the goal "contributing with competence" a bit further. In order to fully and most effectively contribute with his acquired competence, the Newcomer needs to adjust to his work environment ("work adjusting" goal). In order to do so, the Newcomer needs new knowledge about his work and about the organization as a whole ("knowledge getting" goal), and therefore decides to participate in a CoP ("joining a CoP" goal). Note that two new actors, not present in the general model (Fig. 1) appear here: the Supervisor, representing the immediate boss or responsible for the Newcomer in the organization; and the Teammate, i.e. colleagues from his same working team. The Supervisor has a general goal of having the Newcomer adapted to his new working team ("accommodating newcomer in the team"), which leads him to provide the Newcomer with relevant information regarding the team's objectives and procedures (Newcomer's "getting info on procedures and objectives" goal). Similarly, on the Newcomer's perspective, the Teammate aims at collaborating with him ("collaborating with the Newcomer" goal). Thus, the Newcomer takes from the Teammate detailed technical information on work procedures, products, and so on ("getting technical information" goal). The Supervisor's and the Teammate's goals were not the focus of this work and, thus, need to be further analyzed to bring more important insights on the relationship of each of these actors with the Newcomer. On the other hand, this initial analysis already shows us that the type of information exchanged between each of these actors and the Newcomer has different nature.

3.3. Directions for Further Analysis

Up to now, our analysis is restricted to a general overview of the actors' goal dependencies (Fig. 1) and an initial model according to the Newcomer's perspective (Fig. 2). In order to have a more complete view of the scenario, it would be necessary to analyze the perspective of the other actors in more details. Although we have not achieved this yet, we present here some directions on how this work can proceed.

Taking the CoP's Perspective

Analyzing the CoP's goals in more details can be based in the work by Gongla and Rizzuto [14]. This work investigates patterns related to the development and evolution of CoPs in IBM in terms of a dynamic balance of people, process and technology. More precisely, it divides CoPs' evolution in five phases: potential, building, engaged, active and adaptive stages, each one having its own purpose and characteristics. Using these patterns, they developed an evolution model that helped them describe those characteristics that distinguished communities in one stage from those in another. Each of

these phases are thus described in terms of fundamental function, people behavior, processes and enabling technologies where:

- *fundamental function* is the core goal of the specific stage;
- *people behavior* are considered, in a very broad sense, as social individual and group behaviors as well as the larger organizational behavior influence vis-à-vis a community;
- *processes* are sets of documented steps with clearly defined roles and activities for people to perform;
- *enabling technology* refers to the application of science and the body of information systems knowledge that we use to fashion tools, practice knowledge arts, and extract data and information.

We suggest that a detailed Intentional Analysis is made, considering each one of the stages described in this work. In this respect, we are encouraged by the possibility to directly map these four considered aspects in i* elements. The fundamental function can be mapped to the most general goal of the community. Processes could then be used to refine this general goal into other goals and ultimately into i* plans, since they are described as being specified in details. Both people behavior and enabling technology can be represented as i* resources. People's behavior is described as a set of key skills or competencies that helped individuals to work well in each stage. Though not a tangible resource, such as a report or an information system, such skills can be highly valuable for analyzing the intentional dimension of the organizational setting. On the other hand, resources as the ones exemplified as enabling technology are commonly modeled in Tropos [5]. This work is particularly interested in this kind of resource, since we aim here at analyzing the requirements for software systems supporting KM, especially the ones specifically related to CoPs.

We suggest that either a Computer Science or a Business Science master student pursues this work, which can be further refined if these stages are compared to the ones proposed by Wenger [23].

Taking the KMD's Perspective and Refining the Relationship Between KMD and CoP

In order to better understand the goals of the KM Division and its relationship with the CoP, we suggest the work of Dignum and Eeden [8] is taken into consideration.

According to this work, support of communities must focus on the building of social capital, including: *obligations*, that is, generating mutual reciprocity between members; *trust*, which will enable predictability of action and comfortable handling for the members; *norms*, which describe and enforce common standards of behavior and therefore enable identification of members with the community; *identification*, that is, the awareness of each member of its connection to others and to the community as a whole.

Experience shows that the top-down forcing of communities does not work if the target group does not already have any common interests, activities and objectives. CoP literature often distinguishes between two types of communities: self-organized and sponsored. Self-organizing CoPs start from and watch over the interests of their members, which makes such communities very flexible. However, a downsize of self-organizing communities is that they easily collapse when their motor for some reason disappears, or if too much outside pressure is place on the community. Sponsored

communities, on the other hand, are expected to produce measurable results agreed previously with their sponsors. The internal structure of a sponsored CoP must be decided by the members within a formal agreement with the management.

At Achmea Knowledge Networking (AKN) group, the authors have developed the SES (Seduce, Engage, Support) Model to facilitate CoPs across the organization, which combines lessons learned, success stories and collective experiences, skills and tools from previous projects. The SES is a participatory method to develop communities and borrows ideas from community-centered development in the sense that the characteristics and needs of the community members are leading and prior to any decisions concerning technology and social structure.

This work describes in details how each of the SES model phases (Seduce, Engage and Support) are supported by the AKN group, which could play the role of our KM Division. In fact, this is not a coincidence, since this work has been used on the our fictitious scenario elaboration.

4. Existing Supporting Technology for Knowledge Management in CoP's

One of the main objectives of Intentional Analysis is to investigate different possibilities of supporting KM practices, both by changing business processes and with the use of technology. As already stated, this work aims at eliciting the requirements of a software system to support KM processes. At first, we are especially interested in supporting the Newcomer on knowledge exchange but further work can also be done to provide monitoring tools for CoPs, among others.

As mentioned in section 3.2, it is important to take issues of trust and motivation into consideration. This way, we propose the adoption of the Distributed Knowledge Management paradigm [3], formulated in the context of the Edamok project (link). According to DKM, people share knowledge based on two principles:

- *Principle of Autonomy*: each unit (person or group) should be granted a high degree of autonomy to manage its local knowledge;
- *Principle of Coordination*: each unit must be enabled to exchange knowledge with other units not by imposing the adoption of a single, common interpretative schema but through a mechanism of mapping other units' context onto its context from its own perspective.

Examples of systems that adopt such approach are KEx [4] and Help&Learn [15]. Both systems are considered here as appropriate possibilities to support KM in CoPs. Other than these two, other systems can be analyzed in order to provide support for new elicited requirements. Among these, we highlight Ontoshare [6] and COMUTELLA [21], besides the tools mentioned as enabling technology by [14].

5. Mapping Intentional Analysis to AORML for KM System Design

Intentional Analysis basically adopts the same concepts and modeling constructs of Tropos (both are based on the i*framework). Therefore, this section will present a comparison of AORML [22] and Tropos [5], suggesting how the concepts of the latter may be translated into concepts and modeling constructs of the former. In general, we suggest that AORML is adopted for Tropos' architectural and detailed design phases.

The Agent-Object-Relationship (AOR) modeling approach [22][4] is based on an ontological distinction between active and passive entities, that is, between agents and objects. This helps to capture the semantics of complex processes, such as the one that involves teachers and students, owners and employees of a company, and other actors involved in a KM environment. The agent metaphor subsumes both artificial and natural agents. This way, the users of the information system are included and also considered as agents in AOR modeling.

Intuitively, some connections can already be identified between the knowledge artifacts in a KMS and objects, and between the KMS users and human agents. The KMS itself can also be composed of multiple software agents, which perform different tasks, accomplishing various goals, in order to mediate the processes of knowledge creation, integration and sharing. These agents can be identified and modeled with the aid of AORML.

In AORML, an entity can be an agent, an event, an action, a claim, a commitment, or an ordinary object. *Agents* and *objects* form, respectively, the **active** and **passive** entities, while *actions* and *events* are the **dynamic** entities of the system model. *Commitments* and *claims* establish a special type of relationship between agents. These concepts are fundamental components of social interaction processes and can explicitly help to achieve coherent behavior when these processes are semi or fully automated.

Only agents can communicate, perceive, act, make commitments and satisfy claims. Ordinary objects are passive entities with no such capabilities. Besides *human* and *artificial* agents, AOR also models *institutional* agents. Institutional agents are usually composed of a number of human, artificial, or other institutional agents that act on its behalf. Organizations, such as companies, government institutions and universities are modeled as institutional agents, allowing to model the rights and duties of their internal agents.

Similarly to AORML, the Tropos methodology [5] also use the notion of agent and related mentalistic notions in all software development phases, from early requirements analysis down to the actual implementation. This methodology also relies on Object-Oriented development from the architectural design phase downwards.

However, three main differences can be identified between AORML and Tropos:

- as an extension of UML, AORML is rather a modeling language than a methodology, like Tropos, though some methodological directions on how to use AORML for software development have already been identified in [22];
- Tropos gives a crucial role to the early requirements analysis phase that precedes the prescriptive requirements specification of the system-to-be. Though AORML has been proposed for domain modeling [15], it does not provide specific diagrams for requirement's specification (though traditional UML use cases diagram may be applied);
- Tropos adopts AUML for architectural and detailed design. However, AUML does not provide a rich model of the domain and system entities such as AORML. Using the agent diagram, for example, the designer is able to represent all agents and objects considered in the domain, along with their properties (analogously to an UML traditional class diagram).

[4] For further reference, we refer to the AOR website: http://aor.rezearch.info/.

These differences suggest that Tropos and AORML can be rather complementary than competing efforts. The i* concepts adopted in Tropos can be consistently mapped to AORML constructs, allowing them to be carried out farther from the requirement analysis to the design phase. Table 2 shows preliminary directions for this mapping.

Table 1. Direct mapping from Tropos' adopted concepts from AORML's modeling constructs

Tropos Key Concepts	Mapped Modeling Constructs in AORML
actor	agent
goal	-
plan	object / paths for interaction modeling
capability	set of objects or paths for interaction modeling representing plans
resource	object
dependency	commitment/claim
belief	object

An actor in Tropos models an entity that has strategic goals and intentionality within the system or the organizational setting. This concept directly maps to one of the three types of agents in AORML: human, artificial or institutional agent, depending on the its nature. On the other hand, Tropos' plans may be expressed as AORML's objects (if the designer feel it is important to represent this at design level). Or maybe more usefully, plans may also indicate paths for AORML's interaction modeling5. Capabilities in Tropos may be seen as a set o plans and, therefore, could be mapped for the set of objects or interaction modeling paths, representing the agent's plans. Analogously, resources that represent physical or information entities in Tropos become objects according to AORML conceptualization. Additionally, Tropos prescribes that goal dependencies between two actors indicate that one actor depends on the other in order to attain some goal, execute some plan, or deliver a resource. Such goal dependencies will lead to the establishment of AORML commitments/claims between agents. Finally, Tropos' beliefs can be typically mapped to AORML's objects. In fact, AORML models as objects both individual and shared agent's beliefs.

We believe the combination Tropos/AORML will be profitable in both directions. Specifically in respect to organizational or KM Systems modeling, Tropos would benefit from the following strengths of AORML: 1) it considers the organizations and actors of a domain as agents in the modeling process. In this way, it allows to model business processes on the basis of the interactions between (human and artificial) agents working on behalf of their organizations. Related work is mentioned in [9]. Although norms and contracts are not directly supported by AORML, it provides deontic modeling constructs such as commitments and claims with respect to external agents, and obligations and

[5] In AORML, this is done using one of the three diagrams: Interaction Frame Diagram, Interaction Sequence Diagram or Interaction Pattern Diagram, which focus on different aspects of agent's interaction. We should also remember that UML available diagrams, such as activity diagrams as suggested in Tropos, can be also used to represent capabilities.

rights with respect to internal agents. 2) the fact that 'mentalistic' concepts of agents, such as beliefs and commitments, are explicitly considered in system design supports the software engineer to reason about and to model the behavior of agents, both internally and in interaction with other agents of the system; 3) it captures the behavior of agents with the help of rules. Besides these strengths, since AORML is an extension of UML, preserving its principles and concepts, it is an accessible language, and it is likely to face less resistance for industrial acceptance and use. On the other hand, the explicit use of Tropos' goals and plans provide a rich conceptual framework for modeling processes and, as seen in section 3, the intentional dimension of the organization (Intentional Analysis). Such concepts of goals and plans are missing in AORML.

6. Conclusions and Directions for Future Work

In general, we have found Intentional analysis a rich methodology in guiding us on analyzing the intentional dimension of actors and organizations, towards the exploration for possible KM solutions. In this document, we have shown our first results, considering the social dimensions of our fictitious scenario. From now on, further steps are needed in order to accomplish our main goal of eliciting IS's requirements to support CoPs.

Although our analysis is still in a preliminary stage, we have already been able to identify a few deficiencies in the applied notation, for instance:

1. the notation does not consider mutual dependencies between actors. In our case, this can be exemplified in the context of the Newcomer and the CoP relationship, shown in Fig. 1 of section 3.1. The Newcomer's goal knowledge getting towards the CoP is, in fact, the same goal as knowledge providing from the CoP towards the Newcomer. In fact, in practice, both Newcomer and CoP rely on each other for getting new knowledge. It would be more appropriate to express this using a specific notation representing only one mutual goal.
2. In software development, it is much simpler to note differences between hardgoal and softgoal, since hardgoals are much more concrete. Since Intentional analysis focuses on the social dimension of actors and organizations, it is very hard to decide if a goal is measurable or not, because usually the measurement here will be qualitative. For instance, take the goals not overwork and work adjusting of diagram of Fig. 2, section 3.2. Why is not overwork a softgoal while work adjusting is a hardgoal? This choice seems here rather arbitrary.

As future work, besides carrying on our analysis taking the newcomer's perspective, we may also follow the directions already suggested in section 3.3 for modeling the points of view of other actors of our scenario (CoP and KM Division). Besides, we still need to clarify what is the role of the CoP leaders within the community, towards the community's members and newcomers. In this respect, we have not yet found much in the available literature related to KM and CoPs. Furthermore, mapping the results of our analysis into AORML for the design of a KM system seems to be an interesting standpoint that we aim to target.

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