Knowledge Elicitation and Modeling for eGovernment
a Practical Approach⋆

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Abstract. EGovernment is about dealing with knowledge by electronic means. Knowledge has to be collected, organized, shared, and made easily available to citizens and businesses, but also to the government employees.

Knowledge assumes different forms: explicit, encoded for example as laws, decrees, standards, policies, and tacit, embedded in the procedures and routines implicitly enacted by the communities of knowledge workers. To create value these different forms of knowledge have to be combined and made accessible.

We show how Requirements Engineering can be valuable in Knowledge Management for eGovernment, by means of some results from an on-going project about the extraction and analysis of the knowledge embedded in a set of local laws.

1 Introduction

Contemporary organizations, private and public, increasingly rely on their capability of managing and capitalizing their knowledge assets. For a private organization, being able to leverage its knowledge capital means being able to quickly react to external solicitations, also create new knowledge to innovate and compete in a changing environment [11]. Public organizations operate by transforming knowledge, i.e., elaborating knowledge (laws, norms, standards, procedures, administrative rules, etc.), to create and deliver knowledge (policies, regulations, decrees, authorizations, etc.). So, for a public organization, being able to leverage its knowledge capital means to able to provide better services to its customers, i.e., citizens and businesses. To generate value, however, knowledge needs to be collected, organized and shared organization-wide, through easily accessible, understandable, applicable and, above all, tailored to the specific needs, formats. Information and communication technologies (ICT) are crucial in this context.

ICT allow private sector organizations to operate in a knowledge-based network economy, where new alliances and relationships are continuously created (or terminated), and capabilities (production plants, selling facilities, R&D centers) are quickly

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spread or grouped according the business goals and the available opportunities [20, 11]. Similarly, ICT are at the basis of the advocated transformation of the public sector towards the eGovernment paradigm [16]. EGovernment means to exploit ICT to increase efficiency, while providing new and higher quality services, mainly through electronic delivery channels. In particular, eGovernment is about dealing with knowledge: knowledge has to be made available to citizens, to businesses, but also to the government employees. Simplicity, customizable formats, and high accessibility are the key factors.

Knowledge management (KM) is therefore widely recognized as a strategic organizational capability [15]. KM is about providing the right information, to the right person, at the right time: traditionally focused on turning raw data into workable and actionable information [15], KM tools and approaches are now required to deal with a softer kind of knowledge, i.e. to add value to the organization processes, data need to be coupled with experiences, lesson learned, employees' skills and ideas [17]. A highly valuable organizational resource is in fact represented by the flow of knowledge embedded in the (often implicit) procedures and routines underlying the organization functioning [12].

How to capture and represent this soft knowledge? How data can be coupled with experiences, skills and ideas? How can we make knowledge electronically manageable?

To address such issues, we argue that an interesting role can be played by methods and approaches recently suggested in the Requirements Engineering (RE) field [18, 5, 23]. In particular, we show how RE-derived techniques can be valuable in KM for eGovernment, by illustrating some results from an on-going project concerned with the extraction and analysis of the knowledge embedded in a set of laws.

The idea is to merge information from textual sources (laws) with soft knowledge (experiences, point of views) provided by the user, to build a knowledge repository suitable to: a) allow an effective perspective-based navigation, facilitating access for not skilled users; b) provide support for a normative evolution towards a unified framework, by providing a comprehensive overview of the subject, and highlighting possible conflicts and synergies; c) represent a first step towards an automatic support.

The paper is organized as follows. Section 2 discusses similarities between RE and KM needs. Section 3 introduces the application domain of our reference project. Section 4 briefly introduced an advance RE framework (REF) [9, 3, 10], which has been adopted as knowledge elicitation and representation tool during the project. Sections 5 describe the application of REF in the project. Finally, Section 6 discusses the results.

2 Requirements Engineering for knowledge elicitation

RE is concerned with the definition, formalization and analysis of the requirements that a potential information system must have to accomplish organization specific needs. Traditionally, RE has focused mainly upon the system and its interactions with the users. Recently RE has adopted a broader perspective to encompass the systems application context. By treating the system and its context as a larger social-technical system, and focusing on its overall needs, in fact, the analysts not only are better equipped to identify the right system, but also to improve the context to fully exploit the new system capabilities [18, 5, 23]. Consequently, appropriate knowledge elicitation techniques and

representation formalisms have been suggested to support the analysts in dealing with the complex issue of capturing high level organizational needs and transforming them into system and organizational requirements.

As discussed above, the functioning of a complex organization is characterized by organization-embedded knowledge, i.e., knowledge tacitly owned by the communities inside the organization that spontaneously emerges through employees interactions. For example, a group of employees, which shares the common experience (or knowledge by practice) on how to deal with a specific bureaucratic procedure, recognizes itself as having this knowledge. Yet, making it explicit is definitely a hard (and sometimes unwanted) task. So, knowledge transfer is almost impossible to achieve, because, first of all, knowledge identification is denied in principle. The only way to lead these communities to define and thus share their knowledge also outside their boundaries is by improving their capability of analytically, and not only instinctively, apply such a knowledge: enhancing the consciousness of this knowledge is a good vehicle to this end.

Such an issue is very similar to the one that RE wants to address. In both cases, the aim is to capture, make explicit and treatable, the soft knowledge owned by an organization and its communities of *knowledge workers*. In both cases, in addition, the interdependencies among the different actors of the organization have to be recognized and analyzed, in order to identify and understand the embedded knowledge flows, from which the sharable pieces could be extracted.

3   A case study

In this paper, we illustrate our RE-based approach to KM in the context of the project *Fortis*, concerned with innovation in forest domain. In particular, we focus on the part of the project related to the understanding and improvement of the legislative regulation of socio-economical aspects of the forest domain in the Province of Trento (Trentino).

The management of the forest areas is far from being an easy task. In the last decades, the economical role of the forests has been significantly modified. Now, the role of forestry does not relate only to timber production, but also to other functions, such as non-wood products (mushrooms and other small fruits gross production), watershed protection, biodiversity preservation, oxygen supply and outdoor recreation [19].

Thus, when considering the forest economical domain, we need to take into account many different stakeholder (e.g., forest owners, associations for environment, Provincial Forest Service, contractors) with different needs, opinions and points of view.

In Trentino, the forest has always represented one of the essential components of local history, both from the economical and the social point of view. In Trentino, forests management is regulated by the Province Autonomous of Trento. In the last forty years, many provincial laws, regulations, and decrees about forests have been issued, and currently the need of a Unified Body of Laws is becoming more and more compelling.

In this context, one of the objectives of the Fortis project is to provide an analysis of such a set of laws and decrees, and to integrate and compare the results of such analysis with the points of view of the economical operators in the forest sector[4].

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[4] To collect such perpectives, more than 200 face-to-face interviews with forest owners and managers have been carried on [4], even if, here, we do not report on this part of the project.

4 Introduction to REF

The RE approach adopted to elicit, classify, and analyze the legislative knowledge in the context of the project Fortis, is REF.

REF [10, 2, 3] is a Requirements Engineering Framework designed to deal with, and reason about, socio-technical systems. Here, the software system and its application context form a larger human and technological system that has to be treated and analyzed as a whole, and the overall needs are the ones to be fulfilled [13, 22]. Complexity of socio-technical systems goes beyond working procedures and the complexity of the software system itself: it encompasses the complexity generated by the impact of the system upon the organizational structure, from the business process, to the behavior of the single employee. The basic idea behind REF is to provide the analyst with the right tools to capture the high-level organizational needs and transform them into organizational and system requirements. Application context has in fact often to be adapted in order to exploit the capabilities of the new system. Key factor of REF is visualization; the visual impact of the adopted notation makes it a useful means of communicating knowledge, and a useful repository for collecting knowledge.

REF tackles the modeling effort by breaking the activity down into more intellectually manageable components, and by adopting a combination of different approaches, based on a common conceptual notation. *Agents* are used to model the organization [8, 14, 23]. The organizational context is modeled as a network of interacting agents, collaborating or conflicting to achieve both individual and organizational goals. *Goals* [21, 1, 7, 23] are used to model agents' relationships, and, eventually, to link organizational needs to system requirements. A distinction is made between *hard goals* and *soft goals*. A goal is classified as *hard* when its achievement criterion is sharply defined. For example the goal "*document be available*" is hard, being easy to check whether or not it has been achieved. For a *soft* goal, instead, it is up to the goal originator, or to an agreement between the involved agents, to decide when to consider the goal as achieved. For example, the goal "*document easily and promptly available*" is a soft goal, due to the very subjective nature of the achievement of quality issues like "easy" and "prompt".

Distinguishing between *Goal Modeling* and *Organizational Modeling*, and then further between *Hard Goal Modeling* and *Soft Goal Modeling*, is a key aspect of REF, and helps reducing the complexity of the modeling effort. These activities are part of a cyclic flow, and are supported by a continuos interaction with the stakeholders (Figure 1).

During the *Goal Modeling* phase (Step (a)), the soft and hard goals discovered during organization modeling are refined in terms of more elementary goals, tasks and constraints. In particular, Hard Goal Modeling seeks to determine how an agent thinks to achieve a hard goal, by decomposing it into more elementary hard goals and *tasks* (where a *task* is a well-specified prescriptive activity). While Soft Goal Modeling seeks to determine how an agent thinks to achieve a soft goal, by decomposing it into more elementary subordinate soft goals, hard goals, tasks, *resources* [23, 6], and *constraints*. In other terms, Soft Goal modeling aims at producing the operational definitions of the soft goals, thus soft goals refinement has to be reiterated until only hard goals, tasks, resources and constraints are obtained (that is, until all the soft aspects are dealt with). Both soft and hard goals are refined by repetitively asking the agents what they needed
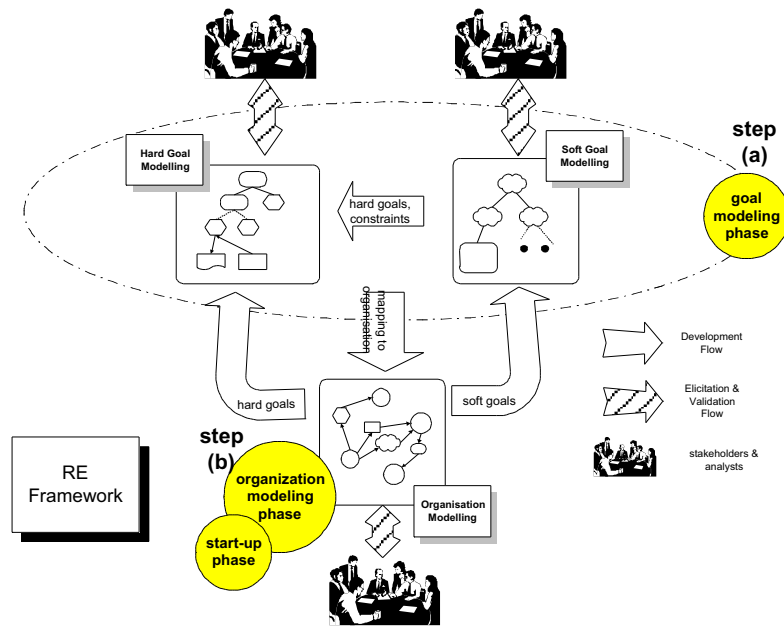
Fig. 1. The REF cycle.

to know, to perform, have delivered or have performed in order to consider the goal as achieved (and by whom, leading in this way to the identification of new agents).

During the *Organization Modeling* phase (Step (b)) the analysts use the information gained during the previous step (see the "mapping to the organization" arrow in Figure 1) to enrich and extend the initial organizational model: i.e., to replace the goals with their models, and to introduce the new agents identified as relevant to achieve those goals. New agents usually lead to new goals, triggering the goal-modeling phase again.

Such a cycle is continued until the desired (and needed) level of details is reached. REF process evolves, as show by the shaded arrow in Figure 1.

5 Applying REF to knowledge elicitation

REF is designed to support the identification of the requirements of a new systems starting from the high level organizational needs.

For our purposes, i.e., to propose a preliminary analysis of the set of laws, decrees, and regulations of the forest sector, we need to focus, here, on the preliminary step of the REF process (the start-up phase), required to draw a first organizational model.

Drawing such a model is indeed very critical and crucial. A good —proper and precise— initial model is essential to solve ambiguities and guarantee a faster convergence towards the desired knowledge model, representing the textual facts (laws), capturing the relevant experiences (tacit knowledge), and establishing the basis for further
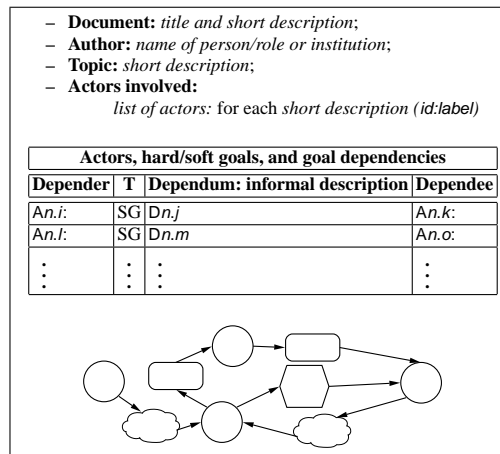
- **Document:** *title and short description*;
- **Author:** *name of person/role or institution*;
- **Topic:** *short description*;
- **Actors involved:**
    list of actors: for each *short description (id:label)*

Actors, hard/soft goals, and goal dependencies			
Depender	**T**	**Dependum: informal description**	**Dependee**
A*n.i*:	SG	D*n.j*	A*n.k*:
A*n.l*:	SG	D*n.m*	A*n.o*:
⋮	⋮	⋮	⋮

Fig. 2. The elicitation template.

and deeper analysis of the forest sector regulations (detect possible conflicting situations, suggest potential solution, and encompass more stakeholders needs).

5.1 A general schema for knowledge elicitation

Several methods and techniques can be used in order to support the start-up phase, including drawing the model while carrying out the activity of knowledge elicitation. While this could be feasible for small or medium sized cases, especially when the analysts are experts in both the RE technique and the domain, in more realistic cases, it is advisable to structure the knowledge elicitation activity by applying well-defined rules. For example, when the number of actors and dependencies increases with the complexity of the domain (and with the amount of available source documents), or when the analysts need some guidelines (e.g., because having little knowledge of the domain). In the Fortis project, due to the complexity and particularity of the domain, we adopted a methodical approach to collect knowledge, before starting to draw any model.

Thus, we introduced a method to help ourselves, as analysts, and the stakeholders, to organize all the collected information, as, e.g., actors, dependencies, high level requirements, source documents involved, and so on. The method is based on the template in Figure 2, and aims at reducing the gap existing between the requirements/knowledge engineer, and the stakeholders, who may have some difficulties in understanding the transition from their knowledge to the REF graphical models. It is crucial to fill this gap, to reduce misunderstanding and interpretation mismatches between the stakeholders and the analysts, but also to stimulate the stakeholders participation.

The process to fill the template (Figure 2) is straightforward. First, by reading the document (the law or decree), all the relevant data, such as the title, authors and main topic, can be easily identified and reported in the template. Then, the REF items (actor, goal, resource, task) and their dependencies can be identified by carefully reading the

Fig. 3. Example of annotation of a law.

text and underlining their occurrences (see Figure 3). The found actors are listed in the template, while the dependencies are describe in its tabular part. In this phase, a unique label (a short description or acronym) and a unique ID have to be assigned to each item.

This approach has several advantages, among others:

Stakeholders' acceptability. Many stakeholders prefer to deal with tables, as, for some aspects, could be easier to browse them than the corresponding diagrams.

Better understanding of the terms. There are multiple stakeholders involved in the RE process, each with different background, skills, knowledge, concerns, and perception of the problem. It may happen that diverse stakeholders have different interpretations even of very simple terms. The adoption of a tabular format, aside the diagrammatic one, allows them to identify the items that have the same meanings.

Finally, the last step for filling the template consists in representing the tabular information in the diagrammatic format, i.e., the REF organizational model.

The final result is a full portrait of the law through different but complementary formats (i.e., the table and the diagram), which support a better validation by the user.

At the current stage of the project Fortis, we have already developed a quite comprehensive REF model of the forest sector provincial legislation, covering more than 10 different laws and decrees [4]. Here, we can present only a very small portion of it. In particular, we show how the described REF-based approach has been applied for analysing and describing a specific decree of the President of the Provincial Committee. Describing the legal scenario in terms of REF organizational models allows us for a precise account, so that a deep analysis of the related knowledge can be carried on.

5.2 Doc.8: Decree of the President of the Provincial Committee 20/1/1997, n.2-46

The Decree D.P.G.P. 2-46/97 rules the circulation of motor-vehicles on forest roads in Trentino. In particular, it defines how to apply for and issue authorizations to drive

- **Document:** D.P.G.P. 2-46/97 2-46/97 and following modifications. Provincial Law 23/11/1948 and following modifications - modification of the regulations for the release of authorizations to transit on forest roads not used for exclusive service of forests, approved of with 24 D.P.C.P. June 1994, n. 7-5/Leg.
- **Authors:** President of Provincial Committee
- **Topic:** transit of motor-vehicles on forest roads
- **Actors involved:**
  - Having the right of civic use (A8.1: Having r.c.u.);
  - Forest service office in charge of the territory (A8.2 Forest office);
  - Management body or owner of forest service roads which doesn't have adequate resources for public contact (A8.3: Man.b.o. w/out res.);
  - Commune where forest service roads are (A8.4: Commune str.);
  - Person requesting authorization to use forest service roads (A8.5: Person);
  - Owner of forest service roads (A8.6: Owner f.road).

| Actors, hard/soft goals and dependencies			
Depender	**K**	**Dependum**	**Dependee**
A8.6: Owner f.road	SG	D8.1: to guarantee proper use — To guarantee the proper use of forest service roads.	
A8.6: Owner f.road	G	D8.2: to establish rules aut. — To establish rules and procedure for giving authorizations.	
A8.1: Having r.c.u.	R	D8.3: permit — To have a permit to use forest service roads.	A8.6: Owner f.road
A8.6: Owner f.road	G	D8.4: to authorize circ. — To authorize unrestricted use of forest service roads during festivals.	
A8.2: Forest office	G	D8.5: to know aut. — To have knowledge of unrestricted use of forest service roads during festivals.	A8.6: Owner f.road
A8.5: Person	R	D8.6: authorization — To obtain the authorization for using forest service roads for motor vehicles.	A8.6: Owner f.road
A8.6: Owner f.road	R	D8.7: personal data — Model of motor-vehicle, number of plate, motivations, etc.	A8.5: Person
A8.3: Man.b.o. w/out res.	T	D8.8: to give aut. — To give authorizations to use forest service roads for motor vehicles.	A8.4: Commune str.
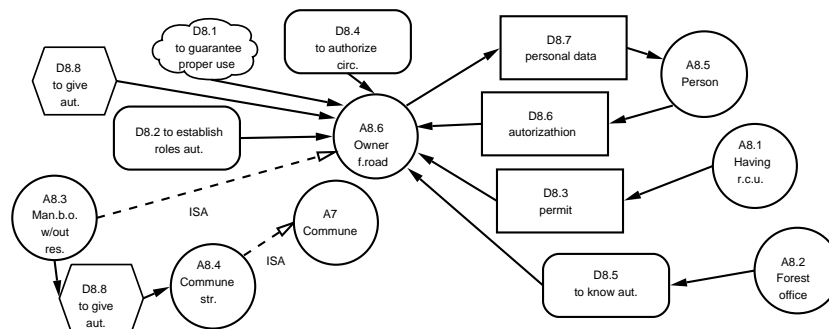
Fig. 4. The filled template for the Decree D.P.G.P. 2-46/97.

motor-vehicles on forest roads. By analysing the decree, the template in Figure 4 has been obtained. It describes the knowledge derived from the analysis, i.e., the list of the emerging actors, their dependencies, and the corresponding REF model.

According with the process illustrated in Section 5.1, the analysis has been carried on, first, by means of a careful reading of the decree itself. Figure 3 reproduces a portion of the decree, in which relevant sentences or terms have been underlined, to better

extract all the references to the actors and their dependencies. The template reproduced in Figure 4 contains the final result of the analysis.

In the diagram provided in Figure 4, the actor A8.6: Owner f.road represents a generic owner of forest service roads. S/he has to achieve the two hard goals D8.4: to authorize circ. and D8.2: to establish rules aut., the soft goal D8.1: to guarantee proper use, and the task D8.8: to give aut. (see Figure 4 for an explanation of these labels).

The actor A8.5: Person —representing a generic citizen who wants to drive a motor-vehicle along a forest service roads— depends upon the Owner f.road for the resource —actually, a filled form— D8.7: authorization to drive. At the same time, the Owner f.road depends on Person to obtain all the data (resource D8.7: personal data) that s/he needs to give the authorization (fill the form).

The actors A8.1: Having r.c.u. and A8.2: Forest office depend on Owner f.road for the resource D8.3: permit and the hard goal D8.5: to know aut., respectively.

Finally, let us consider the dependency among the actor A8.3: Man.b.o. w/out res. (management body or owner of forest service roads which does not have adequate resources for public contact, in order to handle the authorization process) and A8.4: Commune str. (the Commune where the road is located). Man.b.o. w/out res. is defined as a kind of (see the *ISA* dashed arrow) Owner f.road. Because it is not able to issue authorizations, it has to delegate this task (D8.8: to issue aut.) to Commune str. Of course Commune str. is defined as a kind of A7: Commune.

5.3 Initial model refinement

Up to here, we have shown how to obtain an initial organizational model in REF. The development cycle of REF has then to be developed, as introduced in Section 4. In the following, we continue our presentation of the REF process exemplifying only few simple steps of organizational modeling, with the aim of showing how this activity, as well as the other REF activities, may support knowledge elicitation, and, in particular, is a valuable tool to help discovering tacit, or implicit, knowledge.

The diagram produced since here, simply derived by reading the Decree D.P.G.P 2-46/97, may lead the analyst to be curios about the possibility that an owner of forest service roads does not have adequate resources to issue authorizations.

Which are these cases? It may be important to clarify this point, to obtain a clear picture of the situation. To this end, the analyst may decide to obtain more details about the real scenario: s/he guesses that some tacit knowledge (not directly emerging from the decree) that some stakeholder may have, could explicitly be represented in the diagram, not only for the owner of the tacit knowledge, but also for the other stakeholders.

Interviewing a stakeholder, some clarification may be obtained, e.g., about the fact that private individual owners may not be able to issue authorizations by his/herself. At the same time, it may also be mentioned that even the Commune itself may own forest service roads. Apparently satisfactory, this new piece of knowledge is reported in a new organizational diagram (see Figure 5). Here, the new actor A8.7: Commune owner —a Commune which owns forest service roads, that are located in its territory, of course— is represented as a kind of (ISA) both Commune str. and Owner f.road. In this way, the diagram in Figure 5 may lead to an inconsistency. Let us assume that a Commune owner does not have the adequate resources to issue authorizations (no evidence that
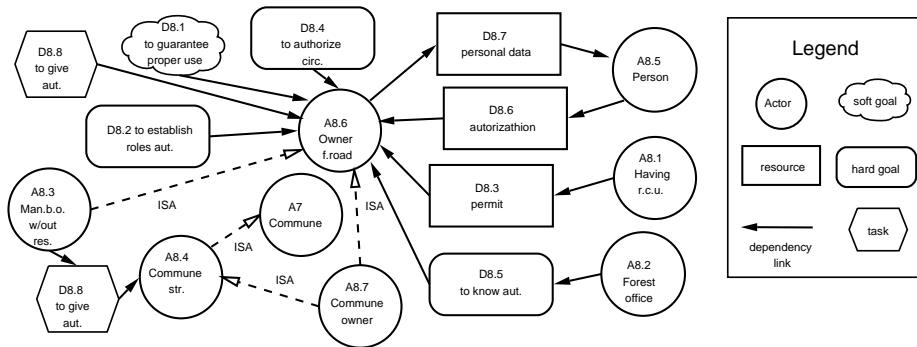
Fig. 5. Revising the initial organizational model.

this cannot happen can be found in the decree), thus, that it is a Man.b.o. w/out res. In this case, accordingly with the diagram, we had that this Commune has to delegate the task of issuing the authorizations to the Commune where the street is locate, i.e., to itself —an evident nonsense!

The solution to this (apparent) inconsistency is quite easy, and quickly derivable simply by using common sense (but tacit) knowledge: every Commune has adequate structures to issues authorizations. Indeed, a Commune is, by definition —given in some Italian laws not included in those considered in the Fortis project— the smallest administrative territorial unit. The correct scenario is depicted in Figure 6. Here, it is explicitly shown that every Commune has adequate resources for public contact (A7: Commune ISA A6: Man.b. with res. —Management body which has adequate resources for public contact), and, thus, that Commune owner ISA[5] A8.8: Man.b.o. with res. — Management body or owner of forest service roads which has adequate resources for public contact— which, by definitions, has to be disjunct from A8.3: Man.b.o. w/out res.

Of course, for the sake of simplicity, the case presented above is trivial: our aim, here, is just to give an example of how the organizational modelling process in REF may help to discover otherwise implicit, hidden knowledge, also by adopting, to some extent, some kind of consistency checking of the temporary knowledge models. The resulting models, obtained through the REF validation and verification cycle, represent an increasing —and step after step more and more complete and precise— body of explicit knowledge, promptly available not only to the owner of the original knowledge, but also to the other stakeholders involved in the project.

6 Conclusions

In this paper we have shown how an advanced RE framework (REF) —designed to deal with organizational knowledge— can be adopted to propose a practical approach to the complex task of knowledge elicitation, by means of which both tacit and explicit knowledge can be described, combined, and made easily accessible.

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[5] This ISA relationship is derived by reasoning: a different dashed line is used to denote this.
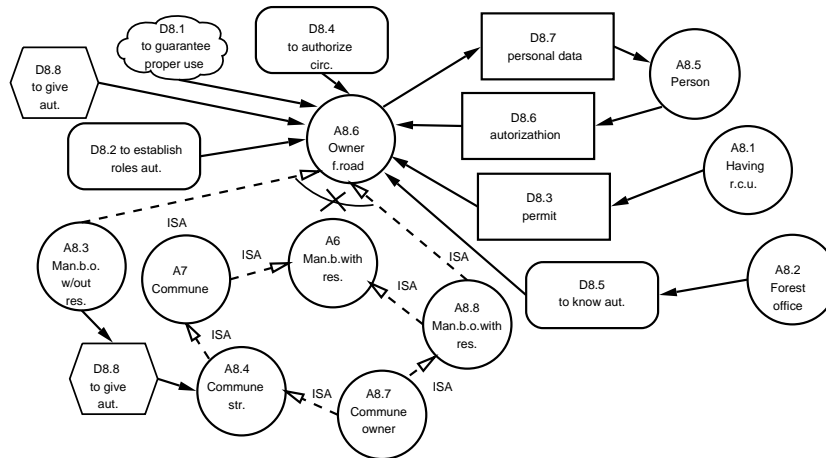
Fig. 6. Revising the organizational model: detecting inconsistencies.

The approach has been illustrated while applied to extract the knowledge from a set of local laws. The adopted example is a small extract from an extensive project, the final result of which is a comprehensive model of the forest management sector in the Province of Trento.

The modeling mechanisms provided by REF —based on the notions of *agent*, *goal*, and *dependency*— combined with a customized elicitation technique, have resulted to be an effective tool, not only to understand and analyze the network of interdependencies that the set of laws create among the different actors of the forest management sector, but also to resolve ambiguities by encompassing the soft knowledge (experiences, point of views) provided by the user.

The result of the project represents a structured and well-formalized knowledge repository (crucial for future automatic support), suitable to allow for an effective perspective-based navigation (i.e., an actor, for example a Commune or a citizen, can more efficiently navigate the knowledge structure according to its specific needs and perspective), to facilitate access for not skilled users, and to provide support for a normative evolution towards a unified framework, by providing a comprehensive overview of the subject, and highlighting possible conflicts and synergies. Future work will address these aspects.

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