REQUIREMENTS AND MODELLING OF A WORKSPACE FOR TACIT KNOWLEDGE MANAGEMENT IN RAILWAY PRODUCT DEVELOPMENT

Diana Penciuc, Marie-Hélène Abel
Alstom Transport, 93400 Saint Ouen, France
diana.penciuc@transport.alstom.com
Heudiasyc CNRS UMR 6599, University of Technology of Compiègne, BP 20529 , 60 205 Compiègne, France

Didier Van Den Abeele
Alstom Transport, 93400 Saint Ouen, France

Keywords: Tacit Knowledge, Knowledge Management, Organisational Learning, Organisational Memory, Railway Products Development, Product-line Development.

Abstract: Our work is focused on finding ways to foster tacit knowledge in the context of a company providing railway transport solutions. Our study refers to a specific process of railway product development, context in which, we consider the problem of tacit knowledge as a concern of organisational learning. We present our findings on the requirements and modelling of a workspace supporting tasks of the process considered and sustaining both organisational learning and tacit knowledge management.

1 INTRODUCTION

Modern large-scale companies are more and more dynamic and rise to the increasing customer demands by continually coming up with innovatory products. It becomes important to minimize the production cost of new products by shortening the product life cycle. One method of achieving this is reusability of not only the existing formalized knowledge (e.g. architectures), but also the knowledge that employees gained after years of experience.

This paper focuses on finding ways to discover, store and reuse this knowledge, referred to as *tacit knowledge*.

Product-line engineering is a method of creating products in such a way that it is possible to reuse product components and apply planned variability to generate new products. This yields to a set of different products sharing common features (Birk 2003). These common features are summed up in a core or a "reference platform" and used to engineer each of the products in the product-line. A few examples of commonalities (core assets) are: architecture, software components, documents etc. The advantage of the product-line engineering lies in the reusability of this "reference platform", which leads to significant gains, such as engineering work reduction, time-to-market and costs reduction, or improved quality.

This paper addresses the case of an international company providing railway transport systems. Railway market is characterised by a great diversity and dynamics of demands guided by the customer's background (e.g. habits, historical reasons), evolving technologies, competitors etc. In the context of this heterogeneity, having a "reference platform" brings considerable improvements, but it cannot perfectly match each request. Thus, the problem of adapting it appears.

When responding to a customer's demand the core has to be properly adapted in order to map the specific needs of a customer. Adapting the reference platform relies not only on its explicit definition or adaptation rules, but also on the tacit knowledge (Polanyi 1966) of the employees, on non-formalized practices and exchanges between employees etc. As this knowledge is volatile, it can be easily forgotten,

Penciuc D., Abel M. and Van Den Abeele D..
REQUIREMENTS AND MODELLING OF A WORKSPACE FOR TACIT KNOWLEDGE MANAGEMENT IN RAILWAY PRODUCT DEVELOPMENT.
DOI: 10.5220/0003100000610070
In *Proceedings of the International Conference on Knowledge Management and Information Sharing* (KMIS-2010), pages 61-70
ISBN: 978-989-8425-30-0

put aside or ignored; contrary to explicit knowledge it cannot be stored and reused, and therefore cannot constitute a lasting capital for the firm (Boughzala and Ermine 2006). Past decisions, lessons learnt, customer specificities and solutions to specific problems are a few examples of knowledge that may be lost. Consequences of this fact are: spending time to reinvent past or existing solutions, repeating mistakes from the past. Once codified, this knowledge could be a source for improving existing practices, avoid re-iteration and reinforce the "re-use" strategy.

Our goal is to find a solution for managing tacit knowledge involved in the process of adapting the "reference platform". A set of 40 employees was interviewed, and data gathered from their answers. Data revealed the need for tacit knowledge management. An analysis of this need led to a set of requirements for a future knowledge management platform and the proposal of first solutions.

The paper is organized as follows. First, we provide the context of our work. Next, we present the analysis of needs we carried out through interviews and emphasize the need of a workspace dedicated to managing tacit knowledge and supporting organisational learning. Then we discuss background information on Enterprise 2.0 technologies and the MEMORAe approach to organisational learning, in order to justify our choices. In the final part we present the requirements and first modelling of the proposed workspace. We conclude with future directions.

2 CONTEXT

It is a fact that one of the most critical processes of product development is "Tendering". This process is triggered as a consequence of a request for proposal (RFP) announcement and its purpose is to build a formal offer that will be submitted to the customer. It is an early stage of product development with a significant influence on contract establishment and success of the final product. Furthermore, decisions taken here often cannot be changed and time allocated to this process can be very short (up to six month).

For these reasons, our research is focused on analysing the "Tendering" process and providing knowledge management solutions adapted to this process needs.

2.1 The "Tendering" Process

The study was carried out in the company A. Its mission is to provide solutions for railway transport management.

In the following, the stakeholders and the workflow of the Tendering process are described.

Stakeholders are the customer and the "ad-hoc teams" of companies competing to obtain the contract. In general, in a railway context, the term "customer" may stand for:

- The demander (a society demanding a railway product, local authorities),
- The consultant (the demander can employ a consultant to write its demand),
- The operators of the railway system,
- The final users (voyagers).

Through this paper, the term "customer" will be used to refer to parties involved in specifying the request for proposal (RFP), which encompass the first three above mentioned categories. "Ad-hoc teams" are built according to the specificity of each offer. Functions of the members are related to: technical, commercial, planning, and support to the Tendering process.

Figure 1 presents a simplified workflow of the "Tendering" process within the studied Company A, competing with the Company B to obtain the contract of a customer.

In the company A, comparing the demand with the reference solution leads to the building of a customer solution reflected in the offer. Understanding of the RFP and customer's need is an iterative activity which results in several successive proposals coming from the two companies (*OfferA1, OfferB1*;…;*OfferAn, OfferBn*).

The customer then chooses the company proposing the most convenient offer and the Tendering process ends with negotiations and contract with the chosen company.

Given the complexity of this process and the diversity of specific knowledge coming from the various disciplines, we have decided to limit our study to the technical aspects of the "Tendering process". These are presented in more details in the following section.

2.2 Technical Analysis

The purpose of the *technical analysis* is to understand the technical requirements of the customer and to propose an appropriate solution/system to answer the demand.

The entry of this activity is the technical part

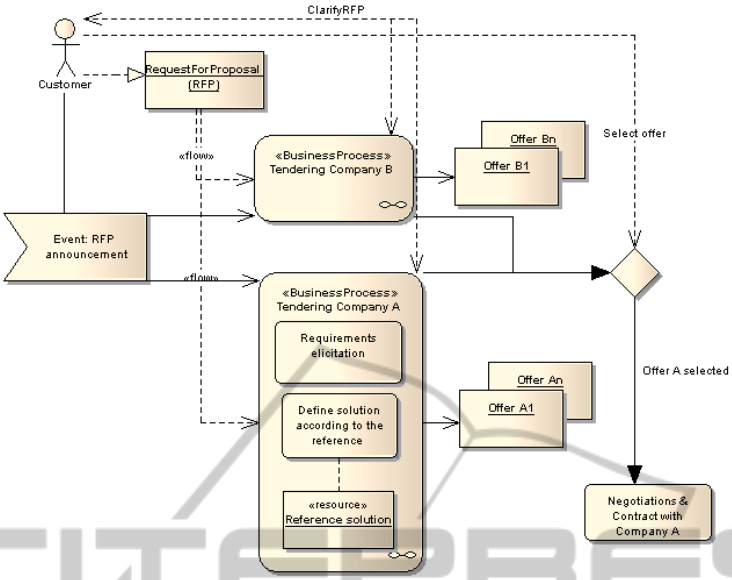

Figure 1: Tendering process in Company A competing with Company B.

of the RFP and knowledge acquired during a previously-made rough analysis of the RFP. The RFP consists of any type of resources used by the customer to specify his need. Typical resources are one or more paper or digital documents containing text and graphics or images, but they can be videos as well.

The result of the activity is a "Technical Answer" of the offered system comprising mainly the architecture of the system, the specification of the requirements as understood by the team, the compliance with the demand and the cost of the solution.

Technical requirements analysis is accomplished by collaboration between multiple stakeholders. The actor managing this activity is the Tender Technical Manager who will select a number of collaborators according to the needs of a specific offer. The so-formed team will comprise key actors of the development of a system: suppliers, subcontractors, system engineers, etc.

Activities to accomplish are:

- Clarify requirements in the RFP.
- Identify gaps between the requirements and the reference solution and determine which of the gaps can be resolved.
- Determine how reference solution can be adapted.
- Define the design of the system.
- Identify work breakdown structure.
- Decide on the cost of the solution.

Requirements are allocated to each team member according to their mission and results are shared with the Technical Manager. Division of work and collaboration are important as the knowledge of the participants is complementary and sharing their knowledge helps the team to converge faster to an adequate solution.

Choice of the proposed solution is based not only on the knowledge of the reference solution, but also on the experience and know-how of each member of this team. Experience and know-how are often lost as they are not capitalized and therefore represent a loss for the company's individual and collective memory. Loss appears in several situations: a) an expert leaves the company and knowledge is lost forever or b) knowledge is stored in the inactive part of the memory and therefore is not actively used. This latter is due to the unshared knowledge (individual written/unwritten knowledge), to difficulties to locate existing knowledge, or to ignorance. On the contrary, once capitalized, knowledge would serve as a means to speed-up the *Tendering* process, to improve practices for future offers, to trigger new knowledge and to support apprenticeship. Benefits are two-folded: boost individual knowledge as well as collective knowledge resulted not only from the sum of individual knowledge, but also from the added-value of the collaboration between individuals.

To accomplish this, members should be helped not only on their individual tasks but also on the collaborative ones. In order to understand how this could be accomplished, a set of needs were

identified through a better understanding of the tendering process and particularly of the *Technical analysis*.
These needs were further used to determine how knowledge management could respond to the problems previously mentioned.

3 ANALYSIS OF NEEDS

As stated before, success of a customer solution is due to: a good adaptation of the reference solution and learning and understanding customer's need. Figure 2 details the contribution of these elements by highlighting the explicit (represented by squares) and the tacit ones (represented by ellipses).

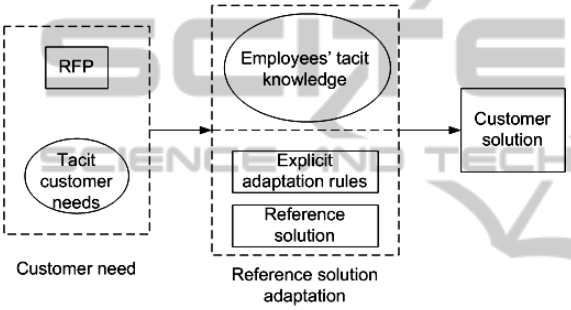

Figure 2: Role of explicit and tacit knowledge in finding a good customer solution.

The adaptation of the reference solution is based not only on explicit rules but also on tacit rules dictated by employees' tacit knowledge. Knowing customer's need implies understanding the need expressed explicitly in the RFP but also the un-written, un-said need which may be learnt by asking questions, observation etc.
To summarize, three factors are determinant for the success of a customer solution: 1) the employees, 2) the reference solution and its adaptation to a demand and 3) the knowledge about a customer.

In order to better understand how these three factors impact the "Tendering" process and the technical analysis, a study of the internal environment has been undertaken using interviews. Details about interviews data and results are exposed in the next paragraphs.

3.1 Interviews Data

From the sample of 80 employees selected, 40 of them agreed to collaborate. Employees have been selected from different divisions and with different functions, which allowed to have a diversity of opinions and a much deeper understanding of the business. Divisions considered were Tender group and its links to other divisions contributing to carry out activities during tender: finances, platform group etc. The subjects were selected based on the suggestions coming from the management and from the already interviewed employees.

Therefore, we selected a set of 15 questions directed to find out more about:

1. Employee's professional profile and daily work.
2. The reference platform and its adaptation to a customer request.
3. Knowledge about the customer and its demand.

The first category grouped topics related to the employee's mission and tasks, tools and resources used to accomplish his job, knowledge critical for his job, relations to other people.

The second category listed questions correlated to the elements of a reference solution, problems of adapting it to a customer demand, ways of improving the reference solution and its adaptation, and performance indicators of the reference solution and adaptation process.

Questions in the third category were directed towards finding the characteristics of a request for proposal, revealing problems related to the understanding of the RFP, and determining the elements impacting the adaptation of the reference solution to the request stated in the RFP.

3.2 Interviews Results

The results of our interviews are two-folded:

- A number of activities impacted by prevalent tacit knowledge use were identified.
- Specific needs were identified.

In what the first matter concerns, the selection criteria consisted in the degree of human contribution in accomplishing the activities. By way of illustration, we cite: "capture customer needs", "estimate risks", "identify gaps between the reference solution and the demand of the customer".
As regard to the technical analysis, Table 1 summarizes the results of the interviews and underlines several issues which need to be improved.

The study revealed that a heterogeneity of tools/methods are used to accomplish technical analysis, which does not allow a rigorous capitalization of knowledge. Informal knowledge coming from individual work and informal exchange (e.g. meetings) may be lost, as they are not

Table 1: Interviews results and issues that need to be improved.

Category	Overall results/observations	Identified needs
Employee's professional profile and daily work	Observations may be captured on personal paper notebook or computers Customer and technical team of the company do not necessarily use the same vocabulary Customer and technical team do not have the same vision on the system Synchronizing work between the members of the team is difficult Communication is accomplished mainly through emails, meetings or telephone Good anticipation is crucial as time is short	Need for a common vocabulary Need for a tool to improve communication and capitalisation of key knowledge (past experience, etc.) Need to better and faster locate previous experience
The reference platform and its adaptation to a customer request	Choices made when adapting the reference solution not always formally justified Better understanding of the customer could reduce gaps and risks Not easy to anticipate the impact of modifications to be made to the reference solution in order to adapt it to a demand; but, lessons-learnt could ease decision-making Decide the balance to keep between reference maintenance and customer satisfaction is difficult	Need to capitalise choices made, decisions Need to better understand customers in order to prepare a more easy-adaptable reference solution Need to better handle the complexity of the reference solution
Customer experience	Return on experience not systematically captured and shared during the process or from one offer to another RFP may evolve in time; RFP traceability not well performed Customer's context and use of the system should be well captured	Need to better capitalise the history of a client Need to capture more knowledge elements not written in the RFP or elsewhere

systematically registered.

Observations showed that a common workspace supporting individual and collective work during the technical analysis is needed, although it does not exist today. This will sustain formal and informal exchange of knowledge.

Existing technologies were studied in order to establish the basis for the future workspace.

4 RELATED WORK

The preliminary study of the Technical analysis revealed the importance of a workspace enabling knowledge capitalization, sharing and new knowledge creation.

Moreover, it clearly showed the importance of tacit knowledge and collaboration in accomplishing tasks during Technical analysis.

The way collaborators are chosen, decisions are taken, priorities are identified, anticipation is accomplished, are all issues of tacit knowledge. (Nonaka and Tackeutchi, 1995) consider that through socialization, the barriers of tacit knowledge can be overcome and knowledge transmitted to others and thus become a collective good.

For all these reasons we can affirm that we are facing a problem of *organisational learning* and therefore we are seeking for appropriate means to challenge it. Indeed, according to (Zhang 2003), an organisational learning process is 3-folded and concerns three processes: individual learning, social learning (allowing collaboration between individuals) and knowledge management.

Considering this, we chose to examine Enterprise 2.0 technologies and MEMORAe (Abel 2009a), an approach to support organisational learning.

4.1 MEMORAe

The aim of MEMORAe is to construct operational links between e-learning and knowledge management in order to build a collaborative learning environment. In order to do so, this approach associates: knowledge engineering and educational engineering; Semantic Web and Web 2.0 technologies (Leblanc, 2009). The underlying

concept for the knowledge management is the organisational memory, which Dieng (Dieng, 1998) defines as an: "explicit, disembodied, persistent representation of knowledge and information in an organization, in order to facilitate its access and reuse by members of the organization, for their tasks". By adapting this concept to the learning process, the concept of Learning Organisational Memory was proposed and its implementation uses ontologies that index learning resources. Social processes in exchange, are facilitated by Web 2.0 technologies.

The advantage of the MEMORAe approach over using Enterprise 2.0 technologies is the integration of the workbench, learning and socialization support into the same platform. From the knowledge management perspective, this allows to accomplish a directed knowledge management in such a way that knowledge creation and sharing are guided by the learning process, which avoids knowledge overabundance and favours innovation (Abel, 2009b).

4.2 Enterprise 2.0

Enterprise 2.0 is a term first used by McAffee in 2006 (McAffee, 2006) to name digital "platforms that companies can buy or build in order to make visible the practices and outputs of their knowledge workers". These platforms are the equivalent for enterprise intranet of the popular "Web 2.0" technologies on the Internet, bringing to the light the benefits of socialization and collaboration.

We considered for our study the following technologies enabling knowledge capture, organising, storing and sharing: RSS feed, wiki, blog, microblog, forum, social networks, folksonomies. RSS feed can be used for real-time capture of knowledge from the sources one is interested with. This technology is not Web2.0 specific but it could be suitable when combined with collaborative tools, given the short time available for the team to accomplish its mission.

Microblogs would be appropriate to communicate short pieces of news and guide users to other sources more complex of information (in the way Twitter does it). A comparison of 19 enterprise microshraing tools is given in (Fitton, 2008).

Blogs could be employed by each team member to write their own reflexions and notes regarding assumptions made or notes about requirements etc. Forum could be employed to allow exchange of questions/answers in order to clarify requirements not well understood.

A social network could keep in contact the members of the team with collaborators sharing the same interests (maybe a collaborator closer to the customer, or subcontractors) or help them detect experts. Generally, we can affirm that a social network can relate between them different communities of practice (Garrot-Lavoué, 2009).

A wiki could be provided to increasingly "build" knowledge on a specific customer. A study presented by (Stocker, 2009) showed that, in order to provide concrete results, corporate wikis have to solve a clearly specified problem crucial for the business and the work practices of employees.

An analysis of commercial and open source Enterprise 2.0 tools according to the services they provide is presented in (Büchner, 2009).

We have shown how Enterprise 2.0 technologies may contribute to the socialization and collaboration processes. Nevertheless, these technologies should be combined in order to provide efficient support. Moreover, a simple combination of tools is not enough and therefore, further knowledge management support has to be added to them in order to increase their capability.

5 WORKSPACE MODELLING

Based on the previous observations, it was decided that a workspace was needed to support organisational learning in the way MEMORAe approach does it.

In order to model this workspace we have first identified a set of requirements based on use cases. We extracted our use cases from a selection of typical working situations revealed during the interviews. The use cases are exposed in the next section.

5.1 Workspace use Cases

We consider the case of a RFP containing text documents and we take as example the following statement contained in the RFP: "The system shall provide an emergency power production system synchronous with the public supply".

Typically, a reader reinterprets this statement according to his experience: "Power supply should be continuous even in the case of an incident".

Case 1: The reader may choose to make an annotation to the initial statement in order to remember easily its meaning.

The expression "emergency power production system" is not usual, but due to his experience he understands that the customer is talking about a source of energy which may be a battery or an electric generator.

Case 2: There is no other sentence in the RFP that can clarify customer need. The reader decides, taking into account the context of the demand what to offer to the customer.

Case 3: There is no other sentence in the RFP that can clarify customer need. The reader decides he has not sufficient information to take a decision. He may: a) consult his collaborators or b) propose to send the question to the customer or c) consult resources he may consider relevant (e.g. previous demands of the same costumer).

Case 4: When customer consulted, the following situations may appear: a) requirement is reformulated, as to be clear for all the parties; b) a new requirement will be added, to specify missing points.

Case 5: The reader finds another statement specifying that "The emergency power production system should be able to function at least 2 days". The reader infers that the customer needs an electric generator, given that a battery could not provide alimentation for such a long period.

Case 6: It was decided the customer needs an electric generator, but the reference solution does not support this component, so the requirement is considered a *gap*. Two cases are possible: a) if the gap can be solved, statement is marked compliant; b) if the gap cannot be solved, statement is marked non-compliant.

5.2 Workspace Requirements

When analysing the use cases, we can observe that, generally, there are two types of actions one can make:

- Individual actions (personal reflexion, decision, individual tasks, like in Case 1, Case 2, Case 3 c), Case 5, Case 6).
- Collaborative actions (like in Case 3 a) and b), Case 4).

Therefore, we decided that the workspace will have two main components: a workbench and a communication space.

The workbench will be dedicated to individual learning while the communication space will be dedicated to the collaborative learning. In addition, a knowledge management component will support the capitalization of knowledge emerging from the two spaces and will allow users to query and search for existing knowledge.

Requirements were then identified based on the use cases and grouped in: requirements for the workbench and requirements for the communication space.

5.2.1 Requirements for the Workbench

The workbench should satisfy at least the requirements:

- The workbench shall contain all necessary resources for one to do his job. Resources consist of RFP resources and personal resources which one may need in order to accomplish his tasks (like stated in Case 2 c)).
- The system shall provide to the user a means to visualise the requirements to be analysed or any other resource related to a customer or his requirements.
- User shall be able to edit his notes (as free-text annotations) while reading a statement contained in the RFP.
- The system should allow new requirements registration for the case new needs, which are not already specified, are identified (like in Case 3 b).
- The system should allow multiple annotations on a requirement.
- Each user will decide on the visibility of each of his annotations to other stakeholders.

5.2.2 Requirements for the Communication Space

The communication space should satisfy at least the requirements:

- The communication space shall allow user to collaborate with other stakeholders and to obtain/transmit real-time knowledge about a topic he is interested in, or a news.
- System shall allow authorised users to create ad-hoc communities (e.g. tender technical manager should be allowed to create a tender technical team).
- The system should allow easy communication between the team members on an annotation of a requirement (Case 2, a),b).
- The system should provide a way for a user to find and stay in contact with any other person/community that could help him in his work (e.g. with a community dedicated to the customer owner of the current RFP).
- A user will be informed each time news appear (e.g. new instructions are given from the management) or a task was allocated to him.

- System should allow a user to locate knowledge about a topic.

5.3 Workspace Model

Once requirements defined, we proceeded to the modelling of the workspace. A simplified model is presented in Figure 3, which highlights workbench and communication space elements as well as the way the two are intertwined through one ore more *topics*. One or more topics will be chosen by a user to index an annotation made on a part of a resource. Users will contribute with their knowledge externalised through annotations, messages exchanged or other resources and stored in a knowledge base. Once stored, users will have the possibility to look-up for knowledge by locating it through a direct search or by locating a potential owner of this knowledge via the communication space.

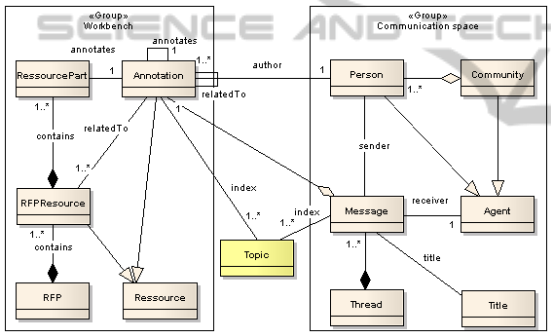

Figure 3: Workspace model.

The workbench main elements are the RFP resources and the annotations one can make on existing resources. An annotation may annotate a part of a resource (e.g. a text representing a requirement) or another annotation (e.g. an annotation which is the response to another annotation edited by a stakeholder). Annotations may be related one to another in two cases: 1) they correspond to the same topic or 2) the user decides to make a direct link between them via the "relatedTo" relation. This latter can also be used to relate the annotation to a resource (e.g. the user decides to attach a drawing to complete the annotation).

The author of an annotation is a *Person* (e.g. a member of the technical team) which may choose to send it as part of a message to an Agent (e.g. a colleague or to the whole community: the technical team).

The communication space is represented by persons/communities and the threads tracking messages exchanged between users. A *Message* contains an annotation and corresponds to one or more topics.

We note that topics allow not only to index annotations but also messages exchanged in the network, allowing therefore to capture and store informal content and link it to formal content which is RFP content. Topics will be defined by the domain ontology: the "Transport system" ontology. As stated in (Uschold, 1996), the role of the ontology is to:

- Assist communication between people and organizations.
- Achieve interoperability between systems.
- Improve system engineering.

The ontology will provide the common vocabulary, allowing understanding between not only the members of the technical team, but also between the technical team and the customer. Furthermore, once created, its consistency can be checked (when represented in an appropriate formalism) and reused.

Topics, along with the information about the members of the technical community and the information specific for a Tender (e.g. about the customer, the strategy, etc.) will provide a *context* to any knowledge captured during the Technical analysis. Contextual information can then be used to locate and retrieve needed knowledge.

Corresponding to the use case Case 3 b) presented in the 5.1 section, Figure 4 shows how the workspace will be used according to this scenario.

Step 1: The reader selects a text to work with;

Step 2: He reinterprets the statement;

Step 3: He makes an annotation to the statement, he writes a question;

Step 4: He chooses from the ontology one topic (*Power Supply*) to index his annotation.

Step 5: He sends a message containing the annotation through the social network to the Customer Director, knowing that this latter can directly address his question to the customer.

Step 6: The Customer Director clarifies the question;

Step 7: The Customer Director will then respond to his question by sending him another message which will be also indexed with the same topic.

Suppose that Luc, the Technical Leader, wants afterwards to check all the elements in all current RFP resources and in all past tenders corresponding to the same customer and concerning the "power system" or related to it. When launching his search,

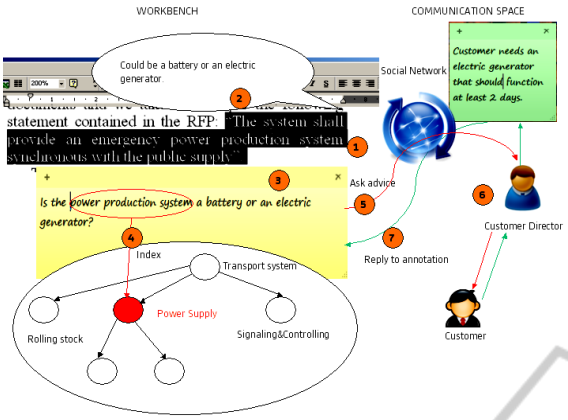

Figure 4: Workspace demo for Case 3 b).

all the elements indexed with the "Power supply" topic will be retrieved, as well as the elements indexed with topics having a relation to the "Power supply" topic.

6 CONCLUSIONS

In this paper we have shown the contribution of tacit knowledge in accomplishing tasks during railway product development. In the context of a specific activity like the "technical analysis" we detailed the problems generated by the loss of tacit knowledge which can arise when knowledge is not capitalized, an employee leaves the company or he changes his function. We think the loss of knowledge can be overcome through a workspace favouring organisational learning. We concluded that this workspace has to sustain three processes: an individual learning process, a social process for collaborative learning and a knowledge management process. Based on the analysis of needs, we deduced that these processes will be supported by: 1) the workbench helping employees to accomplish their analysis 2) the communication component allowing socialization and collaboration, 3) the knowledge management component unifying the previous two and allowing to capitalize knowledge by classifying it into topics. According to the use cases revealed during the interviews we defined a set of requirements which were further used to realize a first modelling of the workspace. As this model is not complete, our next goal is the refinement of the model.

Our future work will equally consist in the implementation of this model. In the section "related work" we presented some of the possibilities of putting into practice our proposal, but these tools/technologies cannot fully respond to the requirements of our workspace (especially regarding the annotation of resources, which should be supported by the workbench). It is for this reason that we are looking forward for means to develop our proposal.

REFERENCES

Abel, M.-H., Leblanc, A., (2009a). Knowledge Sharing via the E-MEMORAe2.0 Platform. In *Proceedings of 6th International Conference on Intellectual Capital, Knowledge Management & Organisational Learning*, Montreal Canada, pp. 10-19, ACI, 10.

Abel, M.-H., Leblanc, A., (2009b). A web plaform for innovation process facilitation. In *IC3K 2009 International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management*, Madeira Portugal, pp. 141-146, ACM, 10.

Birk A., Heller G., John I., Schmid K., Maßen von der T., Müller K., (2003). Product Line Engineering: The State of the Practice. In *IEEE Software*, pp. 52-60, November/December.

Boughzala I. And Ermine J.-L (2006). Trends in Enterprise Knowledge Management. USA: ISTE.

Büchner, T., Matthes, F., Neubert, C., (2009). A Concept and Service Based Analysis of Commercial and Open Source Enterprise 2.0 Tools. In: Proceedings of the 1th *International Conference on Knowledge Management and Information Sharing,* Madeira, Portugal, pp. 37-45.

Dieng R., Corby O., Giboin A., Ribière M. (1998). Methods and Tools for Corporate Knowledge Management. In *Proceedings of the Eleventh Workshop on Knowledge Acquisition, Modeling and Management (KAW'98)*, Banff, Alberta, Canada, 17-23.

Garrot-Lavoué E., (2009). Interconnection of Communities of Practice: A Web Platform for Knowledge Management. In *International Conference on Knowledge Management and Information Sharing (KMIS 2009)*, Madeira, Portugal, 6-8 October 2009, p. 13-20.

Leblanc, A., Abel, M. (2009). Linking Semantic Web and Web 2.0 for Learning Resources Management. In *Proceedings of the 2nd World Summit on the Knowledge Society: Visioning and Engineering the Knowledge Society. A Web Science Perspective*, Chania, Crete, Greece, September 16 - 18.

McAfee, Andrew P., (2006). "Enterprise 2.0: The Dawn of Emergent Collaboration", In *Sloan Management Review* 47 (3): 21–28.

Nonaka I., Takeuchi H. , (1995). The knowledge-creating company : How Japanese companies create the dynamics of innovation. Oxford University Press, New York.

Polanyi M., (1966). The Tacit Dimension. Routledge.

Stocker A., Tochtermann K., (2009). Exploring the value of enterprise wikis – A Multiple-Case Study. In *IC3K 2009 International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management*, Madeira Portugal, pp. 5-12, ACM, 10.

Uschold M., Gruninger M., (1996). Ontologies: principles, methods and applications. In *Knowledge Engineering Review* 11 (2), June.

Zhang, R., and Zhang, Y., (2003). Systems requirements for organizational learning. In *Communications of the ACM*, vol. 46, no 12, pp. 73-78.

DAML Ontology Library, Annotation. http://www.w3.org/2000/10/annotation-ns#

Fitton L. (2008). *Enterprise Microsharing Tools Comparison*. Retrieved Mai 19, 2010, from http://pistachioconsulting.com/wpcontent/uploads/2008/11/enterprise-microsharing-tools-comparison-110320081.pdf