Software Requirements Elicitation in the Context of a Collaborative Research Project : Technical Report*

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Abstract. [Context and motivation] A large part of the research activities performed in European computer science institutions is funded through European Union (EU) projects. Such projects address challenging applied-research objectives and involve both academic and industrial partners that are normally spread across different states of the EU. These projects often include the definition of an integrated platform to be built with the collaboration of the different partners.**[Question/Problem]** Eliciting and defining requirements for the platform in a distributed environment with heterogeneous stakeholders may be challenging. Partners have different objectives and views, needs are not sharply defined and communication is hampered both by the languages and by the physical distance of the stakeholders.**[Principal idea/results]** This paper presents the experience of defining and applying an innovative requirements elicitation approach in the context of the Learn PAd project, a EU project concerning a learning framework for Public Administrations (PA). The approach combines KJ-method and collaborative wiki-based requirements sessions to come to a set of consolidated requirements.**[Contribution]** In the paper, we discuss the lessons learnt in this experience and we present advantages and drawbacks of the implemented approach.

Keywords: distributed requirements engineering, collaborative requirements, requirements wiki, EU projects, experience report

1 Introduction

Since 1984 the European Commission (EC) finances research and innovation within the European Union (EU) through the "*Framework Programmes for Research and Technological Development*" generally referred as FP. The budget of

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the various FPs continuously increased from one edition to the other. In 2014 the 8th edition of the program, named Horizon 2020, has been launched, and it will last till 2020 with an overall estimated budget of 80 billion euros, whereas the first FP, that lasted from 1984 to 1988, costed around 3.75 billions euros[4]. Through the various funding schemes, the EC promoted both fundamentals and more industrial oriented researches, including the possibility to have projects financed for pre-competitive development of products. Generally, with a wide variability depending from the research topic and final objectives, projects are proposed by a mix of industrial and academic partners coming from different European countries (in general at least three different countries should be represented) that will collaborate to reach a commonly specified objective.

With some differences, all the authors have a quite strong experience of work within several EU projects in the area of information and communication technologies (ICT), and with different roles and responsibilities. In particular starting from February 2014 they are collaborating within a EU financed project named Learn PAd (`http://www.learnpad.eu`) with responsibilities at project level. From our experience, the most critical activity of a EU collaborative project actually relates to the communication, and to the elicitation of a clear and agreed set of requirements for the software to be developed within the project. Certainly the most obvious factor, negatively influencing the emergence of clear requirements, is the research and innovation context that somehow asks for the definition and development of something never done before. Nevertheless there are other important factors making communication activities rather difficult. Indeed, requirements elicitation within EU projects requires to tackle typical issues of global/distributed requirements engineering [20, 15] (e.g., physical distance, knowledge management, cultural diversity [5, 4]), as well as more peculiar problems such as the interaction between research-oriented academic partners and product-oriented industrial stakeholders. In some cases, if communication issues are not properly handled since the beginning, the result can be that the projects will be scattered in more than one large project, with complex integration issues when the final results will have to be provided and shown to the EC.

The paper describes the approach that we have defined within the Learn PAd project, in order to reduce the risks related to communication issues during requirements elicitation. In particular, we describe how requirements workshops have been organized, and how requirements have been refined and consolidated through the usage of a collaborative wiki infrastructure. The contribution of this work is twofold: (1) we highlight practical requirements elicitation issues in the context of a EU project; (2) we address the demand for experience reports in the usage of a wiki-based platform in the requirements engineering domain [20].

The remainder of the paper is structured as follows. Sect. 2 summarises the complexity dimensions of EU projects, and gives an overview of Learn PAd. The subsequent three sections describe the requirements elicitation activities performed, namely elicitation workshop (Sect. 3), collaborative refinement (Sect. 4),

[4] `http://europa.eu/about-eu/funding-grants/index_en.htm`

and requirements consolidation (Sect. 5). Sect 6 discusses the lessons learnt in the experience, and Sect. 7 provides conclusions and final remarks.

2 Overview

The experience presented in this paper concerns the requirements elicitation process adopted in the context of the Learn PAd research project. The overall goal of the Learn PAd project is to improve the quality of service of the Public Administration (PA) by providing a platform for process-driven, model-based learning. The idea is to use the Business Process Modelling Notation (BPMN) [9] to teach civil servants how the PA procedures shall be implemented in practice, and to complement the BPMN models with wiki documents that give details about the procedures. Wiki documents can be accessed and modified by the civil servants, according to their daily experiences in carrying out the procedures. The envisioned platform includes also components to provide procedural learning through model simulation, and functionalities for quality evaluation of models and wiki documents. The project is structured over 7 technical workpackages (referred as WPs in the following) and 1 WP dedicated to the definition of 2 demonstrators (i.e., applications of the platform to practical case studies).

Before presenting the approach for requirements elicitation that has been adopted in the context of the project, it is useful to list the peculiar characteristics of EU projects that we have taken into account while defining the approach. The following is probably a non exhaustive list of such characteristics:

- **number/distribution:** the project involves a high number of partners physically distributed over Europe. Learn PAd includes 9 partners, but in some cases EU projects count even around 20 and in general not less then 5. This could make a plenary discussion on the project rather ineffective. At the same time the distribution over many different countries limits the possibility of face-to-face meetings and introduces the need for managing remote requirements elicitation.
- **culture:** partners come from different countries with different native speaking languages. In particular, Learn PAd involves partners coming from 5 different European countries (Italy, France, Switzerland, Austria, Lithuania). As in other distributed projects [15, 5], this cultural difference might let emerge different attitudes and personalities, which can be interpreted differently by the partners. Clearly, this is a quite relevant problem since no mediator is foreseen within the consortium.
- **industrial vs academic mindsets:** the consortium includes partners with different working mindsets such as industrial and academic. Learn PAd involves 2 research universities, 1 research institute, 1 applied university, 2 small-medium enterprise (SME) working exclusively with open source licensing schemes, 2 SME adopting strict closed source licensing schemes and business models, 1 PA. Industrial partners have daily experience with requirements elicitation for software development. Academic partners are normally more focused on theoretical aspects, and might be less rigorous and

effective while performing practical requirements tasks. However, the combination of the different mindsets can enable the development of novel and interesting ideas [18].
- **background:** partners with different technical backgrounds have to strongly cooperate since the expected innovation or research results could be based on the intermix of their respective competences. In Learn PAd, all partners have experiences in previous EU projects, but they have different expertise. In particular there are partners with strong competences in Business and Knowledge management, Modelling of software systems, Software platforms and infrastructures, PA working processes, Software Engineering, Collaborative software platforms. These domains imply different backgrounds and vocabularies, and communication might be hampered by both the previous knowledge of the partners, and by the different terminology used.
- **age/roles:** partners representatives have different ages and experiences. Moreover, partners with different roles in the original organization have to act as peers within the project. The issue here is related to the possible uneasiness that a young researcher could have with respect to an older professor or company manager, which they could not personally know in advance.
- **objectives:** partners can have different objectives and views on the project innovation and research directions to be taken. This is a real issue since requirements could be introduced in order to pursue partner specific interests. This can obviously negatively affect the innovation and research potential of the project and introduce complex effects for requirements management activities.

Process Outline The process for requirements elicitation applied in Learn PAd consists of three main steps aiming to mitigate the effect of the complexity dimensions listed above. First, requirements elicitation workshops have been performed. As suggested in [4], preliminary face-to-face meetings are recommended at the beginning of a globally distributed project. Moreover, the workshops have been designed to reduce the effects related to the number of partners, and their heterogeneous culture, backgrounds and objectives. Afterwards, the preliminary requirements elicited in the workshops have been loaded in a collaborative wiki platform named XWiki, to be further refined. Asynchronous wiki interactions are regarded as an effective tool for requirements elicitation [6], which can mitigate problems associated to the physical distribution of the partners. Moreover, this peer-based collaborative refinement step was also oriented to reduce the role-effect: ice-breaking is normally easier when a computer interface acts as a communication mediator. Finally, a core group of partners consolidated the results in a final set of accepted requirements for the platform.

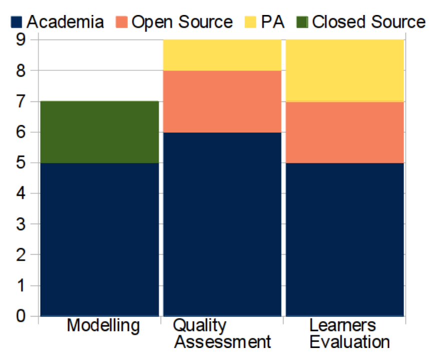
3 Elicitation Workshops

On February 2014 the kick-off meeting of the Learn PAd project took place. For some of the partner members this was the first time they had the opportunity to meet each other. The agenda of the meeting and information about related activities were circulated around 4 weeks before the meeting. The first day was used for project and partners presentations and to permit to meeting participants to get in touch with each other. In the second day, a couple of workshops sessions, lasting two hours each, were organized to let the partners discuss on the possible outcome of the project and define preliminary requirements.

Grouping The 24 participants were organized in three different working groups each one focusing on a specific high-level view of the Learn PAd platform, namely "Modelling", "Quality" and "Learners Evaluation". The assignment of the people to working groups was carefully planned and took into account expertise and involvement of the participant to the various WPs of the project. More specifically, the partners were classified according to four categories: partners from academia (i.e. CNR, UDA, FHNW, partially UNICAM); industrial partners practising open-source (i.e. LIN, XWIKI); closed-source industrial partners (i.e. BOC, NME); and PA partners bringing their expertises on the demonstrators (i.e. MAR, partially UNICAM). In the classification UNICAM belonged both to Academia, and PA because its contribution to the project includes research, and demonstration activities. Further considerations about the size, and the heterogeneity of the working groups led to the definition of the following criteria: (a) each group should have counted around eight participants; (b) a project partner should have had representatives in at least two different groups. However, it was not always possible to strictly abide by such criteria. Fig. 1a reports the breakdown of the partners into the working groups, while Fig. 1b depicts their distribution over the four representatives categories. Notably, the representatives of closed-source industrial partners was only limited to the "Modelling" group. This comes from the fact that both BOC, and NME have very strong competencies on that specific field, and unfortunately only one participant per company company joined the workshop.

	Modeling	Quality Assessment	Learners Evaluation
CNR	1	4	4
XWIKI		1	1
BOC	1		
UDA	1	1	
FHNW	1		1
LIN		1	1
MAR			2
UNICAM	2	2	
NME	1		

(a)



(b)

Fig. 1: Working Groups

KJ Sessions The activities of each working group proceeded according to KJ method [10, 21], an exploratory creativity technique [17], were requirements are first individually written in cards, and then collectively discussed and grouped. For each working group one moderator was appointed to drive the discussion and try to involve all participants. All moderators participated to the planning of the workshops, and had clear in mind the heterogeneity issues that could affect the workshop results. In the first workshop session, according to the guidelines in [21], each moderator illustrated to the group members how the activity of the group had to proceed and the expected outcomes. Successively, each participant had the opportunity to write in post-it cards the requirements that he/she considered relevant for the subject of its group (one requirement for each post-it). Collected requirements were discussed one by one by the group to understand their relevance and elicit novel ideas.

In the second session, participants were asked to provide additional requirements in the cards, according to the discussion performed in the first workshop. Then, the moderator collected the post-its, briefly asked for further discussions on novel requirements, and put them on a blackboard. With the support of the participants, the requirements were grouped according to their topic (e.g., "Metamodelling", "Models Quality", "Cooperation"). The topics were decided along the discussion.

At the end of the second workshop session a wrap-up activity was included in the agenda. During the wrap-up session the vision of each group was presented to the other groups. The activities on requirements carried on during the first meeting permitted to identify 249 preliminary requirements (78 for the "Modelling" group, 81 for "Quality", 90 for "Learners Evaluation"), which would have been the starting point for the successive collaborative activities.

Observations In general, all the sessions were successful and all group members were quite involved in the activity, permitting to suppose that the negative effects of some heterogeneity issue were rather limited. Besides the careful grouping of the participants, the success of the experience was mainly due to two factors: (1) the design of the workshops; (2) the moderators. Starting the workshops with an individual activity (i.e., card writing) and letting each participant present his/her point of view before the brainstorming was paramount in limiting age/-role effects and mitigating objective discrepancies. Then, the partitioning in two workshop sessions let the participants have the time to re-think about their views. Indeed, in the second sessions, the participants experienced a sort of "second chance" to align the terminology with the others, and smooth out cultural and background differences. The smoothing of these aspects was also enabled by the choice of the moderators, and by their attitude. The moderators of the "Modelling" and "Learners Evaluation" groups were the scientific and technical leaders of the project, respectively, and were familiar with all the participants. Therefore, they knew how to deal with them, and they could leverage their role to resolve conflicts. Conversely, the moderator of the "Quality" group, was unknown to most of the participants, and acted as an independent facilitator with the task of reducing relational problems thanks to his independent profile [16].

4 Collaborative Refinement

At the end of the KJ-sessions, requirements were a set of post-its with associated topics. Our goal was to provide a refinement of these preliminary requirements, and continue the collaborative discussion and elicitation process in a virtual, distributed space, after all the partners came back to their headquarters and offices. To this end, we have decided to set-up a collaborative wiki-based infrastructure for requirements.

4.1 Collaborative Infrastructure

Wikis are a lightweight approach to documentation more powerful than plain office suites or collaborative tools, and easier to use and tailor than proprietary RE tools [6]. Moreover, wikis are regarded as promising tools for requirements elicitation/negotiation in distributed environments (see, e.g. [25, 20]). The adoption of a wiki in RE enables the various members of the project to contribute by adding, modifying, or deleting contents. In addition, a wiki platform natively supports the versioning of the handled documents. In this sense, contributors can always access to the history a requirement had and trace its evolution. In our context, we have decided to use XWiki (`http://www.xwiki.org/`), a general-purpose collaborative platform (embedding a wiki) developed by one of the open-source SME in the consortium. The platform, besides the collaborative editing capabilities typical of wikis, exposes a flexible data model (i.e., Classes, Properties, and Objects) which it can be both queried and extended by the users. Indeed, though wikis facilitate collaborative work, customization is required to address RE-specific needs: a template requirements structure has to be defined, and requirements views have to be enabled to ease navigation. To this end, XWiki has been extended with a model of requirements that is based on the widely used VOLERE [23] template. In practice, each requirement was associated to a XWiki page with several VOLERE-like predefined fields such as type (e.g., Functional, Non-Functional), status (e.g. Proposed, Accepted, Discarded), description, justification, relations to other requirements, semantic tags, *etc.*. Moreover, dynamic views for the requirements have been defined. Each view focuses on a specific aspect, for example: supporting the navigation of the requirements by some field (e.g. the initiator, the type, etc.); or showing the semantic dependencies among requirements tagged with the same meta-information. In addition, we provided views to query the data model and return analytics about the collaborative activities performed on each requirement.

4.2 Collaborative Refinement Activity

The collaborative refinement activity performed through the platform included two steps: an offline import step, and an online collaboration step.

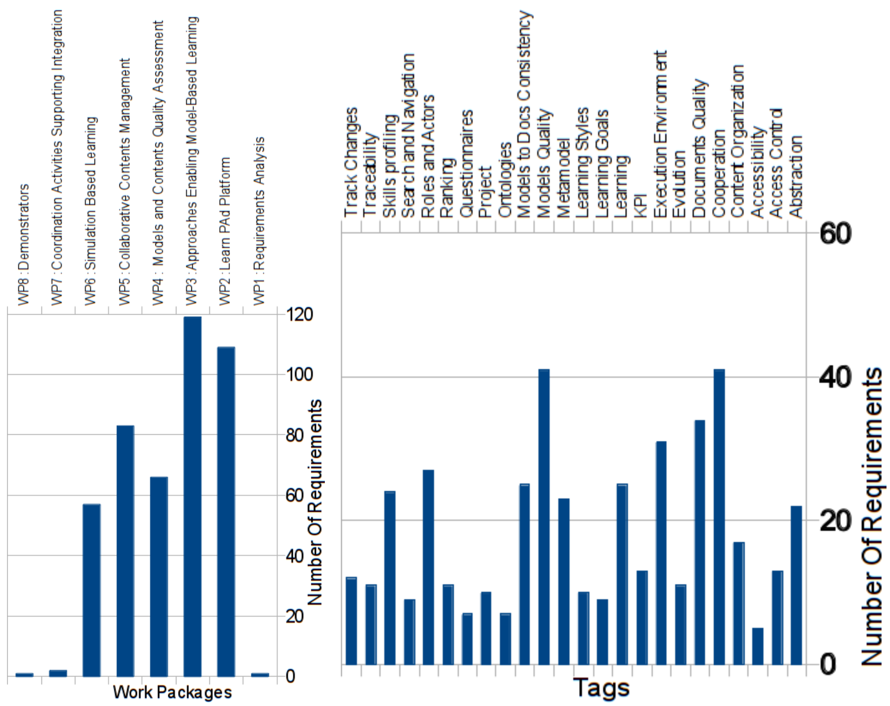
Offline Import During first step, the moderators took care of uploading the preliminary requirements of the post-its to the platform, associating each requirement to the topic that was chosen during the KJ-sessions. The topic was stored as semantic tag in the VOLERE-like template. Moreover, to enable a uniform tagging, the moderators met in a set of sessions aiming to tag the requirements elicited by each thematic group with the categorizations proposed by the other groups. Requirements that could not be semantically categorised with a single tag were tagged with multiple tags of the set.

In addition, for each requirement, the moderators evaluated which work-packages of the project could be affected by that specific concern. This information was codified in the structured template in XWiki by adding the names of the WPs as items in the tags list field of the template.

Fig. 2 shows the number of requirements associated to each WP (Fig. 2a, WP not concerning the software - e.g., Dissemination and Project Management - had zero requirements, and are not reported) and to each tag (Fig. 2b). This visualisation has been useful as a preliminary informal assessment of the project plan. Indeed, we see that most of the requirements are apportioned to WP2 and WP3, which are also the dominant WPs in terms of person-month effort (58 and 51, respectively). Though the effort associated to each single requirement cannot be evaluated in this phase, this coarse-grained alignment between the number of requirements and the planned effort can at least tell us that we did not underestimate the relevance of the WPs that are associated to a higher number of needs to be addressed. On the other hand, Fig. 2b suggests that there are aspects of the project to be delved more. Indeed, we see that for a project aiming to enable model-based learning, the tags related to pedagogical aspects of learning (i.e., Learning Styles and Goals) are far to be a common topic in the requirements. This already showed a weakness of the project: pedagogical expert did not participate to the KJ sessions, and few learning-related requirements emerged. This aspect has been currently taken into account by including in the project also experts in the learning field.

Online Collaboration Once the offline import activity has been completed, we asked the whole consortium to access the XWiki platform in order to improve the specification of the requirements as originally proposed. Indeed, the granularity of the information collected was minimal with respect to the VOLERE-like structure adopted for the requirements, and the sentences provided in the post-its were often unclear and with a free-form structure that made them hardly usable in an official requirements document. The moderators also provided a glossary to be followed by the contributors when modifying their requirements.

In a first iteration, we asked the members of the consortium to improve and detail the information associated to each requirement. In particular, we asked to revise the text of the requirement according to a set of basic requirements editing guidelines, such as: use the verbs "shall" or "should" to indicate mandatory and optional requirements, respectively; use active sentences; the subject of the requirement should be the system, part of it, or an actor; *etc.*. Successively, the consortium collaboratively revised again the whole set of requirements. The goal



(a) (b)

Fig. 2: Number of requirements for each WP and for each semantic tag

of this second iteration was editing the "justification" field in order to provide detailed information about the rationale of each specific requirement. The final iteration foreseen aimed at identifying some existing relations among the requirements. Specifically, the members of the consortium were asked again to access the views given by the XWiki platform, and browse the requirements looking for dependencies, conflicts, or refinements.

It is important to remark that, at any iteration, any member of the consortium had the possibility of both accessing, and modifying *any* of the collected requirements. During each iteration, members were also encouraged to add requirements. At the end of the collaborative refinement phase, the set of requirements increased from 249 to 337.

A set of specific views has been developed in order to get analytic data about the behaviour of the different editors during the collaborative refinement process. Among the others, a view provided the total number of modifications each requirement experienced. The result of this indicator showed that the average of changes on a given requirement is 5.14 (variance 3.01). Another view aimed at counting the number of different contributors who edited each requirement. In this case, we have an average of 2.58 editors per requirement (variance 0.39).

Fig. 3 plots the number of versions, and the number of different contributors for each requirement.

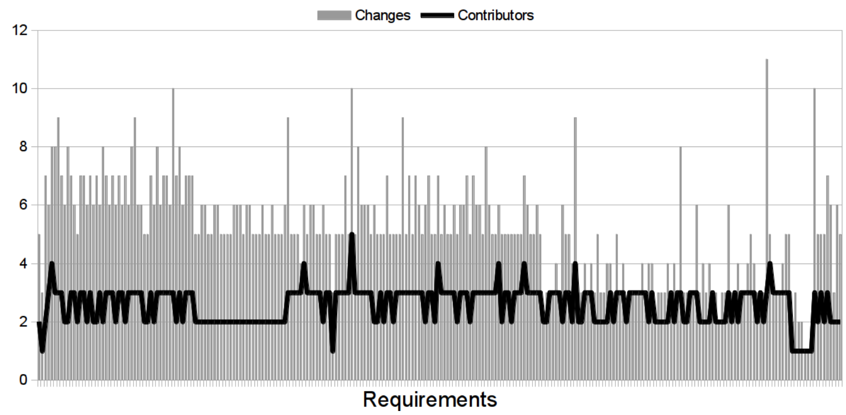


Fig. 3: Analytics on the set of requirements after collaborative refinement

From these data emerges that, in the average, a requirement has been modified more than the number of iterations planned by the process. The participants to the RE process actually perceived some need in order to progressively evolve the set of requirements, for example by aligning the ideas expressed in a requirement according to the current status of the whole set. This observation becomes even more evident if we analyze only those requirements having a number of modifications greater than the number of iterations we requested. In this case, the average of changes applied on a requirement rises to more than 6. It is worth noticing that this sub-set counts more than the 70% of the collected requirements. Thus, the collaborative refinement approach was successful in stimulating further reasoning on the requirements. The remaining 30% includes both requirements that have been modified only according to the instructions given (i.e., almost the 7.5%), and requirements that were not modified (22.5%).

A further comment about the data from Fig. 3 concerns the number of contributors per requirement. In this case, the measured indexes suggest that the editors tended not to modify the requirements initially promoted by other participants. Our interpretation of this result comes from the fact that research project are mainly organized as peer-based projects with a clear separation of competences. Thus, while the initial promoter of a requirement is somehow mostly available in order to reconsider and to let evolve his/her conception about some aspects of the project (i.e. expressed by a requirement), at the same time he/she may be fill uncomfortable in a direct modification of the contribution of some other promoter.

5 Requirements Consolidation

After the refinement task, a core team of key partners led by the coordinator of the requirements activities (referred in the following as "RE coordinator") performed a manual analysis of the requirements in XWiki. The goal of this task was to come to a final set of consolidated requirements. Indeed, though the collaborative refinement experience was rather lively, many requirements still needed both syntactic adjustments – to adhere to the guidelines provided – and semantic refinements – to clarify their content. The analysis started with a requirements scoring activity, in which each requirement was associated to a score by the RE coordinator: (a) ACCEPT, in case the requirement is clear and the RE coordinator evaluates the implementation effort as acceptable; (b) PROVISIONALLY ACCEPT, in case the RE coordinator cannot evaluate the implementation effort; (c) DETAILS REQUIRED, in case the requirement is unclear; (d) REJECT in case the implementation effort is not acceptable or the requirement is equivalent to others. Then, each requirement that was scored with (c) was sent back to the stakeholder who originally produced the requirement to provide further details. In a final panel meeting, the core team discussed each requirement and marked it as (a) or (d). The set of consolidated and accepted requirements consists of 191 unique elements.

ACCEPT	P. ACCEPT	DETAILS REQ.	REJECT	Total	Total (ACCEPT)
110	144	55	28	337	**191**

Table 1: Number of requirements for each score given by the RE manager.

Table 1 shows the number of requirements associated to each score, and the final number of accepted requirements. We see that, among the requirements marked with (c) and (b), only 81 (i.e., 41%) have been finally accepted. This implies that, for many requirements, the implementation effort was considered not acceptable. This result is however tolerable. Indeed, the KJ sessions are a creative space that can naturally lead to a large number of ideas that are hardly applicable. However, such ideas were part of the creative atmosphere of the KJ sessions, and we conjecture that limiting such ideas would hamper also the emerging of those solutions that, in the end, result to be applicable.

6 Discussion

6.1 Industry, Academia and PA

Learn PAd involves three types of associates, namely industrial, academic and public administration (PA) partners. In our experience, closed source industrial partners normally push to include their product *as-is* in the project. They are reluctant to change their platforms for the needs of the consortium, and in general less keen to innovation, if it appears too challenging. Open-source industrial partners have the opposite tendency, and are in line with the academic partners:

they tend to encourage experimentation, and changes to their products are seen as a way to explore new market scenarios. These differences in approach have become evident in later stages of the project, but at requirements elicitation stage the issue was mitigated by the peer-based atmosphere of the KJ sessions, where the pressure of the interests of closed-source industrial partners was reduced by the heterogeneity of the groups. The XWiki environment also contributed to such mitigation. Instead, a significant difference between industrial and academic partners emerged in the initial phase of the KJ method, where the participants were asked to write requirements in the post-its. Industrial partners – closed and open-source SME –, more in use with these kind of creative requirements elicitation approaches, started to write as soon as the session begun, and produced a large set of post-its. For example, in the Modelling group, two participants from the industry produced 43 out of the 78 preliminary requirements (55%). Instead, academic partners perceived the task as a sort of "homework", they appeared less comfortable with the technique and edited less post-its. However, when the discussion started, we could not distinguish between the two types of partners, as the degree of participation was more influenced by the personal attitude than by the affiliation.

In all the requirements elicitation stages, a manifest difference in attitude and behaviour with respect to the other participants was shown by the PA partners. PA associates had to play the role of customers but had visible difficulties in defining requirements for the platform. This is evident from Fig. 2a, where we see only *one* requirement apportioned to WP8-Demonstrators. We were expecting the PA participants to contribute to the requirements of such WP, since they are the domain experts who can provide practical needs, but the expectations did not match the outcome. The reason is manifold. Non-research projects are normally customer driven, while, in research projects, the real-world customers (i.e., the PA, in our case) are not the primary trigger of the project, and are included *after* the idea is conceived. Therefore, they do not have a clear vision of the project, and mapping the general idea with their daily needs is hard to them. Moreover, in our experience, the participation of PA partners was also hampered by their limited confidence with an international, English speaking environment. We argue that these limitations can be addressed by organizing meetings with PA participants only, possibly using other techniques such as interviews and questionnaires, to reduce the perspective gap, and reproduce a customer-developer environment that can be more effective to elicit user-level requirements.

6.2 Motivation and Collaboration

In a collaborative environment, motivation of the participants is a key aspect. In our experience, we saw that during the KJ sessions the people were naturally motivated by their physical participation, their natural involvement due to the need to let emerge their objectives, or simply by the fact that it was a new experience. Moreover, during the collaborative refinement phase, our statistics have shown that the participants actively contributed to the refinement of their requirements (see Sect. 4.2). Therefore, the motivation did not decrease, even though the participation space was now virtual. On the other hand, the degree of collaboration – rather high in the KJ discussions – was lower, since few comments and changes were provided on the requirements of the other participants. Moreover, the quality of the requirements did not increase much, since people tended not to follow the editing guidelines provided. The lack of collaboration and quality contributions identified during the wiki-based collaborative sessions makes us reflect on the need for a web moderator/leader who is in charge of directly asking the people to contribute to the requirements of the other participants, and who checks the quality of the requirements.

While the collaborative refinement task was peer-based, a hierarchical management of the requirements activity was enforced in the requirements consolidation task. Responsible persons were identified in each institution to form a requirements task-force under the guidance of the RE coordinator (see Sect. 5). The responsible persons directly motivated the people in their institutions, and checked their work. Hence, the shift towards a hierarchical management of the activities was the key to come to a set of consolidated requirements. Though this aspect might appear obvious in an industrial requirements process, it is not straightforward in a process that lives within a research project. Indeed, such projects are normally performed in peer-based environment, with a weak hierarchy among participants. In this context, enforcing leadership is not easy and might hamper the spirit of the project. However, in our view, it appeared as an effective solution and we argue that such choice should have been applied already during the collaborative refinement sessions.

6.3 Quality of the Elicited Requirements

During the requirements workshops, the little experience of most of the partners in requirements engineering methodologies and typical requirements problems [1, 7] (e.g., abiguity, underspecification, problem-space reasoning) led to poorly specified requirements. Indeed, though guidelines were given to write the requirements in the post-its, some of the participants wrote more than one requirements for each card, used passive verbs and complex constructions, and, in several cases, they used too generic and underspecified sentences. This problem persisted also in the collaborative refinement sessions. The second author replied a similar KJ experience with a group of 10 computer engineering students, but decided to give a preliminary presentation (30 minutes) on typical requirements flaws. The impression was that the requirements provided by the students showed a much higher degree of quality and could be employed in further analysis phases without additional manipulation. Though the context is different – students vs researchers/industry people, type and size of the system-to-be, etc. – we argue that spending a reasonable amount of time in *teaching* requirements before the KJ sessions can be worthy to ease the subsequent requirements phases.

6.4 Tool Support

Though an exhaustive comparison with other RE wiki tools is beyond the scope of this paper, it is worth mentioning that the capabilities of XWiki are not common in other RE approaches adopting wikis [6]. In particular, among the others these are some of the discussed cons in adopting wikis in RE concern [22][20] : the missing features for restructuring content, particularly for classifying and reclassifying pages; navigation needs that are highly required in distributed requirements engineering tools (e.g. users must remember to explicitly link pages); versioning contents across several page is difficult; limited support in capturing the nature of a link between documents; the structuring of the templates is often complex and it hinders the representation of requirements. The flexible data model exposed by XWiki supports the organization of the information as structured objects conforming to a given meta-structure, and that can be searched and manipulated systematically. Also, the semantic of a given object can be inferred both by its type, and by means of the dynamic relations it has with the other objects rather than the mere page where it is displayed.

The flexibility of the XWiki platform demonstrated its effectiveness in providing analytic data and views on the requirements. This helped in spotting out missing stakeholders (i.e., the pedagogical experts), and reduced participation of part of the stakeholders (i.e., the PA partners). Moreover, the active participation of the partners during the refinement sessions gives us confidence on the usability of the platform. On the other hand, the feeling of the RE coordinator (see Sect. 5) was that XWiki was not giving sufficient tool support to manipulate requirements together, and decided to export the requirements in a spreadsheet. Then, requirements we manually re-imported in XWiki to provide proper versioning. We argue that providing a spreadsheet-like view in XWiki could have helped in the requirements consolidation activities. Moreover, to reduce the effort of the manual import from post-its to XWiki, also computer-based support for the KJ method (as, e.g., in [19]) shall be foreseen.

7 Conclusion and Future Work

In the literature, several experiences have been presented in the application of collaborative requirements elicitation approaches (e.g., [8, 12]), and distributed requirements engineering (DRE) techniques (e.g., [4, 15, 2, 13]). Tools have also been developed to support requirements elicitation in DRE, both based on wikis [20, 6], on social network-based systems [3, 14], and on end-user requirements gathering through mobile devices [24]. In this paper, we have presented the combination of a face-to-face requirements elicitation technique (i.e., the KJ method) with a wiki-based approach for distributed requirements elicitation/refinement in the context of a EU project. We have seen that these projects show issues that are common to global requirements engineering (e.g., communication difficulties, knowledge management, see [5, 4]) and that can be addressed with tools that are suggested by previous experiences (i.e., initial face-to-face meetings [4] combined with asynchronous wiki interaction [6]). However, we have also seen peculiarities that need specific solutions: among them, the tendency to underestimate the customer's profile, and the consequent problems in the participation of the customers to the requirements elicitation activities. To cope with this issue, we are currently focusing on direct interactions with the PA participants to elicit further requirements for the demonstrators. Advanced techniques to distributed requirements clarification (e.g., [11]) are also foreseen to increase the quality of the elicited requirements.

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