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2009 Fourth IEEE International Conference on Global Software Engineering

ICGSE 2009

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ANALYZING ONTOLOGY AS A FACILITATOR DURING GLOBAL REQUIREMENTS ELICITATION

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Abstract

Global software development projects deal with a variety of challenges, particularly those concerning communication and language differences. Bearing this in mind, processes that are crucially based on communication, such as requirements elicitation, must be specially rethought to minimize critical situations. Since effective communication would help to reduce misunderstandings among stakeholders, and therefore help to achieve more committed requirements, we propose a framework for global requirements elicitation focused on minimizing the most frequent problems in GSD. Both the proposal and the preliminary results of a controlled experiment are presented in this paper.

1 Introduction

In order to minimize costs, off-shoring and outsourcing have been easily adopted by industry, but even when these practices are advantageous in many ways, they are far from being a panacea for GSD [11, 14]. According to the experiences from some real-life GSD projects, the dispersion over multiple sites can introduce several factors that negatively affect a team's performance [7, 13]. May be, the lack of face-to-face interaction is the most important; but cultural diversity also introduces many issues that affect communication and that are worth of consideration. Since achieving effective communication is a well-known challenge during the requirements elicitation process [1] establishing practices for a good communication is crucial, especially when stakeholders are distributed along many distant sites. Under these circumstances we propose a framework for requirements elicitation in distributed scenarios that focuses on minimizing the most common problems introduced by cultural differences. To do so, we have adapted the earlier phases of Christel framework [6] to a distributed environment and proposed a method to evaluate problematic factors as well as suggest strategies to improve communication during requirements elicitation in GSD projects [2]. In this paper, we introduce the resulting framework and discuss some preliminary results we have gathered by means of a controlled experiment.

The remainder of the paper is organized as follows: in Section 2 we introduced the RE-GSD framework for global requirements elicitation. In Sections 3 and 4, we describe the experiment design and we present the preliminary results of the controlled experiment which was carried out to validate part of our proposal. Conclusions and future work are addressed in the last section.

2 RE-GSD framework

As we mentioned before, lack of face-to-face interaction makes the *loss of communication richness* one of the most cited problems in GSD [7]; but also *cultural diversity* [7, 12] introduces problems when stakeholders are spread over different countries, regarding language and custom differences.

To deal with such problems, we have proposed a framework for requirements elicitation, called RE-GSD. As a basis for RE-GSD, we adopted the generic model for requirements elicitation proposed by Christel [6] and we adapted its first phases considering the special characteristics of a global software development environment, and we also added a new phase where the environment is analyzed, problematic factors are evaluated and strategies to improve the communication are

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proposed. Figure 1 shows a graphical representation where RE-GSD and Christel phases are compared.

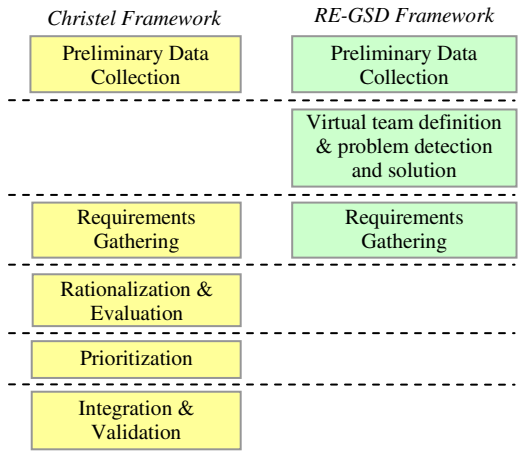

Figure 1: Comparison of Christel and RE-GSD frameworks

PHASE 1: Preliminary data collection

The goal of the first phase of our framework is to discover as much as possible about the requirements elicitation scenario.

The information has been organized into categories, both as regards the domain and the system's main goals, and the stakeholders and the environment in which the requirements elicitation takes place. The main difference between this phase in RE-GSD and collocated methodologies is that RE-GSD focuses on stakeholders' cultural information as well as their distribution on the sites, and the technology with which they are most familiar or are able to use. The stakeholders were asked to fill in a psychological test which would allow us to discover their cognitive profile, and give us an indicator about the way in which they perceive and process information. We refer the reader to [8, 9] for further details.

All this information is arranged to be used during the various procedures of the following phase. For example, during the second phase this information is used to detect problems and define the strategies to be applied in order to minimize them in the remaining phases of our methodology. Gathering this information does not take much time in comparison with the benefits that it represents for the rest of the process. In order to facilitate the task, we have also designed forms, which are easy to understand and fill in, that have been presented and explained in [3].

PHASE 2: Virtual team definition & problem detection and solution

We have specially added this phase in RE-GSD to focus on recommending strategies in order to minimize the problems caused by geographical dispersion. Then, the first step is defining the team, that means, identifying the people that will interact during the requirements elicitation phase. Following, we analyze the information we have gathered in the previous phase about the environment and identify the possible sources of problems. Finally, we recommend strategies with which to improve the requirements elicitation process. In order to do this, we propose two main tasks:

1. Detect the factors that may be a source of future problems
2. Define the strategies to be applied in order to minimize the detected problems.

Figure 2 shows a detailed graphical representation for RE-GSD and Phase 2.

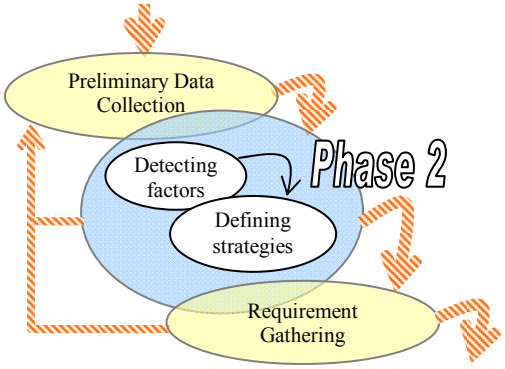

Figure 2: RE-GSD framework – Tasks for Phase 2

We shall now briefly explain each task.

Task 1: Evaluating the factors that may cause future problems

As a part of the first task, we discovered four factors, which are related to the previously explained most common problems in GSD projects, and which are interesting to measure in any virtual team:

- **time overlap** (how much time do sites share for synchronous collaboration?);
- **cultural difference** (how different are the cultures in the countries in which sites are located?);
- **language difference** (what is the level of knowledge of the common language?), and
- **stakeholders' cognitive aspects** (what are the stakeholders' innate characteristics that

influence their behaviour when they perceive and process information?)

For each factor we determined a manner in which to obtain a value. For further details about such a process see [2].

Task 2: Defining strategies to minimize GSD problems

According to the values obtained for time overlap, cultural difference, language difference and team type regarding cognitive aspects, we recommend three strategies which are designed to minimize the problems introduced by such factors:

The first strategy we propose is **learning about cultural diversity**. We have proposed using virtual mentoring, based on simulation and virtual actors, as a way to motivate stakeholders in foreign language training and cultural familiarization [15].

The second strategy, which refers to language differences, is the **use of ontologies as a communication facilitator**. Especially when stakeholders are not from the same country, and even if they share the same mother language, misunderstandings may arise about words meaning, etc. Ontologies may help to share a common vocabulary, especially when referring to the domain components, and to help to build a common understanding of the problem, since ontologies help to clarify the structure of knowledge and allow a clear specification of the concepts and the terms used to represent them [5].

The third strategy is related to **technology selection**, referring the different groupware tools and requirements elicitation techniques that can be used in GSD projects. In order to do so, we proposed a model based on fuzzy logic, that we presented in [4].

Furthermore, the complete strategies selection model has been presented in [2]. Following we will present and discuss the strategy related to language differences and the application of the second strategy during a controlled experiment.

3 Experiment design and execution

In order to validate certain aspects of our proposal, we have carried out a controlled experiment with the participation of post-graduate computer science students from the University of Castilla-La Mancha (Spain) and the University of Comahue (Argentina). So as to focused on the use of a domain ontology, we divided the people into 8 teams, and half of them used a domain ontology while the other half did not. We also ensured that the remaining variables were fixed for all the treatments. For instance, requirements elicitation techniques were reduced to interviews and use case models for all the teams, and more experienced people was assigned first to avoid them being in the same team. The students were divided into 8 teams, with 3 people in each. We chose to have two analysts and one user per team, as we considered that such a distribution would give us the opportunity to analyze not only the user-analyst relationship, but also the analyst-analyst relationship. We avoided educational differences by assigning the same roles to people from the same country, so Spanish students played the role of analysts and Argentinean students played the role of users. Finally, we ensured that each team had the same challenges to overcome: they had a time difference of 4 hours, they had the same difference in timetables, the cultural difference was the same (low according to the Hofstede model [10]) and they had the same idiomatic differences as regards pronunciation and vocabulary.

The team members were able to communicate freely for a week, and after that time, each team gave us the requirements specification that the analysts had written with the user's approval. Finally, on receiving the requirements specification, we asked the team members to fill in a post-experiment questionnaire in order to obtain their personal opinion of the requirements elicitation process and the requirements specification they had written.

4 Preliminary results

A post-experiment questionnaire was designed to collect information about team members' satisfaction. To do so, information regarding *ontology usefulness* was analyzed from different points of view, analyzing how a domain ontology affects different aspects of the requirements elicitation process, such as communication and software requirements specification (SRS) quality:

Q1: Stakeholders' perception of ontology usefulness
Q2: Stakeholders' satisfaction with regard to communication during requirements elicitation process
Q3: Stakeholders' satisfaction with regard to the quality of the SRS they had written.
Q4: Quality of the SRS from the point of view of external reviewers.

In order to collect information for such questions, we included a series of items in the post-experiment questionnaire for team members

that had used the ontology. Since only half the teams had used the domain ontology, it was necessary to analyze 12 questionnaires.

Analysis of Q1

The question in the post-experiment questionnaire related to Q1 was: *"Do you think the ontology was useful in improving communication in your team?"*. The answer consisted of a 5 points scale: (0) *completely useless*, (1) *slightly useful*, (2) *indifferent*, (3) *useful*, and (4) *very useful*. The stakeholders' answers are shown in Figure 3.

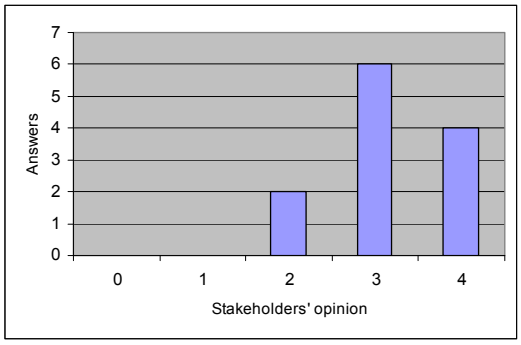

Figure 3: Stakeholders' perception about ontology usefulness

Upon analyzing the stakeholders' answers it was observed that majority expressed that the ontology was "*useful*" or "*very useful*" in improving communication during the requirements elicitation process, with the exception of two people who said that it was "*indifferent*". It is important to note is that both the people who considered the ontology *indifferent* were part of the same team (G1), and this observation should be analyzed with regard to the rest of the questions.

Upon analyzing the data in greater detail, it is observed that the analysts seem to consider the domain ontology more useful than the users, as is shown in Figure 4, in which only one of eight analysts considers the ontology to be indifferent.

Following we will present results for questions Q2, Q3 and Q4. In contrast to question Q1, that only the people in the teams using the domain ontology were asked, the questions for Q2, Q3 and Q4 were included in the post-experiment questionnaire for all the people who participated in the experiment. The analysis of these questions was therefore carried out by comparing the answers for two groups: Group 0, consisting of people in teams that did not use the ontology; and Group 1, consisting of people that did use the domain ontology. According to our expectations, the use of a domain ontology should improve the quality of both communication and productivity. We shall now present the results for each question.

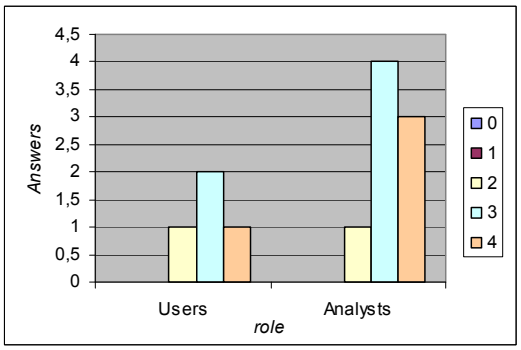

Figure 4: Stakeholders' perception of ontology usefulness concerning the role

Analysis of Q2

The question in the post-experiment questionnaire related to Q2 was: *"How good do you think the quality of communication in your team was?"*. The answer consisted of a 5 points scale: (0) *very bad*, (1) *bad*, (2) *acceptable*, (3) *good*, and (4) *very good*. The comparison between both groups is shown in Figure 5.

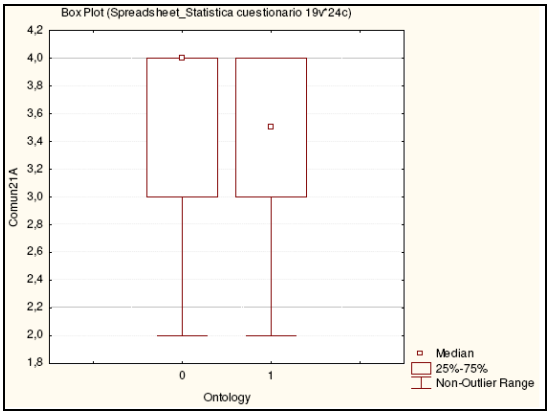

Figure 5: Analyzing the effect of using a domain ontology with regard to stakeholders' satisfaction with communication

Upon analyzing the median it can be seen that the people in Group 0 (median = 4) seemed to be more satisfied with communication during the experiment than the people in Group 1 (median = 3.5). This result does not coincide with our previous expectations, since it indicates that using a domain ontology does not improve stakeholders' satisfaction with communication during a requirements elicitation process.

Analysis of Q3

The question in the post-experiment questionnaire related to Q3 was: *"How good do you think the quality of the SRS written for your team was?"*. The answer consisted of a 5 points scale, as

follows: (0) *very bad*, (1) *bad*, (2) *acceptable*, (3) *good*, and (4) *very good*. The comparison between both groups is shown in Figure 6.

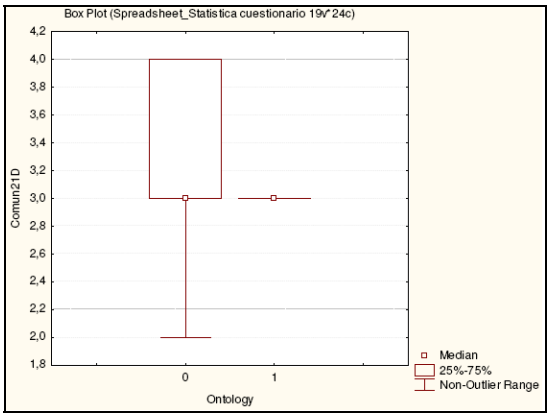

Figure 6: Analyzing the effect of using a domain ontology with regard to stakeholders' satisfaction with SRS quality

According to the analysis of medians, although both groups have the same median, since the quartile Q1 attains a value of 4, it would appear that Group 0 was more satisfied with the quality of the SRS that they wrote than the people in Group 1. This result does not coincide with our previous expectations, since it indicates that using a domain ontology does not improve stakeholders satisfaction with the product of the requirements elicitation process.

Analysis of Q4

The fourth question, related to the quality of the SRS, was answered from the point of view of external reviewers, and it was collected in a different questionnaire which was filled in by Software Engineering teachers from the University of Castilla La Mancha who had not participated in the experiment.

The four evaluators were asked to analyze SRS, considering different factors such as correctness and completeness, and to give a value from 1 to 10. The comparison between the qualifications in both groups is shown in Figure 7.

According to the analysis of means in both groups, it seems that the qualifications in Group 0 were better than the qualifications in Group 1. This result does not coincide with our previous expectations, since it indicates that using a domain ontology does not improve the quality of the product of the requirements elicitation process.

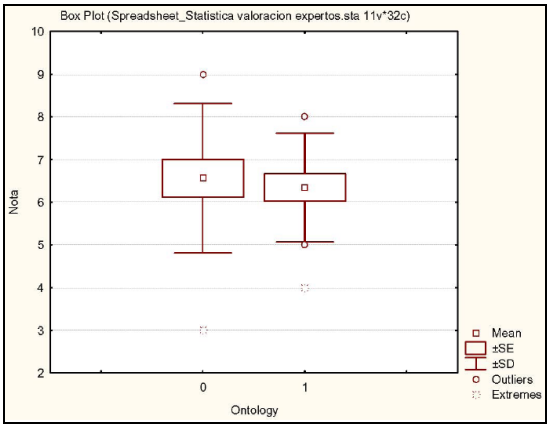

Figure 7: Analyzing the effect of using a domain ontology concerning SRS quality

5 Discussion

The previous sections show the results of a controlled experiment, in which ontologies were used as a communication facilitator during a global requirements elicitation process.

First, the stakeholders' perception of ontology usefulness was analyzed, and the results showed that most people considered the ontology to be *useful* and *very useful*, especially those people playing the role of analysts. However, when we analyzed the effect of using the domain ontology as regards aspects such as stakeholders' satisfaction and productivity, the results did not coincide with our expectations. From the analysis of the post-experiment questions given to stakeholders and external evaluators, we have concluded that using a domain ontology does not seem to improve stakeholders' satisfaction with either communication or the quality of SRS.

Although these results do not coincide with our previous expectations, we believe that it is important to discuss what the possible causes of such results are. For instance, the language difference between the stakeholders in our experiments should be noted, since although both countries (Spain and Argentina) have a different pronunciation and vocabulary, and many ambiguities may occur, they both share a mother language (Spanish), and the language difference is not, therefore, so great. The experiment should therefore be repeated in a scenario with a higher degree of differences between stakeholders' language and culture.

6 Conclusions and Future Work

In order to save costs, many organisations adopt a distributed structure for software development, which is called global software development (GSD). In such environments, software

development projects are affected by many factors which complicate communication. In order to deal with such problems, in this paper we have presented a framework based on previous generic models for requirements elicitation processes, which focuses on predicting problems and proposing different strategies to avoid or decrease their impact on GSD project performance. The suggested strategies are centred on characteristics concerning the environment in which the requirements elicitation process takes place, and also on stakeholders' cognitive characteristics.

Some characteristics of our framework have been evaluated through a controlled experiment, whose preliminary results, regarding the use of ontologies as communication facilitators, are shown here. We are aware that these results cannot be generalized because of the small size of the sample, but this experiment can be seen as a first step in a series of experiments, which must be repeated in order to contrast the results obtained in different scenarios.

Our current work focuses on analyzing the results in greater detail, and we are also analyzing the collected data, considering the effect of groupware tools selection and their effect on both communication and SRS quality.

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