Indian J. Innovations Dev., Vol. 1, No. 8 (August 2012) ISSN 2277 - 5390

Requirement elicitation problems in software development - A case study of a GSM service provider

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. **Abstract**

Most of the problems for requirement elicitation in global software development (GSD) results from the absence of physical communication ease of technology usage, cultural differences and the distance created between the stakeholders. In this study, a method for detecting the problems that occur during global requirement elicitation process, solution used for eliminating the problems, and a simulator that will enable users, especially professionals to acquire a subset of the skills needed for global software development requirements elicitation was developed.

Keywords: Requirement elicitation, Global software development, Cultural differences, Communication.

Introduction

The most crucial among the phases of software development and also the initial stage in developing the software product is Requirement Elicitation (RE). This is because the errors that occur at this stage are complicated and costly to solve due to the effects on other stages. Requirements elicitation is the practice of obtaining the requirements of a system from users, customers and other stakeholders. The practice is also referred to as requirements gathering (Sommerville Ian and Sawyer Pete, 1997). RE is the process of identifying the sources of requirements for a new system and obtaining those requirements from those sources. The potential sources of requirements include users, documents, regulators and even the legacy software codes.

Requirement elicitation process is challenged by different factors, most of which are related to communication between the stakeholders (Brooks, 1987). Also, GSD is becoming continually more common (Herbsleb, 2007; Herbsleb, & Moitra, 2001) and the distribution of stakeholders through various countries makes communication even more difficult. The geographic and temporal distance between the stakeholders increases the difficulty in developing the RE process (Cheng, & Atlee, 2007). Communication is particularly less effective because of the different time zones, which complicate synchronous communication, and distance, which makes face-to-face meetings more difficult (Herbsleb, & Moitra, 2001). Communication is also made difficult by cultural differences (Herbsleb, J.D. and Moitra, D. (2001) and lack of awareness (Herbsleb, & Moitra, 2001), which may cause misunderstandings.

Problems faced in requirements elicitation include problem of scope, insufficient input from stakeholders, ambiguous understanding of processes, conflicting stakeholder interests, inconsistency within a single process by multiple users, problems of volatility, and changes in requirements after starting the project. The impact from some of these challenging factors are decreased with the use of the proposed methodology with different strategies that detect the likely problems that can take place by taking the stakeholders' profile and their environment into account . Tools used in requirements elicitation include the traditional methods and current tools. The traditional methods include stakeholder interviews and focus group studies. Other significant methods used are flowcharting of business processes and the use of

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existing documentation like user manuals, organizational charts, interviews with end-users; process models/process specifications, on-site analysis, market research and competitor analysis. Modern current tools is better equipped to handle the complex and multilayered process of requirements elicitation are prototypes; use cases; user interfaces; data flow diagrams; and transition process diagrams.

Most studies concerning global software development have addressed technical dimensions of meeting systems or tools such as CASE (Damian et al., 2000), Carmel (Carmel 1999), suggests that the success in global software development occurs when rigour is imposed on a team. This requires greater discipline but compensates for the loss of informal communication, which allows developers "to get the job done" as structure is imposed on the team. Issues that appear most frequently in the emerging literature concerning global software development, includes loss of communication richness (Jarvenpaa & Leidner, 1998), cultural differences (Herbsleb, & Moitra, 2001), loss of identity with the team (Battin et al., 2001), and lack of management (Karolak, 1998). Michael and Kyo (Michael & Kyo, 1992) in their technical report on issues in requirement elicitation stated that the problems associated with requirements elicitation and engineering includes problems in defining the system scope, problems in fostering understanding among the different communities affected by the development of a given system, and problems in dealing with the volatile nature of requirements. These problems may lead to poor requirements and the cancellation of system development, or else the development of a system that is later judged unsatisfactory or unacceptable, has high maintenance costs, or undergoes frequent changes. By improving requirements elicitation, the requirements engineering process can be improved, resulting in enhanced system requirements and potentially a much better system.

In this study, the authors worked on a method for detecting the problems that occur during global requirement elicitation process, solution used for eliminating the problems, and a simulator that will enable users, especially professionals to acquire a subset of the skills needed for global software development requirements elicitation.

Methods and Materials

Preparing to elicit requirements

Before starting out on the requirements elicitation activities, the elicitation activities are planned to ensure that the stakeholders are understood, choice of the right elicitation techniques for each stakeholder or group, accurately prioritize the stakeholders and assign the right level of involvement, allocate adequate time and resources to the requirements gathering activities; adequately prepare the stakeholders for the elicitation sessions, and gain the trust and cooperation of your stakeholders.

Requirements elicitation techniques

There are several requirements elicitation techniques such as workshops, brainstorming, interviewing, surveys, review documentation, prototyping, interviewing, focus groups, and observation but interviewing and survey was used in the case study.

Case study

The case study was an international telecommunication company, MTN Nigeria, Abuja. The interviews are physical, with one-on-one meetings where the questions were asked by the researchers to get information from the stakeholders. This created the opportunity to obtain lots of requirements from each person. Surveys are also used to gather information anonymously from the stakeholders. The interviewees are selected based on their responsibilities in gathering requirements from clients, who were engaged in interviewing users, and who were observing users' activities, and gathering documents to construct requirements for development of the system. The users normally are not interviewed because they were not in control of the development of the case study's project manager or among the project team. The principal method for collecting data was by taped in-depth interviews. Open-ended questions were used and members of the team had freedom to describe at length their experiences and problems.

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Methodology

The Requirement Elicitation for Global Software Development method proposed different efforts used to detect likely sources of problems that might take place in a GSD project, and recommends strategies to minimize them. This proposed methodology is divided into three phases. First phase is the initial collection of data while phase two is the practical team definition and detection of problems. The last phase constitutes the requirement gathering, evaluation, prioritization, integration and validation.

In phase one, the plan is to learn everything concerning the environment and the people that will be part of the requirement elicitation process, along with the domain and main characteristics of the system under construction. In gathering the information, the authors made three groups of the stakeholders; the environment in which the elicitation will be carried out, and the characteristics of the system constructed with its areas. Questionnaires and forms are used in obtaining information about the stakeholders and about the organizational environment. The form used in collecting the information includes data concerning the stakeholder's personal information form, academic background, previous experience in software development, etc. From the form, it was ascertained that in GSD projects, it is important to have clear information about the name, date of birth, country of origin, language, etc. Information about stakeholders' jobs, responsibilities and schedules were also collected. The stakeholders' location was also considered, as it is very important for the practical virtual team. Schedules of the stakeholders' routines were taken into account. In obtaining information about the organizational environment, the organization's structure, culture, and internal policies were observed to regulate the software, to the existing environment and to avoid controversies. The groupware technologies, tools, requirement elicitation technique, and pattern of communication within the organization

In the second phase, the target was to define strategies to reduce the problems that may occur during requirements gathering, the likely sources of problems, and proposed strategies to improve the requirements elicitation process. The established sources of problems include problems caused by inadequate communication (Herbsleb, & Grinter, 1999, Sims, 2007), problems caused by time difference or time separation (Chandrasekaran et al., 1998, Herbsleb. & Grinter, 1999), problems caused by cultural differences; and behavioural differences between different cultures (Uschold, & Gruninger, 1996) and problems related to knowledge management (Herbsleb & Grinter. 1999).

Selecting strategies according to the detected problems

From the three selected strategies, some of the listed problems were reduced. In the first strategy, the cultural diversity training, it includes various approaches with the goal of making people aware about other customs and teaching them behaviour to deal with people from the different cultures of the members that form the virtual team. In the second strategy, ontologies were used as bridges to facilitate communication between people with different language, and in the third strategy, the best technology that suits the environmental features with the stakeholders' cognitive characteristics was used. These strategies were tested under inadequate communication, time difference, cultural difference, and knowledge management.

From the application of strategies for minimizing problems in GSD , the information about stakeholders' cultural differences, inadequate communication, time difference, and knowledge management were collected and analyzed. If cultural differences are detected, stakeholders should be conscious of normal behaviour in other cultures as well as being conscious of their own behaviour, which may be seen as offensive or difficult to understand by others.

The stakeholders' country of origin was analyzed. When all the stakeholders are from the same country, it was observed that there is better

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understanding among them; otherwise the ontologies will be used to create better understanding. Also, asynchronous tools can be used to enable stakeholders read and write with better concern. From the study, the author proposed using knowledge about the stakeholders' cognitive characteristics to choose the groupware tools and requirements elicitation techniques that are closer to the way in which they understand the world. In this case, two ways to select the technology, depending on the existence or not of conflicts of preferences between the team members was utilized.

Cultural difference training

As cultural differences cannot be evaded, stakeholders can learn about the differences of the other culture through training. This training is very essential because it will help the stakeholders to be aware of normal behaviour in other cultures and learn what aspect of the culture is offensive or misunderstood. The strategies used to reduce such problems are cultural mediation (considering people who have visited the site before and so to know the tradition, customs and foreign culture relative to normal behaviour become referents for communication with people at the other site. Those people are called mediators, bridgeheads (Carmel, 1993) or liaisons (Herbsleb, & Grinter, 1999), virtual mentoring (which is based on simulation and virtual actors and it can be used to motivate stakeholders in foreign language training and cultural familiarization (Sims, 2007), and literature review, seminars, courses, etc. GSD projects must deal with language differences which can occur in a variety of levels, considering the stakeholders initial language. English considered being somehow the basic language can be chosen for better understanding of domain concepts and relationships.

Using ontologies

This is for reduction of language difference, especially when all the stakeholders are from the same country of origin so there is better understanding between them. Ontologies are important during the requirements elicitation process because they clarify the structure of knowledge (Chandrasekaran, et al., 1998), they reduce conceptual and terminological ambiguities (Uschold, & Gruninger, 1996), they reduce conceptual and terminological ambiguities.

Ontologies can be classified as follows (Guarino, 1998): top level ontologies, domain ontologies, task ontologies, and application ontologies. Top-level ontologies describe all general concepts such as space, time, matter, object, event, action, and are domain independent. Their intention is to unify criteria among large communities of users. Domain ontologies describe the vocabulary related to a generic domain (such as medicine, or automobiles), by specializing the terms introduced in the top-level ontology. Task ontologies describe the vocabulary related to a generic task or activity (such as diagnosing or selling), by specializing the terms introduced in the top-level ontology. Application ontologies describe concepts depending both on a particular domain and task, which are often specializations of both the related ontologies. These lead to the proposed facts - if ontology exist in a domain, it should be used to solve ambiguities and share knowledge, but if domain ontology does not exist, the ontology can be built as part of the requirements elicitation process. The ontology will assist in communication between stakeholders and will also be part of the software life cycle, because it can be started during the requirements elicitation phase and can grow as long as the different cycles during the requirements gathering phase continue.

Technology selection

Communication can be confined to asynchronous tools, giving people the opportunity to read and write with greater care. If the time difference is extensive, technologies for communication are abridged to asynchronous technologies. Knowledge about stakeholders' cognitive characteristics was used to pick the groupware tools and requirements elicitation techniques that are closer to the way in which they learn such as in (Aranda, 2005a), and (Aranda, 2005b). The selection process uses fuzzy logic and fuzzy sets (Aranda, 2004). This was for obtaining

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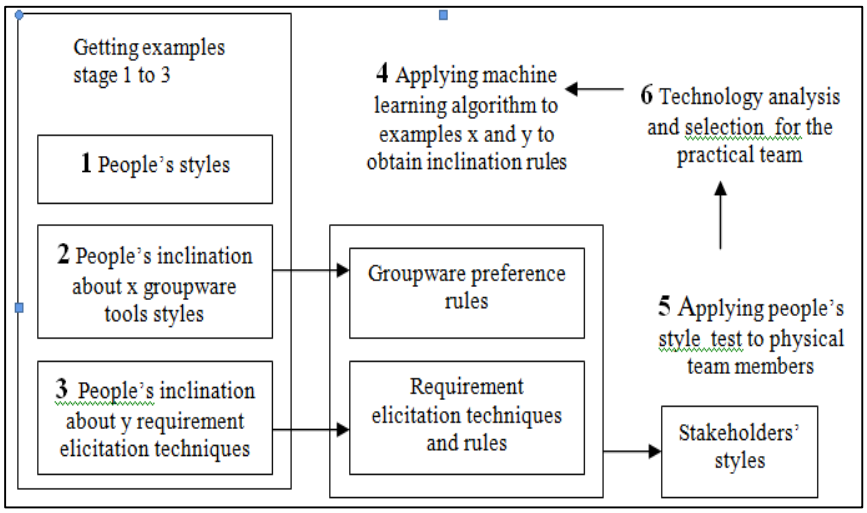

Fig.1: Sections used to define and analyze the personal inclinations in choosing the suitable technology in practical terms

the rules from a set of representative examples, in the form of patterns of behaviour. The selection process is in two sections. The first section is independent of any projects and the second is dependent on a given project.

The Fig.1 is the stages used to define and analyze the personal inclinations in choosing the suitable technology in practical teams. There are six stages; stages 1, 2, 3 and 4 are the independent ones while 5 and 6 are dependent ones. Stages 1 to 3 seek for all examples, which are stakeholders' data in using groupware tools and requirements elicitation techniques.

Machine learning algorithm as proposed in (Castro, 1999), was used. The initial rule and set of fuzzy rules reproduces the input-output of the system behaviour in stage 4. The algorithm was designed to acquire rules with maximum level of simplification, reducing the original part in order to obtain easy to understand rules with real-life examples.

An automatic tool was used in the suitable technology selection process of stage 6 by studying and confronting the personal inclination of people who need to work together.

Verification of proposed strategy in MTN

Verification One - In order to verify the two stages of our methodology, an experiment was carried out in MTN Headquarters in Abuja Nigeria. The MTN stakeholders were divided into four teams (T1, T2, T3, and T4), with four people in each team. One group was taken as the client analysts and the other group as the users. In this verification process, the client informs the analysts their system requirements through their chosen groupware tool. All groups had same problems to get through, that are time difference, cultural difference and the technologies.

The distribution of the stakeholders was performed in view of their knowledge and practice in requirement elicitation, gender and age in order to have the team members with an attempt to obtain teams with analogous features. We tested the use of groupware tools and the ontologies, noting their outcome on the requirements elicitation process, by setting up the dominant variables of time difference, culture difference, language difference and requirements elicitation techniques.

Testing process used is grouped under four selections:

S1 is the selection using suitable groupware and ontology

S2 is the selection using suitable groupware without using ontology

S3 is the selection using unsuitable using groupware and ontology

S4 is the selection using unsuitable groupware without using ontology

The four teams were arbitrarily allocated to one of the four testing selection with each team having one testing selection. None of the team members used in the testing knows about the groupware tools and ontology to enable us get accurate result analysis and then able to assess the

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teams using the suitable groupware tools and ontology obtained an enhanced performance than the rest of the teams. The questionnaire filled by each group concerning their discernment about the communication with people in their group. Variable level used to determine the teams contentment about communication are in the range of 1 to 4; where 0 stands for very bad, 1 = bad, 2 = acceptable, 3 = good, and 4 = very good. The data obtained was analyzed and summarized in Table 1.

Table 1: Assessment of team questionnaire result from collected on groupware tools and ontologies.

Selection	Suitable Groupware	Ontologies	Team
S1	High	Yes	T1
S2	High	No	T2
S3	Low	Yes	T3
S4	Low	No	T4

Verification Two - Still using the same selection method and team members for different class of group, the communication satisfaction among the teams for these selections were rated using the level of suitability. We assigned groupware tools by means of a set of rules obtained in MTN survey we did. Using selection rules S1 to S4, we were able to rate the teams in order to evaluate the group using the groupware tool suggested by the rule S1 and S2 and who will feel more comfortable that those who did not. Then people using the selected ontology (S1, S3) would feel more comfortable that those who did not. Table. 2 shows that our research observations and expectations were realized as satisfaction about communication means was higher for the selection testing process where groupware suitability was high. Also, we observed that the satisfaction for those teams that used suitable ontologies was as good as or better than the teams that did not use it.

The teams were later divided into two groups. Group one is those that used the best groupware tool according to the selection rules, and group two are those which used a less suitable groupware tool. The team that had to use the groupware tools that were not suitable for them was referred to as Group 0 while the team that used the most suitable groupware tools according to selection testing rules was referred to as Group 1.

Table 2: Analysis of assigned groupware tools for each group

Group	Team	Suitable groupware tool	Assigned groupware tool	Level of suitability
0	T1	Telephone	Email	-
0	T2	Email	Telephone	+
1	T3	Email	Email	+
1	T4	Telephone	Telephone	-

This difference between both groups indicates that the MTN stakeholders' satisfaction with regard to communication is better in the groups that used the most suitable groupware tool according to our set of rules.

Conclusion

Most problems of the requirements elicitation stage increases when stakeholders are working on a global software development project. In order to fulfil the challenge of successfully carrying out the requirements elicitation process in a GSD environment, requirements specialists need a suitable preparation and must understand the different techniques used in RE. It is very essential to choose the most suitable tool for communication, because when stakeholders are distributed in different MTN sites, they must communicate with groupware tools.

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