A Protocol for Requirements Elicitation Challenges Model

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Abstract: Software engineering plays a vital role in making a process cost effective. The basic role of requirements engineering (RE) is to collect information for cycles involved in the development of a software. This study uses systematic literature review (SLR) in order to pinpoint the challenges which may be hampering the vendors in offshore requirements elicitation. Benchmark practices are collected for the requirements elicitation challenges from existing literature through SLR and from software industry experts. The ultimate goal of this research project is to develop requirements elicitation challenges model (RECM), which will assist the outsourcing vendor organizations to overcome various challenges faced during requirements elicitation.

Key words: Requirements elicitation, Challenges, Vendor, SLR, RECM, Software engineering.

INTRODUCTION

Requirements engineering (RE) is an intensive process that involves all the stakeholders. It involves requirements elicitation, specification of activities and their analysis (Asghar and Umar, 2010; Laurent *et al.*, 2010). Moreover, it faces the challenges of globalization, as projects are distributed across the world with the stakeholders located at different locations and different sites (Castro-Herrera *et al.*, 2009; Laurent *et al.*, 2010). In this scenario, it is quite difficult to implement face to face brainstorming meetings or joint application design sessions. Though such meetings and designs greatly facilitate the projects which are located in the same locality, they pose many challenges to the projects with multiple sites. Therefore, globalization poses a major research problem in the field of requirements elicitation (Cheng and Atlee, 2007; Laurent *et al.*, 2010).

An important problem involved in RE is to dig out the actual needs of users. Literature reveals that insufficient requirements are accountable for the failure of many projects. Also, socio-cultural factors affect this inadequacy of requirements (Davey and Cope, 2008). It is an arduous and complicated process to develop huge system (Goguen and Linde, 1993; Asghar and Umar, 2010). Previously, this process was not well organized and the programmers were preoccupied with recording codes, which were

necessary. Now, it has been acclaimed that tasks need proper management and planning. It necessitates that every system should have different phases in its development. The first phase of any system, particularly, in computer sciences, consists in requirements engineering science (Goguen and Linde, 1993).

Requirements engineering has the following various related issues (Cheng and Atlee, 2007):

(i) how to define its scope,

(ii) how to create understanding among various social groups, which the system can affect in either way, and

(iii) the pressing issue of ever changing nature of users' needs (Christel and Kang, 1992; Sharma and Pandey, 2014).

Such issues may result in insufficient information regarding the needs of the users, which may, in turn, result in dropping the whole project all together, or else may result in unsatisfactory development at a later stage which may involve recurrent modifications accompanied by greater expenses on its maintenance. Improvement in elicitation of requirements is a determining factor for the success of requirements engineering which leads to the production of a better system (Christel and Kang, 1992).

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RE has multifarious activities that include requirements gathering, specification of requirements and its validation. The prevalent techniques attempt to explore the issue of how to represent the requirements or to specify them (Christel and Kang, 1992). The first step in RE is the data collection or requirements elicitation (Davey and Cope, 2008). Software engineering faces many problems, but RE poses the main issue in software development process (Christel and Kang, 1992). Requirements elicitation is the process which involves the programmers, stakeholders and, for the most part, the requirement analysts. However, stakeholders face some technical problems in requirements elicitation process (Christel and Kang, 1992).

Requirements elicitation may be termed as a process which involves the gathering of requirements of the customers to realize their needs (Nahar and Student, 2013). The basic aim of this process is to functionalize a software project within time and cost in order to cater the satisfaction of customers (Nahar and Student, 2013). In this process, the desired needs of the customers are highlighted and for successful materialization of the said process, stakeholders are connected and involved (Christel and Kang, 1992). The main phases of RE can be divided into requirements gathering, specification and validation (Christel and Kang, 1992).

Unsatisfactory requirements elicitation process may cause a lot of damage. The whole software development process depends upon the satisfaction of requirements elicitation process, otherwise the programmers may fail in realization and development of software (Hickey and Davis, 2003; Davey and Cope, 2008). Thus, it may cause wanted problems, e.g. the cost of the project, time and energy, which may often result in complete failure of the system (Davey and Cope, 2008). Thus, in requirements elicitation, the needs of the stakeholders are determined and the requirements of the end-users are dug out. Therefore, requirements elicitation may be described as one of the vital activities of software development projects (Muqeem and Beg, 2012). The first phase of the Software Life Cycle is RE and it involves the following:

- Informal ideas get specification and production
- Goal: Specification of requirements
- Specification of system requirements which details both the software and hardware
- Specification of software requirements only define the software
- Requirements elicitation describes the function of the system not the manner of its function
- It is most vital influencing factor in software development process

- Failures in requirements elicitation may cause greater losses in subsequent development of software projects

During current study, various methods, models and language specification have been suggested to address the issue of consistency and precision in requirements. In conventional practices and research, methods have been used to separate data, behavioral and functional features of needs, and selected software. For this purpose, specific models have been built. It may be illustrated with the usual creation of an operational model with the help of prototypes which can be directly practiced by stakeholders (Hofmann and Lehner, 2001).

Research in RE is largely situated in conceptualist tradition which focuses on proper techniques and methods to address the issues on a particular study. These case studies do not investigate the relationship between practices in the real world and performance. It reflects that there is an urgent need to investigate RE practices in order to make a particular software project a success (Hofmann and Lehner, 2001).

The proposed protocol focuses on issues relating to elicitation (techniques) and challenges of RE faced during elicitation process. An elicitation methodology (protocol) is suggested to overcome these issues (Christel and Kang, 1992).

BACKGROUND

RE is a complex process which involves gathering, specifying, maintaining and validating the requirements of the end users. Its main function is to satisfy the requirements of the customers at low cost in minimum time. It serves as the foundation for the development of a software. In other words, software development is the main function of RE. The main reason for this is that software requirements reflect the stakeholders' actual needs, which are to be satisfied by software application. The software requirements describe those services, which are to be rendered (Asghar and Umar, 2010).

On many occasions, the product managers have been observed to be unable to communicate their intended meaning regarding their needs. This, in turn, provides the architects fragmentary data which is not satisfactory to suggest any modification in the design for the solution of an existing issue. It makes the elicitation a cyclical process, in which the management does not approve. Such scenarios lead the product managers to increase the control and attempt to find solution to pressing problem themselves in order to develop a product and to make it successful and acceptable (Fricker *et al.*, 2009).

In RE, the most vital activity for a system development is that of requirements elicitation. It occurs during the early stages of system development and it strongly draws on the communication between the customers and the developers (Pa and Zin, 2011). Thus, it has been stated that requirements elicitation is

the most crucial activity, on which information software development system depends. Though, sufficient data exists on the requirements elicitation tools, techniques and models, yet this activity calls for more refined, correct and unambiguous approaches to avoid the failure of information systems. The most pressing issue during this process is that of communication among different communities. This communication gap always causes two major problems in respect of stakeholders, i.e., either they do not know their actual needs or they cannot express themselves (Farinha and da Silva, 2013).

Complex communication between the stakeholders and the analysts always leads to errors in requirements elicitation because the stakeholders are always clear about their requirements, while the analysts may not be able to grasp the business concepts. Existing research demonstrates that the requirements elicitation has always been ineffective due to complex communication between the analysts and the stakeholders (Farinha and da Silva, 2013).

Since long, the researchers and developers have been recognizing requirements gathering as the most vital activity in projects involving software development. Research shows that the conventional practices of elicitation are not successful in their application to larger projects. This is because in larger projects, the knowledge distribution among the stakeholders poses the problem of geographical dispersing in different locations. This has led to the introduction of fresh elicitation tools as is the case with Wiki pages and online forums (Castro-Herrera *et al.*, 2009).

In a software project, the requirements elicitation phase involves various interrelated activities. These activities include identification of stakeholders and their brainstorming for outlining their specific needs and desires for a proposed system. In other words, requirements elicitation includes a variety of activities, such as, interviews, brainstorming sessions and surveys (Castro-Herrera *et al.*, 2009; Laurent *et al.*, 2010). However, the success of these techniques depends upon the identification of an appropriate set of knowledgeable stakeholders and its inclusion in the process, in order to incorporate their views into requirement specification after being discussed. The recent advances in software development, particularly the project scope and its complexity and the extension of software development from local to global level (where the stakeholders' views are seldom taken) have posed serious challenge to the applicability of traditional techniques. These trends have led the software organizations to use online tools such Wiki pages and forums for elicitation requirements to capture the basic needs of stakeholders (Castro-Herrera *et al.*, 2009).

Problems in the existing system are investigated during requirements elicitation stage, however, during the period of development of an application these errors are not usually identified. Rather they remain concealed from the observation until the full operationalization of the system, thereby, making it clear that end users' needs are not fulfilled. Many researches pointed out that during elicitation process the fixing of error is of little value, as compared to its value in the software development phases. Therefore, requirements elicitation plays the most important role in the development of applications (Asghar and Umar, 2010).

In software development, the distinctive feature of requirement phase is the intricate communication with a wide range of people from different backgrounds, having different skills, status and knowledge. The aim of communication is to dig out the problem and to share its knowledge among different stakeholders. The complexity, wide range and ever changing nature of requirements have made the communication more difficult. Moreover, it needs more effort to remove the communicative gap, such as, semantic divides, which may otherwise play a decisive role among different stakeholders, such as, users and designers (Castro-Herrera *et al.*, 2009). Effective communication is the elusive objective to be achieved and is consistently posing a huge challenge to requirements elicitation (Coughlan and Macredie, 2002).

In the development of complex systems, the requirements elicitation does not call only for obtaining and processing of the needs of end users. It is because these systems often have different and diverse stakeholders with diverse and often conflicting requirements. Therefore, there is more likelihood of confronting issues, such as, the cost and quality of the system, and the time duration of its completion and functionality. This necessitates the understanding of the whole conceptual domain, complete expertise over the technology to be used and clear vision of the constraints relating to the technical and managerial aspects of the project on the whole. Thereafter, the existing business processes are required to be made more obvious and the new technologies to be used are to be made prototypical. Such experience can lead to lay the foundation of contract requirements on solid footing and to draw a more realistic and factual estimate of the size of the project and the effort (Demirörs *et al.*, 2003).

The most fundamental errors in requirements elicitation may directly affect the development of the software and the most problematic issues in repairing are classified (McDermid, 1989). The scope of the system is the ill-defined boundaries of the system. The design information given may then be unnecessary or the most desired design information may be missing. Understanding of the system at the end users may have poor and insufficient understanding of their actual needs, or the core problem may be allusive for the analysts. There may be a communication gap, as a result of the language-use by the analysts and the users, such as, figurative or literal usage of language and, hence, a more clear information may be missed out. Moreover, there may

be a clash of needs or perception of needs among the end users. Thus, the requirements may get expression, which is vague in nature, such as "robust" or "user friendly".

Volatility of requirements is the basic thing behind the requirements which changes with time. This may be due to the actual change in needs or in change in perception of the end users and other stakeholders (McDermid, 1989; Rajagopal *et al.*,, 2005).

Volatility is one of the biggest problems, which the requirements elicitation process faces, because with the passage of time, the needs of the end users evolve (Brooks, 1987). However, so far, no traditional requirements elicitation has been able to specify or to use any available early software requirements elicitation detection technique to overcome this issue. Data requirements is the first phase of elicitation. In its first phase, elicitation uses brainstorming and structured or unstructured interviews. However, on account of lack of proper understanding and analysis of resources and constraints of time, elicitation may face either the problems of the lack of input from the users or unrealistic input from the users, despite the fact that the interviews may be well structured and the developers may have a proper understanding of their objectives and are ready to know what they may ask (Rajagopal *et al.*, 2005).

In multilingual situations, the established procedure is the employment of a translator to translate the things which are communicated in a new language. However, whether one or more languages are used, the problem persists because words have different meanings for different stakeholders belonging to different domains, such as, manufacturing, technical, marketing, managerial, etc. Thus, even with an identified keyword, it may not have the same meanings to all, giving rise to vagueness. This problem can be solved by the use of visual images along with the keywords, i.e., the identified keywords may be explained with visual images, as images are like speaking objects that may be understood by anyone across the world, having cross cultural orientations. This labeling process, by giving each keyword a specific picture, may help the stakeholders to come to an unanimous agreement on its meaning. The agreed meaning of the keyword then can be conveniently reminded and shared with one another (Rajagopal *et al.*, 2005).

Successful design of any software system depends crucially on the first stage of the development of a software-based system (Yu, 1997). During these early stages of software development, the requirements solicited by the end users or other stakeholders are to be elicited, negotiated, specified, analyzed and evaluated for successful designing of the system (Widya *et al.*, , 2009).

Although, RE has been regarded as a complex process since long, the factors behind its complex nature are diverse like the complex nature of communication between the analysts and stakeholders, clash of interest and the standard and quality of identified requirements. There is a high risk of errors in requirements elicitation process on account of the rich communication between the analysts and the stakeholders. It is highly probable that the stakeholders may not recognize or spell out their actual requirements and the analysts may fail to grasp the concepts of business on account of the cultural gap between the stakeholders and the analysts (Zowghi and Coulin, 2005).

In literature, different methods for requirements elicitations have been reported. Most of these methods have been adopted from social sciences and other disciplines and, only a few methods have been developed for software requirements elicitation. In this respect, it is the major task of the industry to come forward and take suitable steps for solving the social factors of requirements elicitation to achieve the business goals and satisfy the actual needs of the end users (Farinha and da Silva, 2013).

In software development, the issues of requirements elicitation have become more vital and critical (Browne and Ramesh, 2002). It is due to the fact that the success and failure of the whole software project depends on the quality of requirements elicitations (Hickey and Davis, 2003). The most debated issues in requirements elicitation are the sources of requirements, the techniques and tools used and the problems being faced during requirements elicitation. This process also includes the conversion of data to meaningful information documented as software requirements. This is in reality a negotiating process, which is undertaken to obtain a unanimous agreement of the stakeholders regarding the software system to be developed. It has been stated that this process has four constituent activities, i.e., communication, negotiation, setting priorities and cooperation among the stakeholders (Gruenbacher and Braunsberger, 2003; Pa and Zin, 2011).

It is true that valuable contributions have been made by the researchers in the development of various techniques and tools for different requirements engineering processes, but the field still has many horizons to be explored (Sharma and Pandey, 2013; Sharma and Pandey, 2014). It requires further research to find out new ways for the solution of the current issues, which is blocking the quality of requirements elicitation. The key challenges in requirements elicitation include the problems in defining the limits of the system, the problem of lack of understanding among various groups (to be affected by the development and improvement of a system) and the problem of the volatile nature of requirements of the end users (Sharma and Pandey, 2014). These problems may result in low quality requirements elicitation, which may, in turn, bring about the termination of the system growth and progress or may cause inefficiency of the whole

system, thereby, leading to extra maintenance costs or recurrent changes in the system (Sharma and Pandey, 2014).

Senior management may play an important role in the creation and adoption of corporate policies and for a greater commitment. Moreover, the management's role is important in the identification of stakeholders and their actual requirements and it should proceed on the basis of requirements to design policies. The team members discuss and negotiate the effects of the policy upon the business scenarios. These discussions over a period of time may lead to the convergence of opinions and the formulation of final policy (Callele and Wnuk, 2011).

RE has been acclaimed as the vital component of software development (Aurum and Wohlin, 2005). It is a process to identify and grasp the needs of the stakeholders. It elicits and manages those requirements which are necessary for the project (Condon, 2002). However, such endeavors get complicated when the stakeholders are located in different geographical boundaries (Damian and Zowghi, 2003; Callele and Wnuk, 2011). Breaux and Antón (2005) used semantic models to inquire into the interaction of requirements with privacy policies and to achieve the goals from the policy statements (Callele and Wnuk, 2011).

METHODOLOGY

Systematic literature review (SLR) protocol:

This study aims to contribute to design a SLR protocol according to the guidelines of Kitchenham *et al*. (2009), for Requirements Elicitation Challenges Model (RECM). The SLR consists of planning, conducting and reporting the review. The planning phase has the sole purpose to design the protocol of systematic review that will outline the review's aim and procedure. This study hypothesizes that the possibility of a researcher can be reduced to a minimum level by a pre-defined and well-constructed review protocol. Various protocols have been consulted for guidance in the designing of this protocol.

Research Questions:

RQ1.   What are the challenges of requirements elicitation that should be addressed in offshore software development by vendor organization?

RQ2.   What are the real world practices of the challenges of requirements elicitation?

Authors and Affiliations

In the construction and designing of the search term related to the research questions, the following terminologies have been employed for assistance.

Population: Software outsourcing vendors and clients.

Intervention: Success   factors,   barriers, characteristics.

Outcomes of relevance: Efficient contract management, effective contract management model.

Experimental   Design: Empirical   studies, systematic literature review, theoretical studies, experts' opinions, case studies.

The   research   question   employing   the terminologies detailed above can be exemplified as under:

RQ1. [What challenges/issues] … "INTERVENTION" of [offshore software vendor organization] …. "POPULATION" that addressed by [Requirements elicitation   challenges]   ….   "OUTCOMES   OF RELEVANCE"

RQ2. [What are the real world practices] ……… "INTERVENTION"   as   identified   in   [Software outsourcing   literature]   …   "POPULATION"   of [Requirements   elicitation   challenges]   ….. "OUTCOMES OF RELEVANCE"

Research Strategies

A.   Constructing Search Terms

The following string was used in conducting a trial search in online digital databases, such as, IEEEXplore, Springer Link, ScienceDirect, and ACM digital library.

(("Requirements engineering" OR "Requirements elicitation"   OR   "Requirements   gathering")   AND (vendor OR supplier OR provider) AND (Challenge OR challenges OR risk OR threat) AND (practice OR solution OR advice))

B.   Identifying Search Terms Characteristics

For the construction of the search terms in strings the following strategy has been employed.

1.   In derivation of the major terms, Research Questions have been used, identifying the population, intervention and outcome.

2.   Search has been made for the synonyms and alternative spellings of major terms.

3.   The verification of key words in the relevant papers.

4.   Boolean   operators   have   been   used   for conjunction if the database allows, in such manner as is the case with the use of "OR" operator for the concatenation of alternative spellings and synonyms, whereas "AND" for the concatenation of major terms.

5.   The integration of the search strategy in a summarized form if required.

Results for a)

RQ1:   Offshore   software   development,   vendor organization, challenges.

RQ2:   Offshore   software   outsourcing,   real   world, practices, solution, requirements elicitation.

Results for b)

a) RQ1:

Requirements Elicitation: ("requirements elicitation" OR "requirements gathering" OR "requirements collecting")

Vendor(s): (vendor OR vendors OR service-provider OR dealer OR trader OR marketer OR seller OR developer)

Challenges: (challenge OR issue OR risk OR threat)

b) RQ2:

Requirements Elicitation: ("requirements elicitation" OR "requirements gathering" OR "requirements collecting")

Software outsourcing: ("software outsourcing" OR "information systems outsourcing" OR "information technology outsourcing" OR "IS outsourcing" OR "IT outsourcing" OR "CBIS outsourcing" OR "computer-based information systems outsourcing" OR "software facility management" OR "software contracting-out")

Practices: (practice OR solution OR advice)

Result for c)

Requirements elicitation, challenges, risks, vendor organization, offshore software development, practice, solution, advice.

Result for d)

RQ1:

(("requirements elicitation" OR "requirement gathering" OR "requirements collecting") AND

(Vendor OR vendors OR provider OR supplier) AND

(Challenge OR issue OR risk OR threat))

RQ2:

(("requirements elicitation" OR "requirement gathering" OR "requirement collecting") AND (practice OR solution OR advice))

C. Resources to be searched

- IEEE Xplore (http://ieeexplore.ieee.org/Xplore/guesthome.jsp)

- ACMPortal (http://dl.acm.org/)

- ScienceDirect (www.sciencedirect.com)

- Cite Seer Digital Library (www.citeseer.ist.psu.edu)

- SpringerLink (www.springerlink.com)

- Google Scholar (www.scholar.google.com)

D. Search Constraints and Validation

The searching, conducted for related search in the literature, does not have time limits or date boundaries. The major search terms are:

(("Requirements engineering" OR "Requirements elicitation" OR "requirements gathering") AND (vendor OR supplier OR provider) AND (Challenge OR challenges OR risk OR threat) AND (practice OR solution OR advice))

Selection of Publication: This section deals with the criteria for determining the primary sources which are to be selected, included or removed. The publications which bear relevancy to the research questions will be considered. Requirements elicitation challenges faced by offshore software organization during development process are the focus of this study.

Inclusion criteria

The inclusion criteria are used in order to define the part of literature (papers, technical reports, or "grey literature") found by the search term which will be used for data extraction. The focus has been on requirements elicitation challenges and those papers which are written in English. The criteria are outlined below:

- Research papers which deal with the requirements elicitation challenges in offshore software development.

- Papers which deal with defining the capabilities of the vendor in offshore software development.

- Papers which deal with the practices for the requirements elicitation challenges.

- Papers which deal with the relationship between the vendor organization and offshore developers.

- Papers which deal with defining criteria for a successful requirements elicitation challenges model.

- Papers which deal with the role of the vendor in the offshore software development.

- Papers which are written in English language.

- Papers whose title is relevant to outsourcing contract management.

- Papers containing the keywords which match with the keywords as defined in the search strings.

Table 1: Search results on different databases

	ACM	Science Direct	IEEE Xplore	Springer Link	Google Scholar	Total
RQ1 & RQ2	175	827	303	1525	13,500	16,330

Exclusion criteria

The following exclusion criteria, as the name suggests, are used to omit the papers, technical reports, or "grey literature" which are found through the key term.

- Papers which are not relevant to the research questions.
- Papers which are not concerned with either the vendor of the client.
- Papers which do not deal with the challenges or practices in the offshore software development.
- Papers which do not deal with the offshore software development.
- Papers which are not satisfied with offshore software development.
- Papers which are based on the opinion of the experts.
- Papers which are in duplicate.

Selecting primary sources

The main objective of the initial selection of primary sources criteria is to review the title, keywords and abstract of the papers. It helps to exclude the results which are not relevant to the problem of the current paper.

This criterion of selecting primary sources is conducted to serve as a check on criteria regarding inclusion and exclusion by reviewing the articles completely. In case of uncertainty about the selection or omission of a particular article, secondary reviewer is needed for evaluation of the source. The primary source record is properly maintained with respect to the inclusion or exclusion criteria. The recorded data of the primary source is usually required in decision making whether to include or exclude it, in the final review.

Publication quality assessment:

After the final selection of publication has been made, its quality measurement is carried out. The assessment of its quality is done at the juncture of the extraction of data. This quality assessment is carried out on the basis of the following questions:

- Is it clear how the screening of the vendor has been performed?
- Is it clear how the vital challenges of the requirements elicitation process, faced by the vendor organization, have been recognized and found out in the offshore software development?
- Is it clear that the expert opinion was not taken?

The above outlined factors have been marked as "YES" or "NO" or "NA".

The supervisor (secondary reviewer) will score a small subset for validation.

Data extracting strategy:

Primary study data: This study performed data collection from the publications which focused on satisfying the research questions for the review. The data from each publication has been extracted in the following manner:

- Publication details (Title, Authors, Journal/Conference title, etc)
- Data that address the research questions.

The following data will be extracted that address the research questions:

RQ1

Background information, elicitation challenges: what are the elicitation challenges that should be addressed in offshore software development.

RQ2

What are the real world practices of requirements elicitation challenges?

During data extraction process, the primary researcher who is responsible for data extraction from the publications shall start the primary review. The function of the secondary reviewer is to provide guidance to the primary researcher in case of any difficulty or problem in the data extraction.

After the completion of the data extraction process, the primary reviewer shall be responsible for its inter-rater reliability test. The secondary reviewer will opt for random selection from publications which the primary reviewer had selected. The job of the secondary reviewer is to carry out data extraction from these random designated articles independently. Thereafter, he will compare his results with the findings of the primary reviewer.

Data synthesis: At data synthesis stage, one summary table will be created having columns including S.NO., Requirements Elicitation challenges, frequency, etc., highlighting the list of all the challenges in offshore software requirements elicitation with their frequencies and percentages.

RESULTS AND DISCUSSION

This study is a protocol paper that provides roadmap for the future research work. According to Kitchenham *et al*. (2009), SLR is a protocol base literature review for gathering literature, extracting data and synthesising data in a systematic way. In this study, it is planned to use SLR for gathering the challenges faced by the vendor organisation in requirements elicitation during outsourcing software development. First, a study will be developed to collect the relevant papers from the literature on the basis of their title, keyword and abstract. After that, each paper will be thoroughly read and, finally, all those papers will be selected which fulfil quality requirement and will be challenges, extracted from the finally selected paper.

CONCLUSION

The goal of this study is to develop requirements elicitation challenges model from a vendor's perspective. This model will assist the vendor organisation in requirements elicitation for offshore software development outsourcing activities. During this study, if any variance occurs from the protocol, it shall be recorded.

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