MODERN TRENDS TOWARDS REQUIREMENT ELICTIATION

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ABSTRACT:

Requirements Engineering (RE) can be said as a group of activities which help us to find and communicate the need and purpose and context of system. RE process starts from gathering of requirements i.e.; *requirements elicitation.* Accurately capturing system requirements is the major factor in the failure of most of software projects. In this paper, analysis of data is provided gathered from practitioners. Results obtained from data and discussion about the results is lead to extract the modeled guidelines for elicitation techniques. We also propose an efficient plan for requirements elicitation which intends to overcome on the constraints, faced by practitioners.

KEY TERMS: Elicitation, ethnography, repertory grid, focus groups, laddering, prototyping, contextual inquiry, JAD/RAD, practitioners, story boards.

1. INTRODUCTION

Increasing demand of quality in the field of information technology has lead to the research in the field of 'requirement engineering'. A requirement may be considered as "a statement of a system service or constraint" .IEEE defines requirement as *"a statement of system functionality that must be met by a system to satisfy a customer's need, objective and that is qualified by measurable conditions and bounded by constraints"*(IEEE std 1233, 1998).Requirement engineering is a systematic way to gather requirements in such a way that no errors are left behind and thus the system comes up with the up to the mark functionality. Requirements Engineering (RE) can be said as a group of activities which help us to find and communicate the need and purpose and context of system. We can say that requirement engineering is a collaboration between the customer needs and the developers. It helps to explore the customer needs and demands, what they want in their system. We call them system capabilities, features or functions. RE process starts from gathering of requirements i.e.; requirements elicitation. In 2006 C. J. Davis et al discovered that "*accurately capturing system requirements is the major factor in the failure of 90%of large software projects*". Their work was reflection of Lindquist (2005) according to whom *"poor requirements management can be attributed to 71 percent of software projects that fail; greater than bad technology, missed deadlines, and change management issues. The cost of this failure is enormous."* [5]. Elicitation is all about determining the needs of stakeholders and discovering what the user wants. It is one of the most critical activities in software life cycle. Studies by [3] show that 70% of the systems errors are due to improper requirements and remaining 30% is due to the design faults. Requirements may be elicited via use cases and misuse cases. "Use cases have proven helpful for elicitation of communication about, and documentation of the and misuse cases provides a systematic way for the elicitation of both the functional and non functional requirements"[2].

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2. REQUIREMENT ELICITATION TECHNIQUES

Four basic methods are there

1. Conversational method
2. Observational method
3. Analytical method
4. Synthetic method

2.1 Conversational Methods

This is a verbal way of communicating between people. Typical method includes interviews, workshop, focus groups; brainstorming etc .The table below shows the method, conductor and a brief discussion over these techniques. Brief description is given below.

Interviews:

Analyst discusses products with different group of people to get maximum information regarding the requirements .Interviews can be open or structured.

Experience analyst having generic information regarding application domain, conduct interviews.

Workshop and focus groups:-

Stake holder's representative conduct meetings for a short time and intensively focused over the agenda. Conductors are usually Outsider facilitator.

Brain storming:-

Stake holder's representative gathers and hastily develop large list of ideas .This offers both the ideas generation and idea reduction. Conductors are usually Outsider facilitator.

2.2 Observational Method

This method is a mean of developing a rich understanding of application domain by observing human activities. It is to observe the routine of the people and gain knowledge of the domain which is difficult to be explained verbally. It falls into the category of 'longitudinal studies' and usually take longer periods than any other method. But it is a good practise to start requirement gathering with this method. Even nowadays this method is used in many software industries to elicit requirements. It is used to gain initial understanding of the system and the application domain, detailed understanding of social/organizational cultures, work setting (team interaction and work flow).Information relevant to design solutions, interact ion problems in existing systems and work context and work flow. Brief overview is given below.

Protocol analysis:-

A person under observation is engaged in some task, and in sync speaks out loud and explains his thought.

Ethnographic study:-
A person is attached to the environment for the purpose of observation, by observing the people and their practices, requirements are gathered. The observer must be accepted by the people and he must not hinder their normal routine. Social factors and organizational factors are observed without disturbing the people or staff of the organization. Ethnography aimed to solve a specific problem is termed as "focused ethnography". Protocol analysis and ethnography are related.

2.3 Analytical Method

Analytical method deals with the analysis of the gathered information via the above mentioned techniques. It is used to get knowledge of domain requirements, user interface characteristics, organizational policies, standards, legislation, etc, market information, specification of legacy systems. Some of these methods are as follows

Requirement reuse

"Reuse of the glossaries and specification of legacy systems or systems within the same product family to identify requirements of the desired system."[1]

Laddering

It is an interviewing technique, used to uncover and unfold the different attributes regarding some problem. Questioning is done often in the *"form of ladders (i.e. tree diagrams)."* [1]

Card sorting

"*The expert is asked to sort into groups a set of cards each of which has the name of some domain entity written or depicted on it.*" [1]

Repertory grid

"Stakeholder is asked for attributes applicable to a set of entities and values for cells in entity -attribute matrix" [1]

2.4 Synthetic Method

No single method for requirement elicitation can be thought of a perfect one. And are selected based on the scenario. For example it is good idea to start the requirement gathering with open ended in review or documentation study before the staring of analysis, followed by ethnography. This aids to gain general information of the application domain.

Instead of combination of individual methods, the synthetic method forms a coherent whole by systematically combining conversation, observation, and analysis into single methods. Analysts and stakeholder representatives communicate and coordinate in different ways to reach a common understanding of the desired product. It is used for gaining clarified system requirements related to procedures and data flows of a task, in a highly uncertain situation, an effective and relatively inexpensive way to develop an initial set of requirements, product feature and detailed specifications an early and realistic view of what was feasible. They are also referred as collaborative methods [1]. These techniques are as follows.

Scenarios, passive storyboards

"It is an interaction session to describe a sequence of actions and events for a specific case of some generic task which the system is intended to accomplish" [1]. Scenarios are used widely used in HCI (human computer interface)[4].Since scenarios are to depict the interfacing of human with the system, they are an effective tool for requirement elicitation. And is one of the most advanced techniques. Scenarios are situations that lead to the fulfilment of particular goal and thus the requirements Scenarios and goal are interlinked. Identifying goals is indirectly analogous to identifying a requirement. The Goal-Based Requirements Analysis Method uses goal topography to structure and organize such requirements information as scenarios, goal obstacles, and constraints. *"They support analysts in finding and sorting goals into functional requirements while scenarios help in documenting issues, surfacing new goals and elaborating requirements. Goal hierarchies offer a useful way to visualize goals and their related scenarios as does the previously discussed scenario management strategy also organizes scenarios hierarchically according to goals and goal obstacles; the goals serve as a grounded, shared understanding for stakeholders*" [10]. Finally, goal scenario

coupling provides an integrative approach to goal and scenario oriented requirements analysis".[4]

Prototyping, Interactive storyboards

Incomplete software versions or different models of system are built so that customer may get clear understanding of the end product. "*It is often used to elicit and validate system requirements* "[1]

JAD/RAD sessions

"*The goal of JAD (Joint Application Development) is to involve all stakeholders in the design phase of the product via highly structured and focused meetings*."[2].Typical participants in the session involve end users, developers, observers and a facilitator. The requirement engineering team is assigned task to find and gather information. The output of this assignment is taken as requirements. The real JAD session is then used for validation of the requirements. This method is the most modern way for requirement elicitation, as JAD is one of the most modern and efficient way of software development nowadays. But too much JAD session must be avoided in order to avoid customer's feelings that developers are shifting their responsibilities over them.

Contextual inquiry

It is a combination of open-ended interview, workplace observation, and prototyping. This technique is suitable for interactive systems because they have critical user interface design .[1] The conductors involve analysts and stakeholder representatives.They coordinates to reach a common understanding of the requirements.

3. GSD METHODOLOGY

In this methodology RE-GSD (Requirement Elicitation for Global Software Development projects) advanced problems that might take place in projects in advance are gathered and the strategies are suggested to lessen them. According to Carmel "*the distinguishing features of global software development teams are distance, time-zone differences, and cultural differences*". [11]

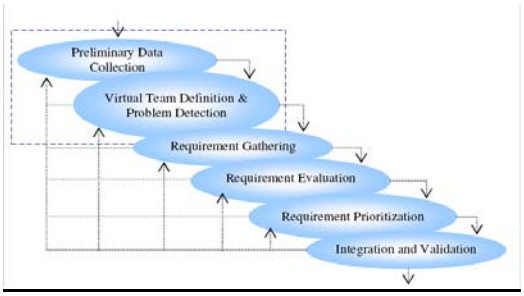

Figure 1: RE-GSD process

4. ANALYSIS OF DATA:

Until now we have studied the elicitation techniques for requirement engineering. We wanted to check that how many of these methods are used by the practitioners and in which conditions. We wanted to find out the gap between the practical and theoretical knowledge of requirements elicitation To identify the recent trends in the software development industry, we conducted a survey for which intended audience were of two categories,

a) Practitioners
b) Researchers

Elicitation techniques which we have included in our research are;

a) Interviews & Surveys
b) Checklists
c) JAD/ RAD
d) Scenarios/ Story boards
e) Ethnography
f) Existing Systems Study

Similar survey forms were designed for both of them. The data obtained from them was compiled and results were obtained. In this section we will provide these results which we have obtained after compilation of data.

Although the data was complied separately, but to get clear understanding and visibility of the combined trend of the researchers as well as practitioners, we have presented the data in comparative manner.

4.1. Effect of Elicitation on Project

In the figure 2, we see that the trend of both of the groups is much correlating with each other. The correlation of both of them is 0.69045. Majority of practitioners (P-group) and researchers (R-group) agree that requirements elicitation counts more than 71% in project's success or failure.

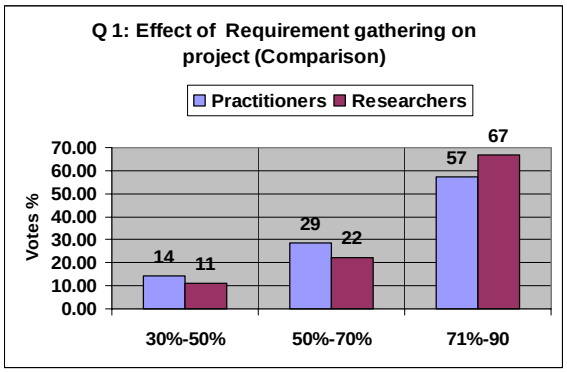

Figure 2: Effect of elicitation on project's success

And this statement is also verified by the C. J David et al, 2006. According to him, more than 90 % major projects fail due to the inaccurate requirements capturing.

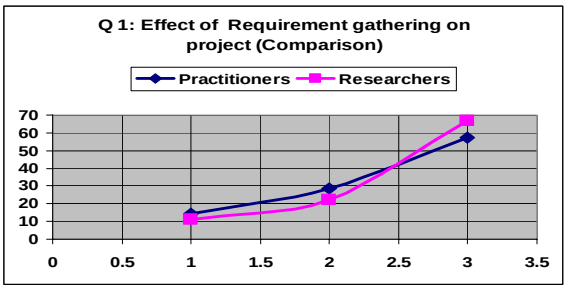

Figure 3: Correlation in groups = 0.7approx

The results are showing that P-group and R-group both are aware of the importance of requirements elicitation for a project.

4.2. Elicitation methods mostly used

Researchers were asked about the methods of requirements elicitation which they used in their projects. Similarly, practitioners were asked about the recent and current methods which were used in their organizations for projects. We can see the comparative results of the findings.

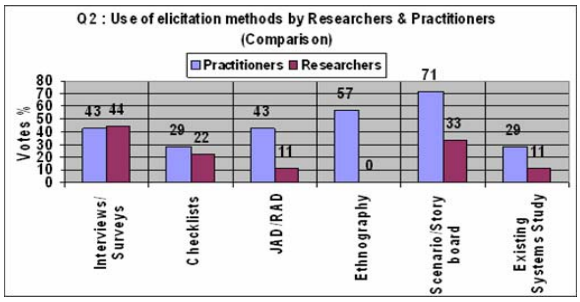

Figure 4: Use of various elicitation methods

The trend of both groups varies for each approach. In case of Interviews/surveys & checklists, the trend is alike. But for other techniques, it keeps dispersing. Methods of common interest for P-group and R-group are;

a) Interview/ Surveys
b) Checklists
c) Scenario/Story boards
d)

Important thing to note is response of R-group against JAD/RAD and Ethnography. They have very low usage rate. The reason is that these both methods require much resources and time. Therefore R-group didn't prefer them in their limited time and budget projects.

4.3. Elicitation method for Specific type of project

Its quite obvious that the selection of a requirement elicitation method also depends upon the development process. In this research we have considered: Web based System, Application Utility, Embedded Systems, Distributed Systems, Critical systems, iPhone Applications. Now for all of these projects choices had to be made from already defined elicitation methods which were are mentioned in section 4.1. Data from both of the groups (R-group & P-group) was collected.

Table 1: *Comparison of Elicitation techniques vs various projects*

Percentages												
	Interviews/ Surveys		Checklists		JAD/RAD		Ethnography		Scenario/Story board		Existing System Study	
	P-group	R-group	P-group	R-group	P-group	R-group	P-group	R-group	P-group	R-group	P-group	R-group
Existing System's Updatio	57	89	14	0	14	0	29	0	0	0	43	11
Web based System	29	44	57	0	14	33	0	0	14	33	14	0
Application Utility	43	33	29	11	29	11	0	0	14	22	0	11
Embedded Systems	43	11	29	33	43	22	14	0	29	0	0	0
Distributed Systems	86	33	0	11	43	22	0	11	29	0	0	0
Critical systems	43	22	29	56	43	22	57	33	57	22	57	0
iPhone Applications	29	0	29	0	29	0	0	0	57	0	0	0

Table 1 is showing the entire data of comparison. Next we took individual elicitation technique and analyzed it against given project types with practitioner as well as researcher views to see the comparative trends. The results were very diverse with low correlation.

4.3.1. Interview/Surveys

Both of the groups votes showed that interviews/surveys are the agreed upon option for the application utility and web based projects categories. Interviews/Surveys have also proved effective for process improvement and innovation.

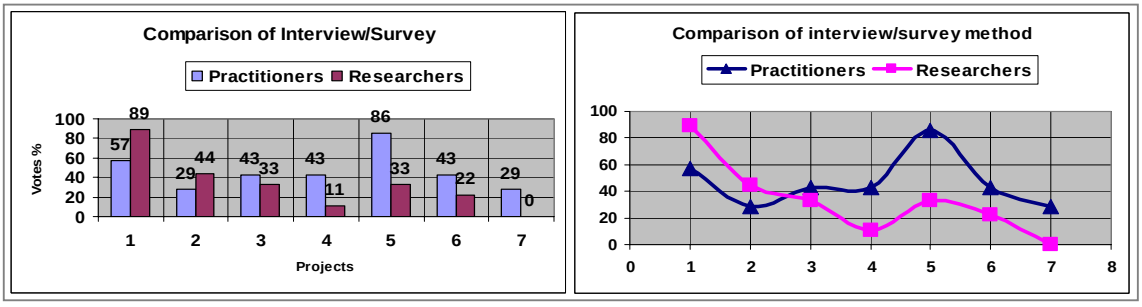

Figure 5: Comparison of Interview/ Survey: Correlation=0.327666

4.3.2. Checklists

From mutual point of view, Checklists are better for embedded systems and web based systems. Checklists should be used for the system which are small and have less number of requirements of known requirements. These checklists can be the output of the successful projects of same domain. For example, projects regarding billing calculation of telecom companies will have limited and alike requirements so they can be tackled by checklists.

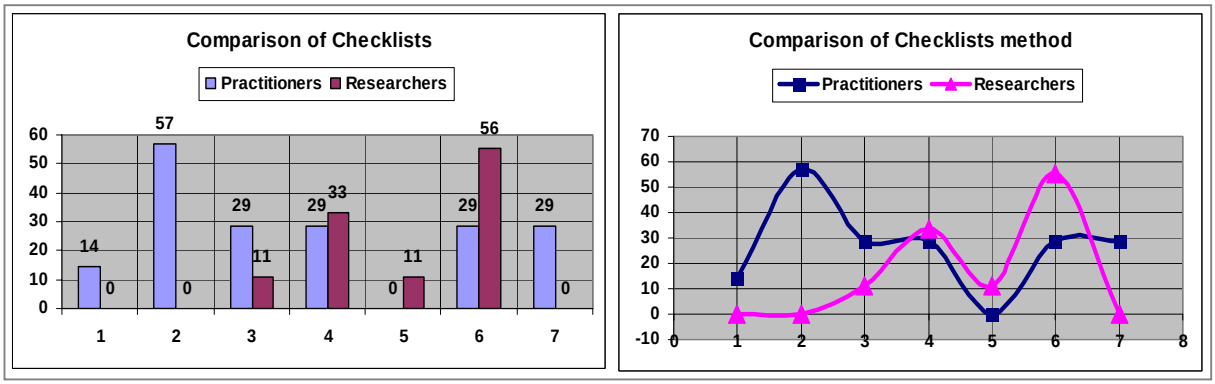

Figure 6: Comparison of Check lists: Correlation=0.01265

4.3.3. JAD/RAD

More than 42% of P-group is in favor of using JAD/RAD for embedded, distributed and critical systems. For the projects which have to be completed in limited time span and have rather more requirements and multiple stakeholders, it is suggested that use JAD/RAD for those projects.

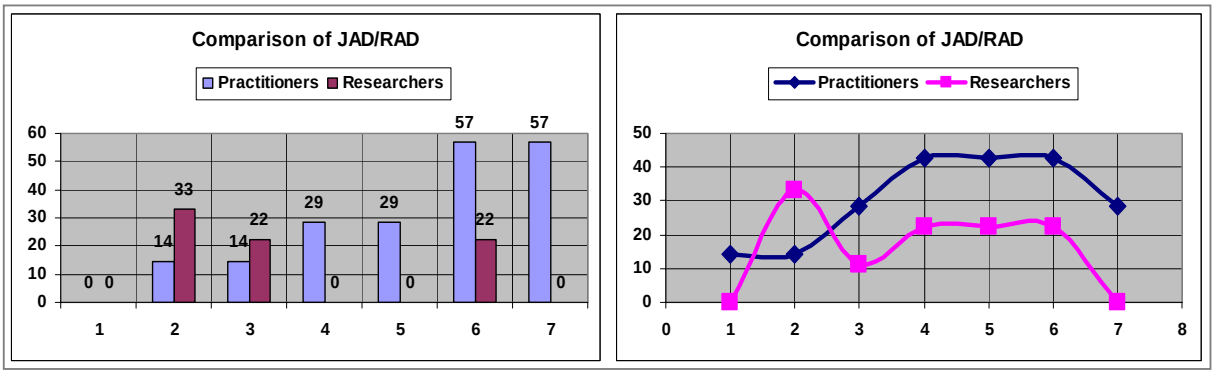

Figure 7: Comparison of JAD/RAD

But JAD/RAD requires willingness of all stakeholders and is suitable for those projects that are not of low budget. Purpose of arranging JAD is to combine all of the stakeholders under one roof and communicate with all of them to know their

viewpoints and perspectives. JAD provides fast way to communicate with multiple perspectives and helps to identify, negotiate and resolve conflicting requirements.

4.3.4. *Scenario/Story board*

Overall scenario story boards are highly recommended of the systems which have complex and critical requirements. This will help to remove any ambiguity in the requirements. Not only this, requirements of web based systems can also be gathered by scenario story boards. Scenario/Story boards are also effective for the projects which have to completed in short time window or the projects in which process improvement is needed.

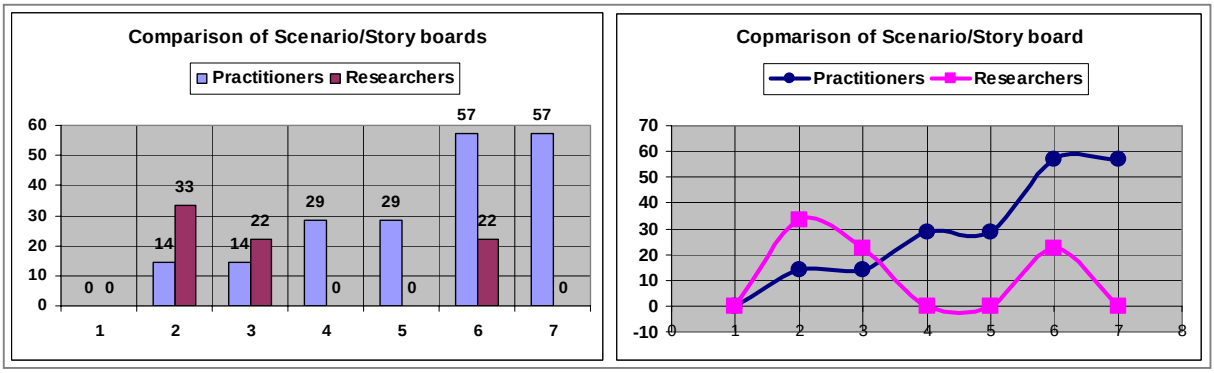

Figure 8: Comparison of Scenario/Story board

4.3.5. *Ethnography and Existing System Study*

Both of the groups suggest ethnography and existing system study is a good option for critical systems. Ethnography is also suggested for updating the existing system. It also proves effective when existing system needs to be updated and improved. Observer candidate has to observe the legacy system and look for the hot spots (that need change) in the system. Once they are identified, one can suggest a change strategy. However things get changed when we are talking about global software development (GSD). Research shows unanimously to use video conference and live meetings to communicate effectively.

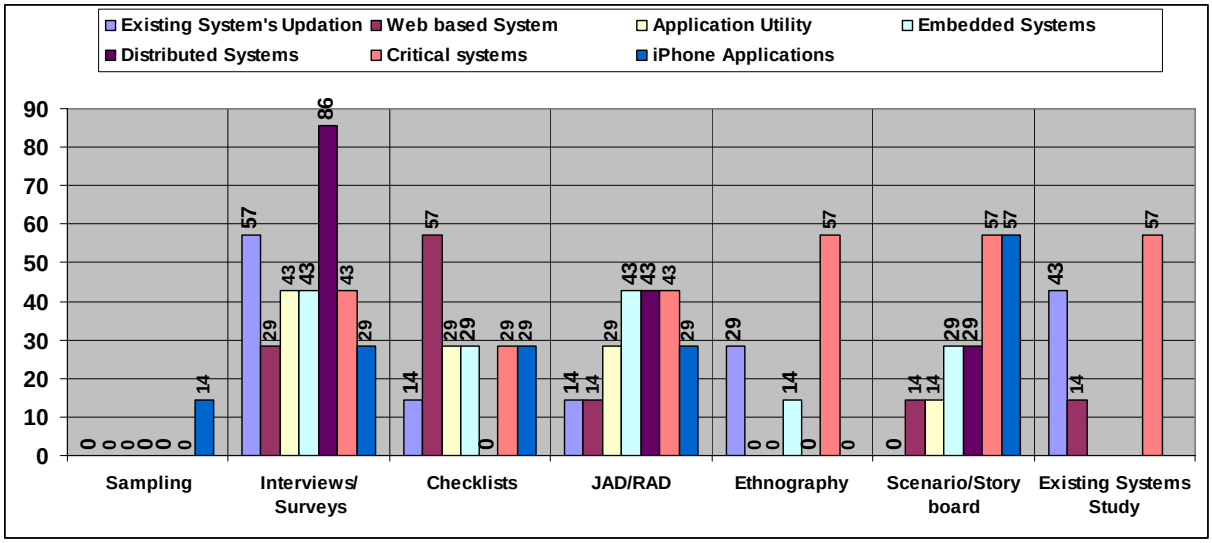

Figure 9: Elicitation techniques for specified project types

4.4. Elicitation methods and development processes

Elicitation method also depends on development process. Some methods help to get requirements more correctly depending upon factors of time, budget, and developmental technique. Requirements gathering can be done more effectively if proper method, that suits the process, is used. As it is obvious that gathering of requirements, for a project that is intended to be made using agile process or prototyping, will slightly be different from a project that is being made using waterfall. Both are used for different situations. And selection of correct elicitation methodology is as much important as the

selection of process model for a given project. A table 2 is shown for elicitation methods for specific process methods of development. This table is derived from the data after analysis.

Table 2: *Elicitation techniques for various development processes*

Mutually Suggested Techniques by practitioners and researchers	
Waterfall	Interviews, Checklists, Scenario/story boards
Agile	JAD/RAD, Scenario/ story boards
Prototyping	JAD/RAD, Checklists, Scenarios/ story boards
Iterative	JAD/RAD, Scenarios/ story boards

5. RESULTS & DISCUSSIONS:

5.1. Communication barriers

Lack of communication, Natural Language Ambiguities, Lack of Domain Knowledge, Lack of Willingness, Culture & Perspective Differences or Poor Analyst, these are the most common communication barriers that are experienced by the practitioners during development. Figure shows the various communication barriers identified during this research.

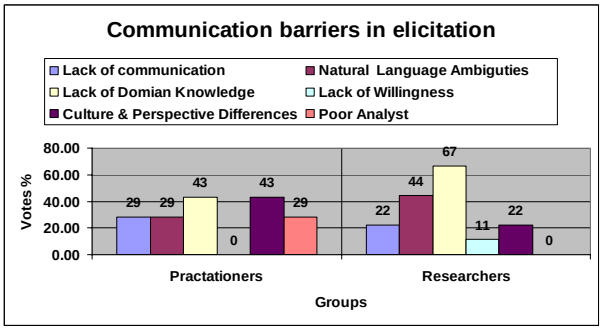

Figure 10: Communication barriers in elicitation

Customer does not understand the importance to communicate for the project, or if does understand then this communication is more often last in its priorities where as at the same time to get the product exactly as ordered and well in time is its top priority. He is not aware of the fact that both of these things are interlinked and are dependant on each other. Sometimes the natural language ambiguities and lack of domain knowledge also makes gathering of correct requirements difficult. In few cases, it was noticed that customer was not willing to give sufficient time for elicitation. Cultural differences and difference of perspectives causes a gap between the "stated requirements" and the "needed or real requirements". At that stage, analyst has to play its part. He has to resolve ambiguities related to domain and cultural as well as perspective differences.

5.2. Criteria for Requirements freezing

Ideally speaking requirements should be frozen once the requirements specification report of the first draft is signed by the customer i.e. before going into design phase. General confusion about agile methodology is that if it welcomes change by customer then when and how to freeze requirements. Answer to this misconception is that requirements are freezed once design and development of the iteration starts. During the iteration, requirements don't change, if any change is needed, it is scheduled for next iteration. As far as other methodologies are concerned, practitioners agree that before the starting of design phase, requirements are freezed. Fig 11 shows the numbers that are obtained by this research.

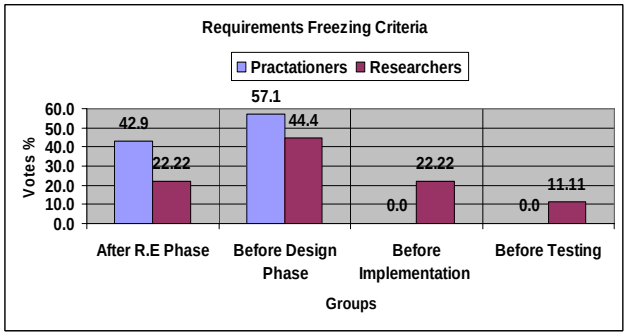

Figure 11: Requirements freezing criteria

If customer insists for changes during or after the design phase, then he is told about the additional time and budget needs to meet these changes. If customer is willing to accept the burden, then requirements are altered else not. Mostly customers are much aware of exactly what they want. Their

requirements are clear. Especially in this age, every large enterprise have its own I.T department. Therefore, requirements to the developing organizations are forwarded by their corresponding I.T departments. This resolves domain knowledge issues, ambiguities and other concerns as a result we don't need to change the requirements often.

5.3. Preferred elicitation methods

Practically one method is not enough for digging out all of requirements. It is suggested to use two or even more than two methods for requirements elicitation. Both of the groups were asked for best combination of elicitation methods and the options were open. Results show that interviews/surveys with scenarios/story boards are the best choice. Both groups agree upon and this is the aim of research i.e.; to find out that elicitation method that is more close to practicality. So the recent trends suggest using interview/surveys along with scenario/story boards. Interviews provide the requirements in raw form and then further, these raw requirements can be validated by the customer in form of scenarios and story boards.

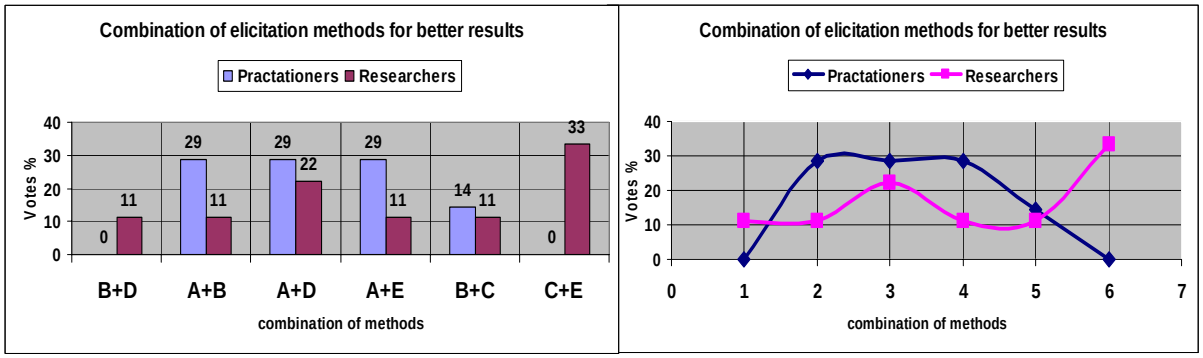

Figure 12: Combination of Elicitation techniques: (A) Interviews/Surveys (B) Checklists (C) JAD/RAD (D) Scenario/Story boards (E) Ethnography

6. PROPOSED PLAN OF REQUIREMENT ELICITATION:

Practitioners face two constraints time and limited budget. Keeping these constraints in mind, we have proposed a plan for elicitation.

6.1. Elicitation Guidelines

Lets us have an overview of the finding of this research. We present them into the form of elicitation guidelines.

1) Interviews/Surveys are effective for process improvement and innovation and also web-based systems.

2) Checklists should be used for the system which are small and have less number of requirements of known requirements.

3) Use JAD/RAD with if numbers of stakeholders are more, and you have to deal with multiple diverse perspectives in limited time with medium to high budget.

4) JAD/RAD is also recommended for critical and distributed systems or for prototyping and iterative development processes.

5) Use scenario/story boards along with interviews/surveys for projects to be completed in limited time and with low budget. They can also be used for legacy system updates.

6) Ethnography is effective when existing system needs to be updated and improved and time span or budget is sufficient.

7) Single method for elicitation is not enough to get complete, unambiguous and non conflicting requirements, therefore use two or more methods to get clear picture.

6.2. Proposed Elicitation Plan

As mentioned earlier, two important constraints are time and cost. It is observed that in large organizations, there is separate department for requirements gathering, they do all of the elicitation for a project, design is made from the gathered and validated requirements and it is passed to the developers and they code the validated requirements. Now when it comes about medium or small organizations, this elicitation process becomes cost effective for them. Mostly organizations can not afford separate employees for elicitation or design due to their limited resources. They work on basis of "*one person, ` many roles*". In that case, it becomes difficult to meet the project end timeline.

Therefore we propose to work in form of teams. Tasks of elicitation must be divide among the members to save time. Assume that a software house has six employees, when a statement of work (SOW) comes to that team, they should

divide the team into two groups. Group-1 should identify and structure the raw requirements mentioned in the SOW by customer. After doing that, and sharing the identified requirements with Group-2, they may set time to conduct interviews/surveys. And during the interview session (conducted by group-1) Group-2 should be working on writing scenario/story boards. An appropriate CASE tool can be used to make things easy and quick. As the interview session ends, Group-2 will provide the scenarios which they made, to the stakeholder for validation. As both of groups will be working simultaneously, it will save time and cost.

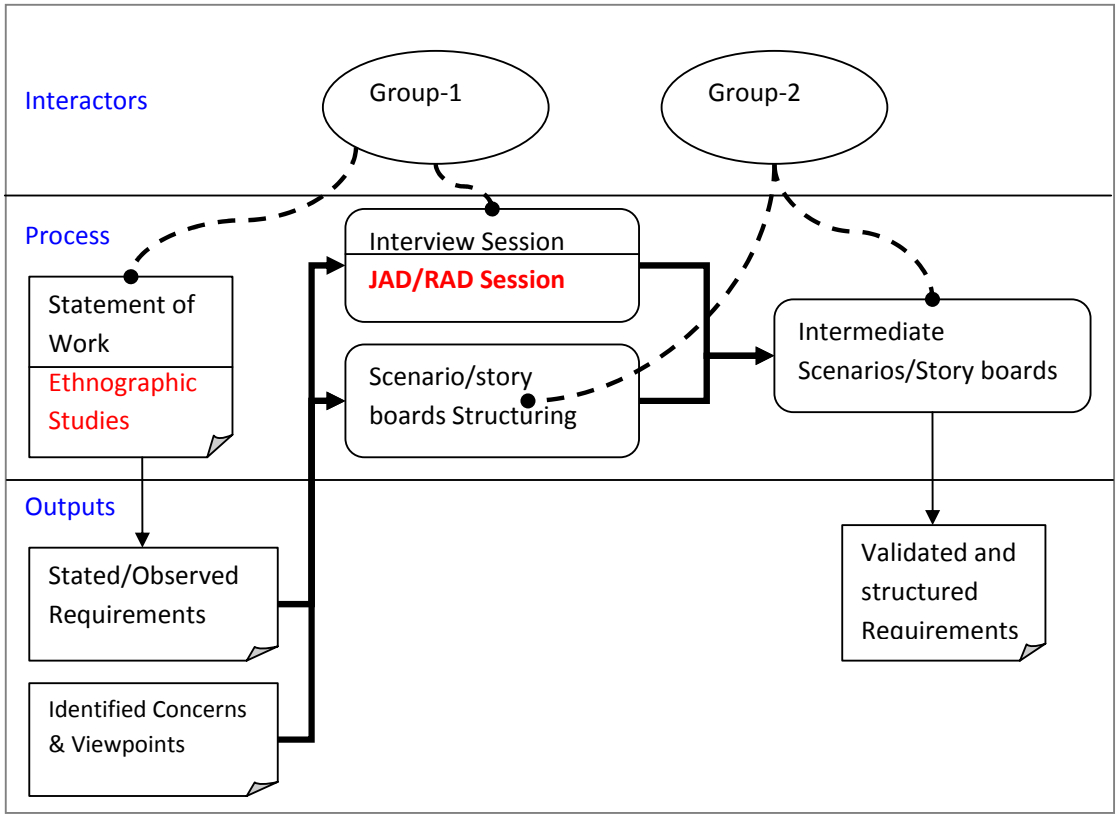

Figure 13: Proposed model of "Efficient Elicitation plan

6.2.1 Explanation of model:

As discussed earlier, team will be divided into two groups. In the fig 14, we have separately divided the diagram into three parts to identify interactors, process and outputs. Group-1 is interacting with SOW and conducing interview. Dotted lines are showing this interaction; where as oval shapes are showing interactors. Other arrows are showing the flow of the process. Round edge rectangles are the show the ongoing activity. Outputs from the process are shown by folded edge rectangle. Interview session and scenario/ story board structuring, both of these activities will be going in parallel. As the interview session end, Group-2 should have the intermediate scenarios ready with them. These can be shown/discussed by the stakeholder/customer and thus validated. This is model is suitable for the projects with short time span. However with little variations, model becomes applicable for the projects with sufficient time and cost. JAD/RAD instead of interviews and ethnographic study instead of only SOW can be used.

7. CONCLUSIONS

It is noticed that organizations (software houses) want to keep the way as it is. It is found that mostly organizations have predefined set templates of their own, they like to follow them. It limits them; some times the predefined methods are not applicable for all types of development. The model which is proposed in the paper, can be used by the practitioners because it is time and cost efficient. As the model is combination of multiple methods for elicitation, we expect it will provide better results.

References:

[1] Zheying Zhang: Effective Requirements Development - A Comparison of Requirements Elicitation techniques: EurekaS! 2023 Programme, ITEA project ip02009, FAMILIES

[2] Sadiq. M et al, Adding Threat during Software Requirements Elicitation and Prioritization: IACSIT International Journal of Engineering and Technology, Vol.2, No.3, June 2010 :ISSN: 1793-8236

[3] Beichter F. et al, " SLAN-4-A Software Specification and Design Language", IEEE Transaction on Software Engineering, SE- 10,2, 1994, pp 155-162.

[4]. Anton A.I , Dempster J. H, SiegeD. F : Managing Use Cases During Goal-Driven Requirements Engineering: Challenges Encountered and Lessons Learned: IEEE International Conference on Software Engineering (ICSE 2000) Limerick, Ireland.

[5] Davey. B & Cope. C : Requirements Elicitation – What's Missing?: Issues in Informing Science and Information Technology Volume 5, 2008.

[6] Gabriela N. et al: Strategies to Minimize Problems in Global Requirements Elicitation: Clei Electronic Journal, Volume 11, Number 1, Paper 3, June 2008.

[7] Teaching Requirements Engineering in Global Software Development A report on a three-University collaboration

[8] Linda Westfall : Software Requirements Engineering: What, Why, Who, When, and How

[9] How to write software requirements specification

[10] Maiden, N., S. Minocha, K. Manning and M. Ryan. CREWSSAVRE: Systematic Scenario Generation and Use, International Conference on Requirements Engineering (ICRE'98), pp. 148-155, April 1998.

[11] Carmel, E. Global software teams, Prentice Hall, 1999