

Comparison of Various Requirements Elicitation Techniques

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ABSTRACT

No requirements elicitation technique has capability of finding all of the software requirements so we have to use variety of techniques that will help us to cover all the requirements, resulting in more effective elicitation. Each technique has its features which makes it different from all other techniques and which make it suitable for a particular condition. The important thing is to use the most appropriate technique. Before using any technique we should have thorough knowledge of that technique. In this paper, we present an in-depth review of different requirements elicitation techniques. We also present Pros and Cons of different elicitation techniques.

Keywords

Requirements Elicitation Techniques, Ethnography, Joint Application Development, Card Sorting, Repertory Grids, Software Requirements, Stakeholders, Traditional Techniques, Cognitive Techniques, Contextual Techniques, Collaborative Techniques.

1. INTRODUCTION

Requirements Elicitation (RE) is defined as the process of obtaining a comprehensive understanding of stakeholder's requirements. It is the initial and main process of requirements engineering phase. Elicitation process usually involves interaction with stakeholders to obtain their real needs. It helps users to express their needs and expectations from the new system. RE is a complex process as it constitutes seeking, determining, learning, acquiring, discovering and elaborating requirements of potential stakeholder [11] [15]. It is impossible to get all solutions from an individual or a one particular group. Different stakeholders are involved in this process from different fields. And analysts can never get requirements of users by simply asking them. There are ways and techniques to get as much information as possible from stakeholders. High quality requirements are only obtained when right people are chosen and are involved in elicitation process. Requirements can also be compared after getting them from users just to prioritize them. Analysts need to involve appropriate stakeholders based on project needs. Based on project type and stakeholders involved, appropriate technique is selected for eliciting user requirements. The Requirements Elicitation methods that can be employed are Interviews, Questionnaires, Observation, Joint Application Development (JAD), Brainstorming, etc. There is no ideal technique that works in all situations. One technique is suited for one particular situation and other works best at any other situation. Weakness of one technique can be neutralized by some other technique. Using variety of techniques ensures uncovering most of the requirements and therefore results in effective requirements elicitation. RE is usually the poorly completed process of requirements engineering phase. Applying inappropriate techniques has negative impacts on

the system development which in turn affects requirements of stakeholders. RE process needs to be handled carefully by applying appropriate techniques effectively towards the people [8]. Analysts need to have thorough knowledge about almost all the techniques only then they can select the appropriate one.

Most of the projects fail due to poor requirements elicitation. The quality of software depends on properly documented requirements. Missing out the important requirements can lead to project failures and unsatisfied stakeholders. In a European study regarding IS projects, McManus and Wood-Harper observed one the common factors in the failure of requirements was "the lack of due diligence at the requirements phase" [5]. Appropriate stakeholder involvement, thorough understanding of user's requirements, carefully selected elicitation technique and proper attention to all the details make project a success.

This paper aims to provide overview of different elicitation techniques, their characteristics, their advantages and disadvantages.

2. DIFFERENT REQUIREMENTS ELICITATION TECHNIQUES

Requirements Elicitation techniques are basically the ways and procedures to obtain user requirements and then implement them in the system to be developed so that it satisfies the needs of stakeholders. The technique which is suitable in developing one project may not be suitable for the other. There is not just one factor that affects technique selection. There are many factors responsible for selection of appropriate elicitation technique e.g. Business procedures, resources available, project type, individual preference. To select an appropriate technique for a particular system development, characteristics of that technique are identified and based on the features it possesses it is employed if it suits the project type and other criteria. Following is the classification of different requirements elicitation techniques.

2.1 Traditional Techniques

The earlier used and the most commonly used techniques for requirements elicitation are called as traditional techniques. They include Interviews, Questionnaires/Surveys, and Document analysis. The following section outlines what these techniques are and their pros and cons:

2.1.1 Interviews:

It is a conversational or verbal method which is considered easy and effective for idea sharing and expressing needs between analysts and stakeholders. Interviews are the most employed and popular ones for requirements elicitation. It includes face to face conversation with one or two people asking questions and documenting the results which finally lead to requirements. Due to the ability of this technique to

obtain thorough knowledge, it is considered as the important technique to obtain and validate software requirements. Interviews are of 3 types: Structured, Semi-Structured, and Unstructured. The goal of first two methods is to acquire quantitative data, whereas the later method points towards understanding user expectations through open-ended debates with the stakeholders and acquiring qualitative data [2].

a) Structured or Closed Interviews: They are formal with a set of predefined questions is prepared and asked to stakeholder. It is considered as effective technique and provides quantitative data. Structured interviews doesn't allow generation of new ideas and expressions but are preferably effective [15]. Questions are asked in already defined manner. Interviewer needs to be patient while listening to answers of questions and stakeholder must be able to express his knowledge properly.

Pros:

- No biasing as questions are checked beforehand.
- Few additional questions may be added to further add clarification.
- Interview can be repeated to check reliability of data.

Cons:

- Because of formal approach interviewee may be uncomfortable not revealing much information as needed.
- No new concepts are produced.

b) Semi-structured Interviews: It is a combination of predefined and unplanned questions. In other words, it is a blend of Structured and Unstructured interviews.

Pros:

- Structured questions provide consistency.
- Unstructured questions allow interviewee to share new ideas, themes and their experiences.
- Helps discuss problems which are not examined by interviewer before.

Cons:

- Time consuming.
- Since questions are not predefined so interviewer may lose its focus to other questions which might not be important.
- Training is needed by interviewers to conduct interviews.
- Findings are hard to generalize.

c) Unstructured or Open Interviews: It is an informal interview containing unplanned questions. It is an open discussion between analysts and stakeholders producing qualitative data. But in unstructured interviews some topics get neglected while others are discussed in detail. Unstructured interviews are most useful when emphasis is on developing the deep understanding of a specific issue within a particular community [13].

Pros:

- New ideas and opinions are generated.
- Due to informal approach interviewer may feel ease to properly answer questions.

Cons:

- Interviewer can be biased in asking questions.
- Difficult to repeat in case data reliability is checked.

Pros of Interviews:

- Good for complex topic.
- Rich in information and are good in eliciting detailed requirements.
- Ambiguities are clarified.
- No answer falsification by the person being interviewed as he is being screened face-to-face.
- Interviewer can analyze emotions or some kind of discomfort caused to interviewee from the questions asked. In other words interviewee's body language is easy to read.
- Non-responsiveness remains low.
- Provides overview of the whole system.

Cons of Interviews:

- Small number of people involved.
- It is difficult to set appropriate time for interviews with all the people.
- Information cannot be gathered from large population sometimes because of cost constraints.
- Quality of data gathered depends on the skills of interviewer. Sometimes biasing of the interviewing may affect the respondents.
- Sometimes follow-ups are necessary for information clarification and in that case participants may not recall information properly.
- They are effortful and time-consuming.

2.1.2. Document Analysis

This technique involves analyzing and gathering information from existing documents and other related information. This technique can be effectively used to initiate requirements elicitation process. Human interaction is needed sometimes to add to the information or confirm it [3]. The information gathered in this technique may vary depending upon the documents available and human interaction. This technique is used when an expert needs to study domain information thoroughly. It includes analyzing documents in the form of design documents, templates and manuals of existing systems. This technique is adapted when existing system needs to be replaced or enhanced. The important point here is that the facts and figures studied must be checked to see if they are valid and relevant otherwise they will be of little use to the analysts.

Pros:

- Helpful when stakeholders and users are not available.
- Helps business analyst to get proper understanding of the organization before meeting the stakeholders there.
- Provides useful historical data.
- Can be useful to frame questions for interviews.
- Can be used for requirements reuse.
- Inexpensive technique.

Cons:

- Time consuming to find information from huge amount of documentations.
- Sometimes valid information may not be available i.e. documents may be outdated.
- Periodic updation of documents is required.
- Information might be incomplete.

2.1.3 Questionnaires/Surveys

It is considered the cheapest way of eliciting requirements. In the situations when face-to-face interviews, online meetings are not possible with stakeholders, questionnaires are used. This technique is used to collect requirements from a larger group of population distributed over a large geographical area and from different time zones. Questionnaires must be clear, well-defined and precise besides including the domain knowledge [1]. To make this technique a success and quick preplanning and proper attention to detail is important. Time limit must be mentioned as up to which date questionnaire is to be returned.

Pros:

- Reach large number of people within a short time.
- Useful when same question is asked to large number of people.
- No biasing occurs.
- It is economical.
- Easy because multiple choice questions or true false or fill in the blanks are included.

Cons:

- Cannot get further clarification regarding the problem what analyst actually wants from the user.
- Questions can be misinterpreted.
- Sometimes useful feedback isn't received.
- To get further information other techniques like interviews can be used as follow ups.
- Sometimes question ambiguities may arise.
- Used for general purpose software.

2.1.4 Introspection

It can be used to initiate requirements elicitation process and is used in combination with other techniques. Introspection is

observing one's own thoughts and inner self. Analysts work for what they imagine and observe by themselves how a system design should be. His ideas will serve as initial requirements. Analysts need to be well known and experienced about the domain. This technique is effective with users who have a lot of experience of their own fields but have less knowledge about the other fields as well as the new system. This method can be very useful, but the problem is that users and experts being from different fields and the introspection of one doesn't reflect the understanding of the other [6].

Pros:

- There are almost no costs for implementing this technique.
- Easy to implement.
- It can act as a good initial step to start requirements elicitation.

Cons:

- It is hard for analysts to imagine the environment in which the new system works.
- It doesn't allow discussion with stakeholders and other experts. Therefore, it is not encouraged if not used in combination with other techniques.
- Analysts and stakeholders need to be well known about the domain.

2.2 Contextual Techniques

They are the techniques that collect requirements in context of the user and therefore collect requirements at the workplace of the end user. Requirements are gathered at the working environment where the system will later be used. Techniques in this category are Observation, Ethnography and Protocol Analysis.

2.2.1 Observation

It is also called as Social Analysis. The requirements engineer observes the user's environment without interfering in their work. This technique is used when customer is not able to explain what they want to see in the system, how they work and when some ongoing processes are to be monitored. It is often used in combination with other requirements elicitation techniques like interviews. Requirements engineer visits and notices the customer's workplace where the system services are to be provided [7]. Data to be collected during observation process needs to be predefined so that analysts doesn't get confused as to which event is to be recorded and which one is to be skipped. Observation can be done actively or passively.

Passive observation is when analyst doesn't interact with the user while he is observing.

Active observation is when the user is interrupted for questions during observation.

Pros:

- Authentic and reliable because analysts by himself goes to observe the environment.
- Can be useful to confirm and validate requirements collected through other methods.
- It is inexpensive method.

- Gives idea about how users will interact with the system.
- Helpful in work measurements i.e. how long particular task takes to be done.

Cons:

- All the requirements cannot be checked in just a single session; multiple sessions may be required.
- Users can behave indifferently while they are interrupted for asking questions in active observation.
- In passive observation, it is difficult for analyst to make out why some decisions are made.
- It is time consuming.

2.2.2 Ethnography

In this technique, analysts observe the activities of people from different communities for a period of time in detail and in the mean while collect requirements needed. It is a kind of field work done in order to observe a particular work place and actors and relationships between them. Analyst involves himself completely in the organizational environment to understand its socio-organizational requirements. These techniques are used particularly while dealing with contextual problems like usability and detailed observation of collaborative work places [15]. It is used in combination with other elicitation techniques like interviews and questionnaires to gain more detailed answer to some questions.

Pros:

- Helps to discover certain features of a work place in a shorter time period.
- Helps understand how people work in an organization and how they interact with each other.
- Doesn't need much resources to be effective.
- Helps reveal critical events not observed by any other technique.
- Useful in validating requirements.

Cons:

- There is no detailed guide on how to perform ethnographic technique effectively and therefore, it all depends on the skills of the person performing it, the ethnographer.
- It requires engineers to have a lot of experience to perform it.
- New and unique features added to the system might not be discovered.
- Fails to produce desirable results due to diverse population.
- Focuses mainly on end-users.
- Sometimes it can be time consuming.
- Different backgrounds of users and ethnographers can result in misunderstanding problems between them.

2.3 Collaborative/Group Techniques

Group elicitation techniques involve teams or groups of stakeholders who applying their individual expertise on a particular issue agree upon a set of decisions. It involves people from different fields given equal powers to give their opinions regarding a particular system. These techniques include: Prototyping, Joint Application Development, Brainstorming, and Group Work. These are considered better techniques because more ideas are generated from all the stakeholders from different backgrounds, more skills and knowledge is involved in making decisions.

2.3.1 Prototyping

It is an iterative process in which dummy version of the product is launched to obtain user requirements and is refined over and over again according to the user feedback. Prototyping is used for elicitation where the users have no knowledge about their requirements and where early response is required from the stakeholders [4]. This technique can be used in combination with other techniques like interviews or JAD. It is useful in developing new systems. Prototype of the system gives an idea to the user about what he actually wants from the system by providing him the basic interface design. Prototypes are mainly designed in systems which have more user interactions and less internal functionality.

Pros:

- User involvement during development process.
- Allows early user feedback for requirements refinement.
- Saves development time and cost.
- Users and analysts get better understanding of the system.

Cons:

- The disadvantage is that when users get used to particular kind of system they often resist changes.
- Effort and cost estimation may get high as calculated earlier.
- For complex systems, it can be time consuming.

2.3.2 Joint Application Development (JAD)

JAD sessions are basically collaborative workshops that last for 4-5 days and whose outcome is a proper set of user requirements. It helps to gather lot of information in a shorter period of time and preplanning is must for JAD sessions including presence of key participants. Participants share their opinions on what must be done and what needs to be changed and all these sessions are recorded. The roles of participants, goals of the system are predefined. Visual Aids like monitors and GUI is also used to make the session interactive. Participants are chosen very carefully. Sometimes prototype may also be the end product of the JAD session to refine the system. The stakeholders and the users keep on exchanging their ideas until the final collection of requirements [12].

Pros:

- Decreased time and cost of requirements elicitation.
- Accelerates design of the system.

- New and rapid idea generation leading to creative outputs.
- Promotes user feedback.
- More user satisfaction.
- Good communication between stakeholders, analysts and other professionals.
- Visual aids and case tools used make the session interactive.

Cons:

- If not properly planned can lead to wastage of time and resources.
- Requires trained facilitators.
- Requires lots of planning and effort.
- It is an expensive technique.

2.3.3 Brainstorming

It is an informal discussion where free expression of ideas is given to every participant for a new kind of system to be developed. The members are from different fields and each member is given a certain time period to share the ideas. This technique focusses on a particular issue and participants come up with new creative ideas related to that within a prescribed time limit. The ideas generated are recorded; inappropriate ones are eliminated and appropriate ones are prioritized. The more the ideas the more is the quality of requirements. The main advantages of using brainstorming is that it encourages innovative ideas and expressions, and it promotes generation of advanced and recent practices to current issues [10].

Pros:

- Costs very little and not much resources are needed.
- Participants need not to be high qualified and each participant takes part actively in the process.
- It is comprehensible and easy to implement.
- Helps in new ideas generation.
- Helps in conflict resolution.
- Each participant is equally allowed to speak and share ideas.

Cons:

- It is not suitable to resolve major issues.
- If not organized properly can be time consuming.
- Quantity of ideas doesn't always equal their quality.
- Can lead to repetition of ideas if participants are not paying proper attention.
- Some people due to extrovert nature may take over all the session and all the time sharing their ideas and other people who are less outgoing will be afraid to take the time sharing their views.

2.3.4 Requirements Workshops

It is a structured meeting where selected stakeholders come together to discuss, refine and validate requirements after multiple sessions. Proper planning is needed to make it effective and participants need to take active part. These requirements are unchangeable as they are collected after multiple sessions. Expertise of facilitator and knowledge of stakeholders is must for its success. Participants discuss and identify requirements then they are reviewed and assigned priorities. Well planned and well run workshops yield good quality requirements. It is somewhat similar to JAD. It can be combined with interviews, document analysis, brainstorming prototyping, etc. Although there are budget constraints with regard to money and time but it is suitable for large and complex projects [2].

Pros:

- Collect requirements in a relatively shorter time.
- Cost is lower than performing interview sessions.
- Feedback is quick.
- Helps to develop trust and understanding between analysts and stakeholders.
- Participants work together to come up with a particular set of requirements.

Cons:

- Due to busy schedule of stakeholders and experts it is difficult to get them on the same table at the same time.
- Too many participants may slow down the process.
- Few number of participants may lead to requirements that are incomplete and doesn't represent proper set of user requirements.

2.3.5 Group Work

In this technique, stakeholders are invited to attend a meeting to elicit requirements for projects. They share their needs and preferences. Each requirements is discussed and proper suggestions are given. The moderator keeps the groups focused and encourages participants to interact openly with each other. Interaction within a group encourage new idea generation and discussing every topic in-depth. The views and opinions discussed are recorded simultaneously which makes the members to take active part in the meeting. It is cumbersome and it is difficult to bring all the stakeholders at one place at the same time [14].

Pros:

- Quality requirements in a shorter period of time.
- Saves cost as compared to conducting interviews of same number of people.

Cons:

- It takes lot of effort to bring all the stakeholders on the same table at the same time because of their busy schedule and political aspects.

- Participants may have issues related to trust and may feel hesitated to discuss critical or sensitive matters.
- Members may get influenced by dominant people in the meeting leading to biased results.

2.3.6 User Scenarios

Scenarios are representation of user's interaction with the system. It is a real world example of how a system is used. Scenarios can be used once the initial requirements are collected. It includes whole description of all the processes i.e. starting state, flow of events, concurrent activities, end state etc. They are only useful when system needs to be described from the user's viewpoint. Writing a scenario needs basic understanding of the tasks performed by the system and the user involvement in them. They are written in a simple natural language. Scenarios prove to be useful to validate the requirements and create test cases [14].

Pros:

- Well-developed scenario helps organizations to be proactive and work specifically for the desired product.
- Gives good clarifications regarding an activity or event its normal flow, exceptional behavior, alternative paths.
- People with no technical knowledge can also understand it.
- Easy to understand as no special language is used to write them.
- Ensures system is designed properly as end-user's perspective is considered for requirements elicitation.

Cons:

- It is difficult to draw useful scenarios.
- It is not suitable for all types of projects even if they capture more requirements.
- They do not cover all the processes i.e. not the complete view of future system.

2.4 Cognitive Techniques:

Cognitive techniques allow analyzing and gathering information up to the human thinking level. It involves understanding the problems in depth. Techniques under this category are: Laddering, Card Sorting, Repertory Grids and Class Responsibility Collaboration. They are interdisciplinary, spread across different fields like psychology, business, cognitive science, etc.

2.4.1 Laddering

It is an interviewing technique to elicit stakeholder's goals, values and attributes. Initially main product attributes are elicited from the users. With the help of main attributes interviewer digs deeper with his skills to extract more information from users about criteria of their preferences. Users are taken from one ladder to another at one time. Questions and answers are arranged in hierarchical manner according to the priorities. It can be done by tool support or by an expert. Too large requirements make it difficult to make modifications like additions or deletions at any point in the ladder [2].

Pros:

- Easy to understand requirements because of hierarchical nature.
- Reuse of requirements saves time and cost.
- Not good for building a new system.

Cons:

- Maintaining requirements is a difficult task while adding or deleting any user requirement anywhere in a hierarchy.
- Technique becomes complex when requirements are in large number.
- Expert opinion or initial data is must to elicit requirements.
- It is too long and tiring technique.

2.4.2 Card Sorting

It is a knowledge elicitation technique in which stakeholders are asked to sort cards according to domain entity names using index cards or some software packages. It helps in grouping and association of user requirements. Participants arrange cards in categories in which they make sense to them. Sorting is done using pieces of paper or online. Card sorting provides in-depth understanding of user's mental model, explaining the way that users often use to tacitly group, sort and label assignments and content within their own mind [9].

Pros:

- It is fast and inexpensive.
- It is accessible through internet so the participants that are geographically remote can take part in it.
- It is reliable and easy technique.
- Helpful in providing good understructure.
- It is an established technique.
- Useful in gathering qualitative data.
- It involves real inputs from the users.
- Makes information structured to be fed into information process.

Cons:

- Not suitable for complex, large and heterogeneous architectures.
- It involves variable results.
- Useful when cards are limited in number.
- It includes only superficial characteristics.
- Not much effective as it doesn't provide much insights about the content involved.
- Limited interactions and in-depth explanations reduce the value of the technique.

2.4.3 Repertory Grids

In this technique domain elements are represented through matrix assigning the constructs and ratings by stakeholders. Semi-structured interviews are conducted which involve stakeholders to identify names of elements and constructs. It

is used in initial representation of requirements. It is used in combination with other methods like interviews. It involves categorization of elements; evaluates and compares elements constructs and their ratings. Repertory grid is more precise in capturing details than card sorting but is less precise than laddering, therefore, repertory grids is not considered efficient to describe characteristics of the complex requirements [1][14].

Elements	a	b	c	d	e	f	g	h	i
Constructs	Ratings								
I	3	5		3	7	8	5	6	8
Ii	1	4	5	7	4	8	5	4	2
iii	3	5	6	1	7	2	5	7	4
Iv	2	5	4	9	1	5	3	7	8

Figure 1: Repertory Grids

Pros:

- Differentiates differences and similarities between elements which were not known to experts.
- Minimizes bias from expert's side while he develops understanding of domain from user's perspective.

Cons:

- Lots of effort is needed in this technique on the part of experts and analysts.
- It is time consuming.

2.4.4 Class Responsibility Collaboration (CRC)

It was introduced in 1989 by Kent Beck and Ward Cunningham for defining requirements for object-oriented applications but now it is used as a modelling technique. It includes collection of cards where each card is divided into Class, Responsibility and Collaboration. A class is a group of similar objects, responsibility is functionality of a class, and Collaboration represents relationships of a class with other classes. Cards are arranged according to their functionality and collaborations with other classes. CRC cards are used to represent software requirements where each card represents a particular class. Every class is assigned responsibilities to process user requirements. CRC cards does not provide much details about requirements elicitation [2].

Class	
Responsibilities (What a class does)	Collaborators (Other classes interacting with this class)

Figure 2: CRC Card Structure

Pros:

- Can be used in place of UML diagrams.
- Natural language used to describe classes and collaborations.
- Users and experts work together to create the model.
- Experts do the analysis and develop the model as well which ensures that the right model is built.

Cons:

- Provide limited details about software requirements.
- These cards are mostly useful for designers not software engineers.
- Not suitable for large systems.
- Large number of card creation is time consuming and difficult.

2.4.5 Protocol Analysis

In this technique, user is asked to think loudly while performing their tasks i.e. speaking out loud their ideas as they continue with their work. It is not a team-oriented approach rather it is an individual approach to the solution of the problem. The user is observed while he is engaged in work and at the same time he explains his thoughts and opinions regarding that. It helps to understand problem solving at an individual level i.e. how a person thinks about a problem and its solution to be. The disadvantage to this technique is that introspection is required while explaining the work; therefore this technique isn't reliable [16].

Pros:

- Easy to implement.
- Low in budget. No special instruments are needed.
- It can be used at any stage of development.
- Useful when analysts gain in depth knowledge about product domain.
- It gives idea about how individuals perceive the problem and solution i.e. how the system will work in real life.

Cons:

- Not suitable for projects with tight schedule because they are time consuming.
- Prompt user every time for clarifying their actions and decisions and also keep them talking.
- It is suitable for situations where an individual can delineate in his mind the entire scenario of problem and solution domain.

3. CONCLUSION

In this paper we presented an in-depth review of various requirements elicitation techniques. Based on comparison of various elicitation techniques we conclude that every technique has its advantages and disadvantages. Every technique according to its characteristics is used at certain stage of requirements phase and for eliciting different kinds of

requirements. Some are used at initial stages, some at later; some for quickly eliciting requirements and some for elementary requirements. But the point to note is that we must acquaint ourselves properly with the details of elicitation techniques (what a technique is all about) then only we can select appropriate technique(s) and implement that accordingly. Although, using number of techniques will make sure that maximum requirements are gathered but then it results in using excessive number of resources which in turn reduces the efficiency. So the future work will be to evaluate these techniques to check which one of these is efficient and effective in eliciting requirements. Since our knowledge base regarding effectiveness and efficiency of techniques is limited. This work will be a boost to our requirements engineering knowledge.

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