

# Requirements Engineering: Elicitation Techniques

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**Abstract**— This paper is about the elicitation methods for requirement collection. Requirements engineering initial step is the most key phase of the software development life cycle (SDLC). If the first step is conducted in wrong way the whole project may fall down. The elicitation techniques are used to eliminate the barriers in communication of the user and the requirement engineers. In this paper we examine the strategies connected to name the necessities. We attempt to know the flaws and plus points of these practices and come up to a convenient or suitable technique amongst them.

**Index Terms**—Contextual, Cognitive, Elicitation Techniques, Modern, Requirement Engineering, Tools, Traditional.

## 1 INTRODUCTION

THE essential and driving portion of the Requirements Engineering is to perceive the genuine prerequisites. "Requirements" implies the nitty-gritties or requests that desires to be fulfilled. Prerequisites Elicitation is the arrangement of stages to gather the necessities. The accomplishment or setback of the project essentially lay on requirements elicitation. [1]

The requirement elicitation tells you what to build. For that purpose, we go through a defined set of paths to make sure it is less prone to errors.

On the off chance that the prerequisites measured are unfitting, uncertain or not up to the check, the entire venture may tumble and the closing item won't imply the genuine needs. For this focal advance of the Software Development Life cycle (SDLC), the product designers, clients, clients of the framework and framework engineers cooperate [2].

## 2 REQUIREMENTS ELICITATION

Requirements elicitation process is a gathering of four stages:

### 2.1 Requirements Discovery

In this step, we identify that a problem exist which needs to be tackled in future. In other words, we need to enhance the functionality of the software such that it can compete with the ever-changing environment.

### 2.2 Requirements characterization and Organization

Requirements are sorted a semi-structured form and are analyzed according to the organization protocol and prescribed key points.

### 2.3 Requirements Prioritization and Negotiations

The requirements are structured in final shape depending upon what is most important and what is least important feature to be embodied. After this, final list is negotiated to all the concerning parties like stake holders, programmers and end users etc.

### 2.4 Requirements Specifications

The SRS is a specification document which describes the requirements through use cases, sequence diagrams, Test cases etc. It covers the inconsistency in the requirements description and shows a flawless picture of the product to be build.

The requirement elicitation deals with the customers by handling and understanding the first expression of the user's expectations and converting them into technical requirements that a system

should comprise. To correctly interpret the requirements, Elicitation methods are defined to carry out the task.

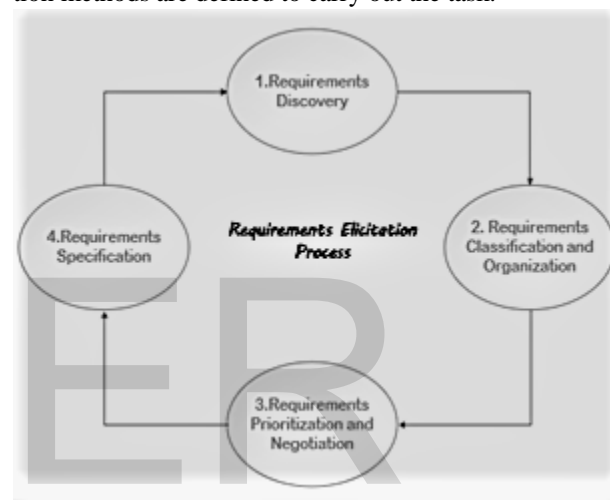


Fig 1 Requirements Elicitation Process

This paper centers around requirements elicitation techniques.

## 3 REQUIREMENTS ELICITATION TECHNIQUES

Requirements elicitation techniques are the tools that are used to know, form, manage and execute the requirements in a well-organized way. These techniques help in a certain way to dig deep down and scrap out the unimportant needs that are dominating the actual requirements.

### Categories of Requirements Elicitation Techniques:

The elicitation requirements are largely characterized into two main groups in terms of communication channels:

#### 3.1 Distribution with respect to communication channels

##### 1. Direct Method

As the name suggests, Direct method is in which the developer directly interact with the stake holders or users of the product to know their view about the product. There is no intermediate person or media working for the communication. It is more reliable in its nature. As the developers get to learn the behavior, tone or judge him/her by body language. This helps in getting more ideas about the need. On contrary, it enlarges the time span and can cause chaos if there is no or less under-

standing between the stake holders and the developer's team. Some examples of such techniques are: [3]

- Interview
  - Prototyping
  - Brain storming
2. **Indirect Method**

This method is inverse of the direct method. There is an intermediate media or person acting as a communication channel between the developers and the stake holders or the users. There is a chance of misinterpreting the needs or the user is not interested and answer the questions being biased. These are used when the audience is dispersed. It is considered to be the most economical ways to collect information from the far-flung areas. It helps to remove the distance and time constraints. Some examples are: [3]

- Questionnaire
- Laddering
- Ethnography
- Card sorting

There is another view of dividing the techniques. After a long tiering research on the topic and many techniques have been developed so far, the researcher has managed to group the techniques according to their behavior. This type or arrangement have characterized the tools according to their complexity and type. [4]

**3.2 Distribution with respect to common features:**

There are mainly four categories according to the common features namely, Classic/Traditional techniques, Contextual techniques, Cognitive techniques and modern elicitation techniques. [5] There are groups under which many techniques are collected due to their distinctiveness and characteristics.

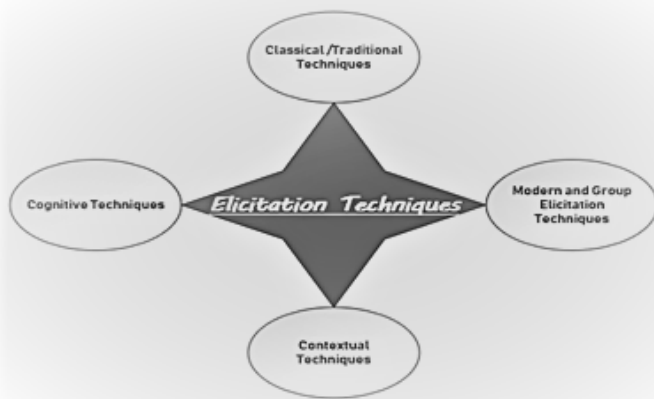


Fig 2 Elicitation technique in terms of common features

**1. Classical /Traditional Techniques:**

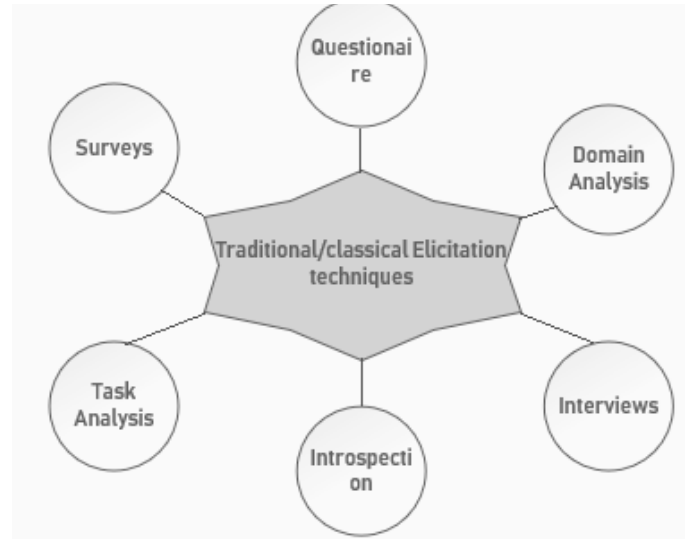


Fig 3 Types of Traditional Elicitation techniques

**1. Introspection**

It is a preliminary stage in requirements elicitation. It chiefly hinge on the expertise of the requirement engineers. They use their experience to interpret the stakeholder's wish into the relatable functions of the new system. This technique does not allow to held meeting or any other sort of the communication with the user. Instead it depends on the imagination of the experts that what a customer need. At times, if wrongly assumed the final product may not reflect the customer's view. Experience of the requirements engineers are the back bone of this kind of techniques. It has its own advantages and flaws.

**Pros:**

If the required expertise is met, the process is even more smooth and the requirements has best representation of the user's point of view.

**Cons:**

Inversely, the requirements may cause to collapse the whole system. It cannot be used with the combination of other techniques because it depends on the experts view and is applied when the user is unwilling to be a part of requirement elicitation or is not aware to them.

**2. Interviews:**

*In this type of method, the meeting sessions are arranged between the requirement engineers and the customer. A face-to-face session is an old-school thing where the needs are explained in a conversational environment.*

Interview is "A dialog to convey the information amongst people for the principle purpose of one gathering information from the other/s". (Pole and Lampard 2002)

**Types of interviews [6]:**

The writers have their own way to describe the interviews categories. Nevertheless, interviews are often to be found rendering to their structure.

- Structured
- Semi-structured
- Unstructured

**Structured interviews:**

The structured interviews are directed for the quantitative type of data. Closed ended questions are questioned by the interviewer. The user response is predefined. Respondent can not pass its own statements rather is bound to answer the by choosing the given statements. In other words:

- Multiple interviewees can be questioned by a single structured interview.
- It is easy to analyze.
- The interviewer is dominating character in this process as he carries out the process by asking well-organized questions in a specified sequence.
- It is also known as researcher-administered survey.

**Semi-structured interviews:**

Semi-structured interviews are combination of pre-set question and spontaneous questions coined by the interviewer as and when required.

The interviewer set up the questions as a guideline and the interviewee responds. At the same time, the interviewer tends to ask other unstructured questions to prompt the teller to express his/her own idea.

- The respondent is allowed to speak of its mind as the interviewer thinks the point needs more clarification.
- Pre-set questions still can be used for the quantitatively measure of the data.
- The spur-of-the-moment questions should be monitored and should be relevant to the topic.

**Unstructured interviews:**

There is no pre- defined set of questions for this kind of interview. It is an informal interview in which you do not specify the topic or the context to be discussed. The respondent is allowed to speak freely.

- It is of conversational type in its nature.
- Less control over the respondent.
- It represents qualitative data instead of quantative figures.
- It is time taking also difficult to judge and organize the data.
- There is chance for the interviewer to lack in impartial behavior.

**Pros:**

- Bring together the rich and comprehensive data.
- Well thought of surveys can be planned by using the gathered information.
- It presents the broad representation of the system.

**Cons:**

- It is time consuming activity.
- It can cross the budget limit.
- There can be many representations of a single result by different interviewers.
- It takes time to generate the results.

**3. Domain Analysis:**

Domain analysis gives the idea and information about the reusable components of the existing applications documentation. It is a former elicitation technique to explore through the

whole system by the experts. It is usually adopted when the system needs an update or additional functionality.

The following techniques is the software development elicita-

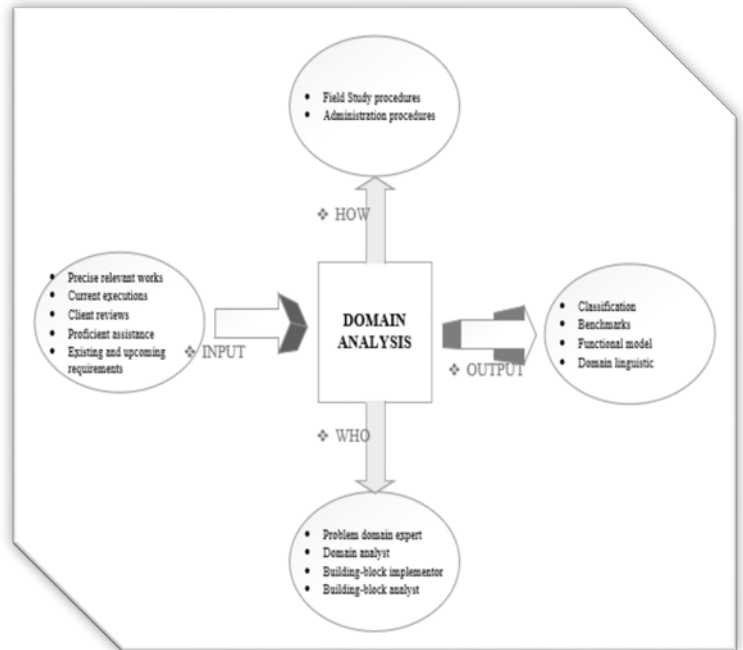


Fig 4 Domain Analysis

tion techniques context representation of the domain analysis. The model was presented by the Arango an Prieto-Diaz. [7] Domain Analysis represents the problem in actual, not the solution. There should be simple measures but complete information.

**PROS:**

- The existing forms, documents, design document and instruction manuals are studies in detail for the requirements elicitation of the new system.
- It is frequently used in blend with the other techniques as a starting point.
- Previous work can be utilized to explore more in its domain.
- The problem and solutions can be linked to their previous versions to link and understand their nature.

**CONS:**

- It is complex and covers a vast area to study.
- It can be done well by using skilled and experience software engineers.

**4. Task Analysis:**

Task Analysis [8] is the arrangements of the tasks in top-down structure. Theme of the techniques is to define the main task and the sub-tasks. The hierarchical manner representation is to identify the minor tasks to develop the root task. It represents the tasks done by the user and the system as well to know the things desirable to complete the tasks. [9]

**PROS:**

- The task at hand is achieved by the user and the system, hence ensuring the interaction of both entities.

- Project manager uses this technique to arrange the user and system tasks efficiently.

**CONS:**

- This requires more work and insights than other techniques.

The lower level tasks need careful investigation as the root task depends on them. Hence more hard work is required to carry out task analysis.

**5. Questionnaire:**

Questionnaires is the simplest among the technique and may fetch remarkable results if constructed properly. There is some measure that should be taken off while preparing the questions about a topic. [10]

- The questions must be to the point.
- There should not any repetition.
- The ambiguous statements should be avoided.
- The questions should be arranged in a reasonable manner.
- These should be relevant to the domain of the system.

There are dual forms of questions:

❖ **OPEN-ENDED QUESTIONS:**

The open-ended question allows the user to talk normally and tell in his/her own words what the requirements are. They are not bound to answer in a specific format. It is a user centered approach to know the requirements.

❖ **CLOSED-ENDED QUESTIONS:**

This is a pre-defined structure of questionnaires to be asked in a strict manner. It cannot vary form one person to the other. Every person intermingles with the it in a similar way. It does not allow user to speak of his/her mind. These types of questions are easy to judge and generate reports.

**PROS:**

- It is a quick way to collect data from different stake holders in a minimum time span.
- It uses a checklist to certify that every single section is covered carefully and provides a solid base for further elicitation process.

**CONS:**

- The new ideas are not welcomed by this kind of investigation.
- The expansion in the requirements is limited.
- This can lead to misunderstandings and does not provide any plate form to clear the confusion created.

**6. Surveys:**

This technique is applied to encompass bulky amount of audiences living far away. This is to know their requirements that can differ due to their geographical representation. Hence large number of requirements are gathered in this way. This works for the general software development. The response rate could differ from 1% to 95% [charity survey, Censes survey]. [11]

**PROS:**

- Covers a huge number of audiences working parallel.
- The ease of collecting data depends on the design structure.
- Cost effective.

**CONS:**

- Behavior observation is not possible.
- Data quality is limited.
- It does not portray a complete picture.

**2. Cognitive Techniques:**

1. *Repertory grid:*

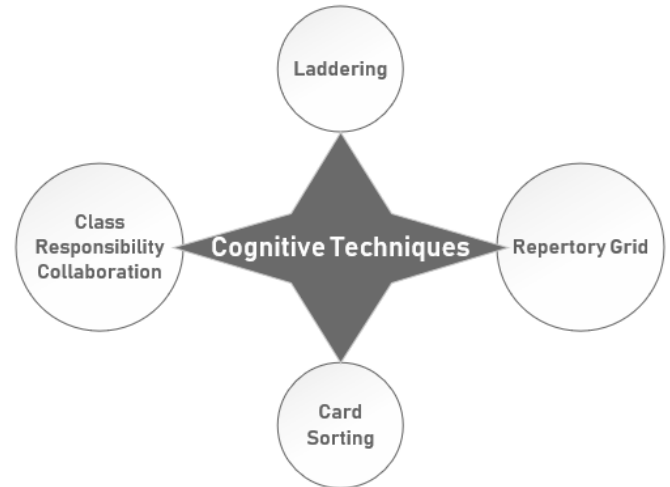


Fig 5 Types of Cognitive Techniques

Repertory grids [9] [4] is generated in a form of matrix. The stakeholders are asked to value the requirements coined in the grid. The domain units are rated according to the stakeholder's view of the project.

**PROS:**

- Matrix is a first-rate utensil for the traceability.
- It is among the best techniques in terms of arranging the attributes such that one can understand the full scenario by just having a glance at it.
- The differences and similarities pop up in an instance.
- The abstraction helps understand the unfamiliar users.

**CONS:**

- It becomes tough to understand some complex requirements as it is just named not explained well.
- It creates a barrier to dig down and know minor details of a complex requirements.

2. *Laddering:*

In laddering, series of questions are arranged in top-down manner to collect the coins of requirements in clear and concrete way. The answers are straightforward and helps in sorting out the needs. The domain knowledge has a direct impact in this method.

**PROS:**

- Helps to make a strong interaction between the stakeholder and the requirement engineers to sort out the needs.
- The hierarchy arrangements of the needs are simple and comprehensible.

**CONS:**



- it becomes a cumbersome task when the requirements are large in numbers.
- Editing the requirements in this method is a hectic work to do and may cause errors. [9] [4]

### 3. Class responsibility collaboration:

CRC [9] [4] is an extension of card sorting technique. The requirements are breaking down into classes. Then classes are further assigned responsibilities to achieve the user needs. It provides a higher abstracted view.

#### PROS:

- Cost effective
- Easily available
- Greater user interaction
- It works as a bridge between the process to object-oriented presentation.

#### CONS:

- Time consuming activity
- The cards are recommended to use by the designers.
- It does not provide the detail version, hence may prone to leave confusions.

### 4. Card sorting:

This kind of method heavily depends on the stakeholders/user domain knowledge. They sort out a bunch of cards along with the reasoning (the method) they used to sort the entities. [4] [9]

#### PROS:

- The cards are sorted in descending order with respect to prioritization.
- It gives an overview of the customers knowledge about the problem area.

#### CONS:

- If the customers lack the knowledge of the problem domain OR miss out any of the entities, it may produce erroneous results.
- As compared to group work, it is less effective technique because in group work the stakeholders doesn't need the full information of the domain.
- Intricate cards may not be correctly interpreted by the new stakeholders.

### 3. Modern and Group Elicitation:

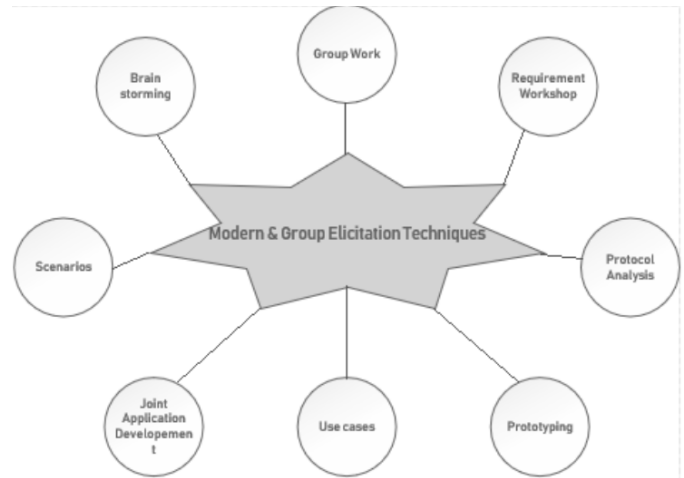


Fig 5 Modern & Group Elicitation Techniques

#### 1. Brainstorming

Brainstorming is an informal group technique that invites every participant to share his/her view about the problem. It is used to engender new ideas in a short time frame. Every one is given equal chance to present its vision of the problem solution and is welcomed without any biasness or interruption. It enhances the creativity abilities and needs a healthy environment for success. [4] [9]

#### PROS:

- It dominated other techniques in a way that it produces many ideas about a problem in tiny period.
- Every participant has alike privileges to speak, hence a sense of equality helps in convincing the stakeholders on a single point.
- Allows to think out of the box and create its own way to solve a problem.
- The key decisions are made using this method.

#### CONS:

- Criticism may affect the activity solely resulting it in a failure.
- Complex issues are not easy to evolve using this method.
- There could be many ideas in number but might be quality ideas.

#### 2. Group work

Different stakeholders are gathered around a table for a group meeting in a harmonic way to induce the requirements about the in-hand project. It is used to remove the conflicts among the stakeholders. It is most common but most difficult task. It needs hard work and concentration on the problem statement. [4] [9]

#### PROS:

- This strategy is particularly powerful to resolve the contentions among clients in request to influence them to concur on single point.
- Every piece of requirements is talked about and legitimate recommendations are given utilizing bunch work.

- The partners give the immediate comments about the product requirements.
- Stakeholders work in the agreeable condition.
- Group work provides the wonderful results at the end.

**CONS:**

- This system needs a considerable measure of exertion as thought about alternate requirements engineering strategies.
- Its hard to gather all the stakeholder at a time as they could be committed to other work.
- Group work is less fruitful in the exceptionally political tense circumstance.

### 3. Requirement workshop

There are number of different meetings conducted by the system partners to name the requisites of a project needs to be build. [4] [9] This illustrate the comprehensive image of the requirements by covering system's all corners.

**PROS:**

- The requirements elicited using this technique are more concrete than other group elicitation techniques.
- The requirements do not tend to change as these are developed under professional environment with great care.
- This should be used for larger, complex projects.

**CONS:**

- Its relatively slow in process.
- This is not feasible for smaller projects.
- It is expensive as far as time and money are the measures.

### 4. Joint Application development

This involves all the stakeholders into a healthy discussion to form a solution in swift manner. The stakeholders involved are those who are interested in a common problem. This approach presents the measure taken to name the requirements and their possible dimensions that can change them. It is different than the brainstorming as the agenda of the meeting is decided beforehand conducting the meeting. The steps and issues are nominated for a meeting and participants are informed. In Joint Application Development the requirements are explained on base of users need and stakeholders. For the time being, the technical issues are kept aside. [4] [9]

**PROS:**

- The decisions are taken rapidly and solutions are presented on the spot.
- The rapid changing requirements are handled easily.
- It is a well-structured method.
- The direct communication of the stakeholder and the project handlers takes place.

**CONS:**

- Under the pressure to make quick decision, it often fails to produce good solutions.
- The experience and knowledge of the domain are strong measures needed for it to succeed.

### 5. Prototyping

Prototyping is the first face of any software project. The software is partially developed and handed over to the user. The user runs it in its environment. [4] [9]

The user's response is important factor in this technique because the changes are made according to them. It is improved by removing the errors (if any) and adding the functionality that was requested or engendered by the user feedback [12]. Prototype is never considered to be the final product but tends to evolve into a final product by reviewing and improving it. The version no is change after every loop.

**PROS:**

- Every feature of the prototype is investigated by the user so it delivers an elaborated version of information.
- It is not solely used. The other methods are the combined with it like JAD or interviews.
- It gives you the chance to develop a good graphical interface for the user for better human computer interaction.
- It is helpful when an initiative is taken to build a completely new idea and evolve it over time and experience.

**CONS:**

- After user get used to the software, it might resist change.
- It is costly and takes times to evolve into final product.

### 6. Protocol analysis:

The participants of this kind of meeting are bound to think aloud when discussing a customer need and its importance. The main theme of the activity is to know the thinking process of the idea giver to analyze its basics. The analyst observes the pattern of thought and understands the rationale behind the idea.

**PROS:**

- It provides environment for enthusiastic partaking.
- The key data is gathered by the analyst that is compulsory to follow the path to reach the target.

**CONS:**

- Presenting the thinking process verbally may result in disagreement on a requirement or answer to a problem statement.
- The methods circle around the steps taken to reach the final statement hence may pose to failure by missing the actual statement with its parts and does not depict the actual portrait. [4] [9]

### 7. Scenarios:

Scenarios are utilized to discover and design the chronical of the system. These describe the present and upcoming progressions of the final product. It is exercised to know the preliminary details of the software product. It states the activities and relations of the user and the system. The test cases are developed using scenarios because these are thought to be the best method to prove the requirements as authentic and workable.

**PROS:**

- Scenarios uses an incremental approach for the development of the project instead of leaning on the internal body of the product.

**CONS:**

- The exceptions should be handled on each step rather there is potential for many pitfalls in a project. [4] [13]

**8. Use Cases:**

Use cases are used to illustrate the actors and users in a pictorial format. It makes it easy to understand the system for the stakeholders. Use cases are informal way used to tell a story of your system.

**PROS:**

- It helps in removing the ambiguity in the requirements by clearly stating them in a pictorial format by identifying the actors and the users of the system.

**CONS:**

There could be a functionality in a system that is independent of any input from the user, hence don't have an actor to perform it but essential for the software working.

**4. Contextual Techniques:**



Fig 6 Contextual Techniques

**1. Observation:**

As the name is well defining the technique meaning and purpose. It is an extension of an ethnography technique that helps to observe the user. The requirement engineer observes the actions of the user and the environment where he is performing his tasks. Many other techniques can be used with its blend like task analysis and interviews. [4] [9]

**PROS:**

- It is highly recommended activity to know the workplace environment and identify the actual necessities of the workers by the requirement engineers.
- The requirement engineers make sure that the requirements stated, met with the workplace norms and remove the deficiency (if any).

**CONS:**

- Traveling to far away areas might be an intensive task and costly in terms of money.
- The environment might be misguiding or the observer might miss out important facts that later results into stating the problems in a perspective that is inverse to the actual scenario. [4] [9]

**2. Ethnography:**

It deals with the perspective of the customers that how/what they think and expect from a software to accomplish a job. The

ethnography is a learning about people in their working atmosphere about their understanding of a problem.

**PROS:**

- It is mandatory to gather the quality features i.e. non-functional requirements that are not stated but crucial for a project success like usability etc.
- If public norms are taken into consideration and bugs are resolved according to them, it makes the method even more suitable and fruitful.

**CONS:**

- It is difficult to understand a human mind and its thinking process by a common person. You need to take some psychologist help in this regard.
- People come from diverse environments and it is tough to understand their ethical cliques that cause a failure for this method.

**4 RELATED WORK:**

By looking back, we know that researchers have practiced numerous experiments to elaborate this hot topic of the software requirement engineering most crucial step. [14] [15]

According to Babok, the most promising nine techniques are Questionnaire/Survey, observation, requirements workshops, prototyping, interface Analysis, brain storming, focus group, interviews, document analysis.

Where Naem & co-participants [4] proposed a bottom-up approach to collect the requirements. This works well in a well-structured organization. In this technique they combined the direct and indirect manner to name the requirements. The system analyst approaches the end-users first to get the initial expression of the requirements and the CEO of the organization is interviewed at the end to acknowledge what they desire from the software. In their proposed method the low-level needs are collect before the high-level requirements, so that minor details are not miss out and satisfaction level of the end users and high authority is the same.

Sadiq et al [16] said that first step in requirement engineering is to name the requirements. It is an exhaustive task to perform where requirements are named by using many techniques named as brainstorming, surveys etc. According to them, JAD is the best of all the methods known. A mathematical approach can be used to rank the needs after they are elicited using the existing methods like ontology, JAD and many other. It is easy to list the requirements in a specific order in terms of user's view of importance.

The techniques to elicit the requirements are categorized in four sections by Zhang [17] on the base of communication. These are: Observational approach (social analysis, observation, ethnographic, protocol analysis), Conversational approach (focus groups, interviews, workshop, brainstorming), synthetic approach (contextual inquiry, passive storyboard, JAD, scenarios and interactive story board) and analytic approach (documentation, content analysis, card sorting, laddering, repertory grids). Requirements designing is a mind-boggling social association process, along these lines, investigators should utilize an appropriate and logical ways to accomplish this practice.

Gunda [5] heads forward in stating that every elicitation technique has some positive and negative characteristics but one should take special care while selecting the techniques by considering all borders of the project. The experiments considered and the case studies helps in determining the approach for a project.

At the end, it all rest on the kind and nature of being intricate of the project under process. If the project is of universal type then survey is the best approach. Conversely, if it is precisely for an organization then interview is best to be practiced [9].

Hickey and Davis [18] have taken a review of techniques proposed and concluded a certain elicitation technique selection criterion as follows:

- The approach might be applied because its only one that the requirement engineer is familiar with.
- The reason of selection might be biased decision taken by the analyst.
- The chosen method is effective for the framework in the view of requirement engineer. [9]

## 5 ANALYSIS AND CONCLUSION

All the techniques elaborated or defined up to date have its own strong points and weaknesses. No one can rate one technique higher than other. It all depends on the circumstances, project specifications and area of expertise in use. As Gunda [2] explained that it is matter of time frame and present condition that what technique should be chosen.

It can not be like waterfall methodology but should be used in combination of spiral model. It is termed as an art. The more you practice the more you get the insights what step is suitable at what stage of the requirements gathering. The invoice will definitely have trouble in this process until they consult and indulge the expertise with their innovative ideas.

There is a number of techniques and it is less desirable to have new techniques in future but the newer versions of the existing techniques are to be developed by combining the strengths of two or more techniques and eliminating the flaws of one technique by the plus points of the other.

## 6 ACKNOWLEDGMENT

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