

Towards Investigating Primitive And Modern Elicitation Techniques: A Review

Dr. Babur Hayat Malik, Nimra Ashraf, Muhammad Asaad Subih, Abeer Abbaas

Abstract: Requirement is one of the vital and obligatory attributes of any software project. Most of the software projects usually fail due to the wrong elicitation of the requirements. Requirement elicitation is the first pivotal step of a requirement engineering process, which aims to gather, uncover, acquire and elaborate requirements for software systems. In software development, requirements are a description of what the system must do or how it should behave. The process of requirement elicitation can be regarded as core activity of the whole Software Development life cycle. This research paper is aimed of reviewing all the existing, in use requirement elicitation techniques. This research article will help the requirement engineers to understand the characteristics and effectiveness of each technique and it will also serve as a recommendation in order to select a particular technique for a certain type of project.

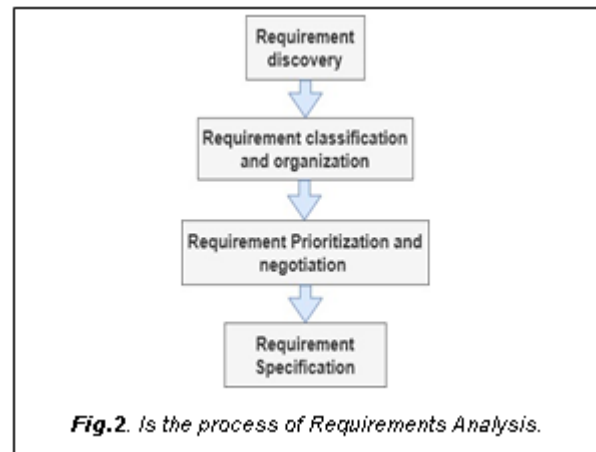
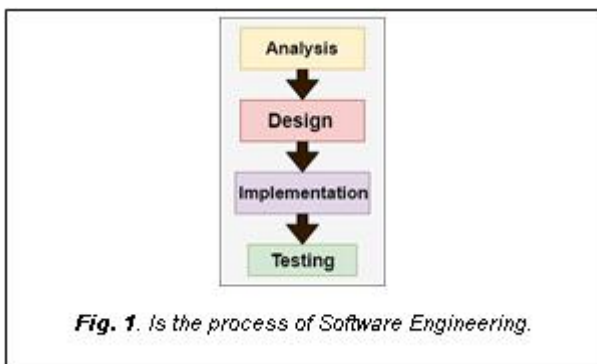
Index Terms: Software Development Life Cycle (SDLC), Observational Method, Conversational Method, Synthetic Method, Analytical Method, Ethnographic Study, Software Requirements Elicitation.

1. INTRODUCTION

THE Software industry has revolutionized the life a man used to live a few years ago. Technology, computer applications and software have revolutionized the way of life. The current era is the era of technology. The usage of computer applications and software is expanding day by day as these systems plays a crucial role in life we live today. The essential activity in the development of any software project is requirements engineering [2]. Requirement engineering is the process of eliciting the requirements. Requirement engineering can be stated as a method of eliciting, developing and managing the requirements in a way that we can eventually help in developing a software product. Requirements elicitation is regarded as the first, paramount of a requirements engineering process for elaborating and gathering requirements for software systems [8]. We can say that the requirement engineering is the heart of the whole software development life cycle (SDLC) and the soul of this requirement engineering is the process of requirement analysis.

The requirement analysis is a systematic process, which can be further subdivided into four main sub activities which are

- Requirement discovery
- Requirement Organization and Classification
- Requirements Prioritization
- Requirements Specifications



The main and the igniting process of the whole activity of the requirement analysis is the way we collect the requirements or we discover the requirements. The only way to collect the requirements is to elicit the requirement. The process of eliciting or collecting the requirement from an end customer is known as Software Requirement Elicitation. This research article will be mainly comprised of 6 main sections. Section 1 will be the introductory part which will mainly focus on the introduction of all the main terms which are used in the paper and provide the end reader a background of the problem and the ultimate outcome of the article. Section 2 will be about requirement engineering and elicit. Section 3 will be about the types of elicitation techniques. Section 4 will be about software elicitation methodologies. Section 5 will be about new requirement elicitation techniques and Section 6 will be about conclusion.

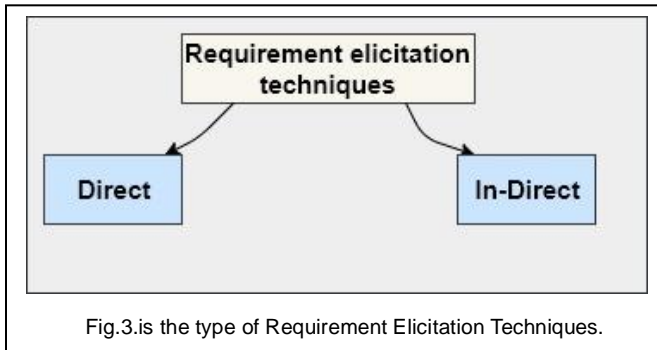
2 REQUIREMENT ENGINEERING AND ELICITATION TECHNIQUES

In requirement engineering, requirement elicitation is the very first step that performs to obtain the scope of the project and the needs of user, and to generate the understanding of wants and desires of different stakeholders [2]. Requirement elicitation is a technique, by which we analyze the problem and the domain of application which might help in developing the solution that compensates of those problems [4].

3 TYPES OF ELICITATION TECHNIQUES

There are two main types, which have been used for gathering requirements and obtaining difficulties. Which are

- Direct approach
- Indirect approach.



3.1 Direct approach

In direct approach, information is obtained by interacting directly from the domain expert. The main motive is to develop the understanding of problem of system that is presently in used. In order to get success domain expert should be expressive and inclined to allot information. The example of direct approach techniques is

- Interviews
- Brainstorming
- Prototyping
- Case studies [1].

3.2 Indirect approach

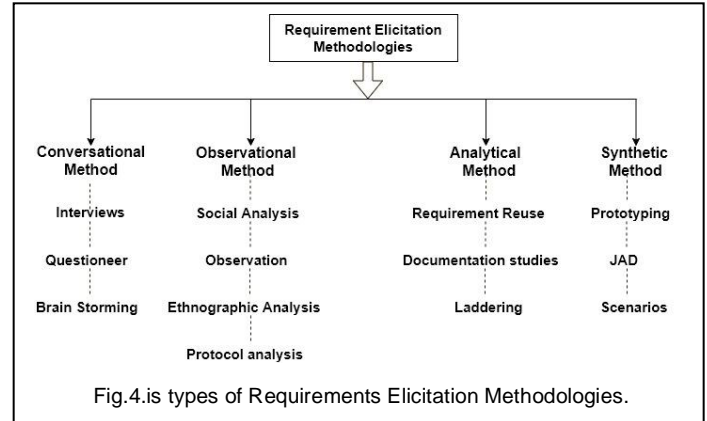
Indirect approach is used when information cannot be comfortably expressed directly. In this approach it should be presume that the users and stakeholders involved in the project have little knowledge about system so it is very necessary to intelligibly state the requirements concerning the problems of system [4]. Data can be collected in a huge amount from the documentation analyzes. The common examples of indirect techniques is

- Questionnaires
- document analysis [2].

4 REQUIREMENT ELICITATION METHODOLOGIES

Methodology is a process which can be iterative, sequential or both in order to achieve some common goal. In the process of requirement elicitation, the information which we get from the problem of the system helps in developing the solution and will also help other researchers to get benefits from that case study or research. There are many methods that how we can identify the exact problem and can get the exact requirement from the end user. The methodologies for requirement elicitation can be categorized on the base of communication flow and information gained [3] [6]. The requirement elicitation methodologies are

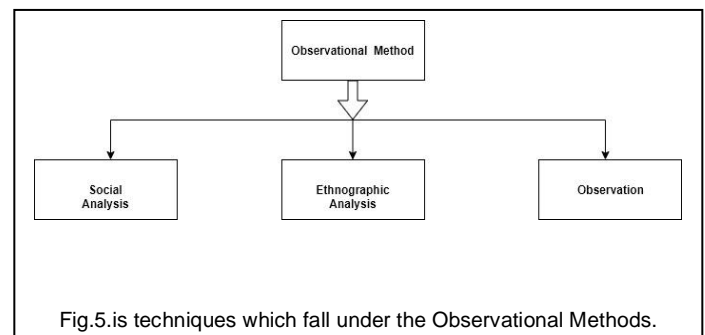
- Observational Methods
- Conversational Methods
- Synthetic Methods
- Analytical Methods.



4.1 Observational Methods

Observational method is a technique which requires deep study and analysis of the system. Observational methods work by observing and analysing the human activities where the system should be deployed or needs to be deployed. Observation methods basically works by observing that how people perform their daily tasks. Observational method is most suited when end user is unable to state his requirement about a particular system. The most common observation techniques are

- Observation
- Social analysis
- Ethnographic study



a) Observation

Observation is Commonly known as the social analysis. In this technique observer which is a requirement engineer observes all the work environment without interfering their work or generating an interrupt. Observation is commonly used when customer or end user is unable to describe that what they want from the system or what requirements are needed by the them. Analyst have to visit the work space where system is to be deployed [3]. The pros and Cons of the Observation technique are given in the table.1 below

TABLE 1
PROS AND CONS OF OBSERVATION

Pros	Cons
It's in expensive	Time Consuming
Authentic and reliable	Requires specialized skills
Give the idea that how user will interact.	All requirements can not be checked in ONE session.

b) Social Analysis

Social analysis basically involves an observer who needs to observe and spend some time in environment to study their culture and to make a detailed analysis of their practices. The ultimate aim of this methodology is to find the reasons behind the practices and to answer the questions that why some end The Pros and Cons of Social Analysis are shown in table 2

TABLE 2
PROS AND CONS OF SOCIAL ANALYSIS

Pros	Cons
It gives the prevailing facts	Time Consuming effort
Helps to understand that system in a particular environment.	Requires a specialized observer.

c) Ethnographic Study

As its clear from the title ethnographic analysis, it involves the study and analysis of people from different ethnic groups over a certain period of time and collects all the related requirements. It is a kind of field work involving a certain work space, actors in that workspace and the interrelationship between them [3]. This technique is commonly used while addressing the context related requirements such as usability. It used in collaboration with other elicitation techniques such as interviews and questioners [4]. The Pros and Cons of the ethnographic analysis are given below in the table 3.

TABLE 3
PROS AND CONS OF ETHNOGRAPHIC ANALYSIS

Pros	Cons
Lesser time consuming.	Focuses on end user primarily.
Needs less or no resources to be effective.	No proper guide lines to be followed to perform it.
Digs out all other events and activities which are ignored by all other related techniques.	In competent to produce desired results as it involves large diverse population.

Table 4 Shows all the techniques which fall under the Observational Methods.

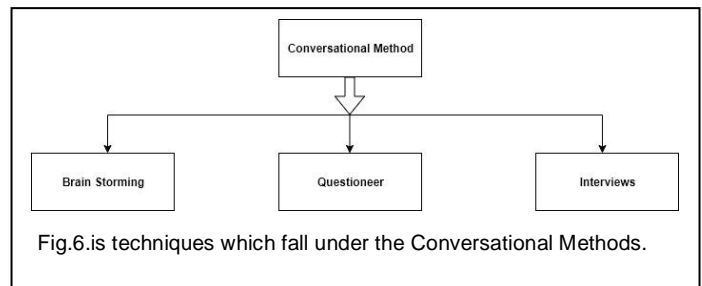
4.2 Conversational Methods

Conversational methods lie in the direct communication. Direct communication defines the methods by which we can interact with the end users to elicit the requirements [1]. One of the biggest benefits of the conversational method is that the end user can directly communicate with the stake holders such as Software Engineer, Project Manager and Software Requirement Engineer as well. Communicating is of the finest way of sharing and transferring the information as it is a natural process [1]. The techniques which follow this methodology are

- Interviews
- Questioners
- Brain Storming

TABLE 4
PROS AND CONS OF ALL TECHNIQUES WHICH FALL UNDER THE OBSERVATIONAL METHOD

Techniques	Pros	Cons
Observation	<ul style="list-style-type: none"> ➤ It's in expensive. ➤ Authentic and reliable. ➤ Give the idea that how user will interact. 	<ul style="list-style-type: none"> ➤ Time consuming. ➤ Requires specialized skills. ➤ All requirements cannot be checked in ONE session.
Social Analysis	<ul style="list-style-type: none"> ➤ It gives the prevailing facts. ➤ Helps to understand that system in a particular environment. 	<ul style="list-style-type: none"> ➤ Time consuming effort. ➤ Requires a specialized observer.
Ethnographic Study	<ul style="list-style-type: none"> ➤ Needs less or no resources to be effective. ➤ Lesser time consuming. ➤ Digs out all other events and activities which are ignored by all other related techniques. 	<ul style="list-style-type: none"> ➤ Focuses on end user primarily. ➤ No proper guide lines to be followed to perform it. ➤ In competent to produce desired results as it involves large diverse population.



a) Interviews

The interview technique is based on communication between two or more people where questions are asked by the interviewer [1]. It is considered to be easy and effective for ideas and problem sharing between stake holder and interviewer [3]. Interviews are the most widely used requirement elicitation technique. Interviews involve the direct communication between stakeholders. It is considered as one of the basic and pivotal technique for validating the requirements. The interviews are further classified into two main types

- Open interviews
- Closed Interviews

b) Questioner

Questioners sometimes known as the surveys are one of the cheapest methods of eliciting the requirements. One of the biggest benefits of choosing this technique is that it can address the requirements from the large no. of people. This technique is used when we need to collect the requirements

TABLE 5
PROS AND CONS OF INTERVIEWS

Pros	Cons
Provides Overview of the whole system.	Small amount of masses is involved.
Good for Complex topics	Effortful and time-consuming effort
Ambiguities are clarified	Difficult to set time of interviews with all the people.
Non-Responsiveness is low	Information can not be gathered from large masses

from a large no. of people and from different distributed population. In order to prepare the questioner a preplanned and deep analysis of information is necessary. The Pros and Cons of questioner are given below in the table 6

c) Brain Storming

Brain Storming is another elicitation technique which involves direct communication among the steak holders [4]. In this technique all the steak holders gather around for a very short period of time, but in that short period they study and discover large possibilities and ideas. Brian Storming involves many

TABLE 6
PROS AND CONS OF QUESTIONER

Pros	Cons
Involves large no. of people in a very short period of time.	Only used for general Software products.
Un biased data collection.	Some times questions can be ambiguous
Economical	Data received is not useful some times.
Easy to execute.	One can misinterpret the questions.

steak holders from different steak holders' group and engage in the informal discussion. The main theme of this technique is the "out of box thinking" and it works on both idea generation

TABLE 7
PROS AND CONS OF BRAIN STORMING

Pros	Cons
Helpful in generating new ideas and solutions.	Fights, Arguments and Counter Arguments.
Natural and easy environment for sharing the ideas among steak holders.	Not necessary that its always effective.

and idea reduction [7]. The Pros and Cons of Brain Storming are given below in the table 7 and the table 8 shows the Pros and Cons of all the techniques which fall under the Observational Method.

TABLE 8
PROS AND CONS OF ALL TECHNIQUES WHICH FALL UNDER THE OBSERVATIONAL METHOD

Techniques	Pros	Cons
Interviews	<ul style="list-style-type: none"> ➤ Ambiguities are clarified. ➤ Non-responsive ness is low. Give the idea that how user will interact. 	<ul style="list-style-type: none"> ➤ Difficult to set time of interviews with all the people. ➤ Information cannot be gathered from large masses skills. ➤ All requirements cannot be checked in ONE session.
Questioners	<ul style="list-style-type: none"> ➤ Involves large no. of people in a very short period of time. ➤ Un biased data collection. ➤ Economical . ➤ Easy to execute. 	<ul style="list-style-type: none"> ➤ Sometimes questions can be ambiguous. ➤ One can misinterpret the questions. ➤ Data received is not useful sometimes. ➤ Only used for general software products.
Brain Storming	<ul style="list-style-type: none"> ➤ Natural and easy environmen t for sharing the ideas among steak holders. ➤ Creative and innovative solutions. ➤ Helpful in generating new ideas and solutions. 	<ul style="list-style-type: none"> ➤ Fights, Arguments and Counter Arguments. ➤ Not necessary that it's always effective. ➤ Not a right technique for every particular person.

4.3 Analytical Method

As its clear from the title, analytical study involves the analysis and study of expert's knowledge of already working and existing systems. This technique is all about studying and exploring already existing documents, facts about the system and system as a whole. The existing techniques for eliciting the requirements are

- Protocol Analysis
- Documentation Studies
- Laddering Protocol Analysis

a) Documentation Studies

Documentation studies involve the study and analysis of already existing documents in order to find the requirements that can prove effective during the requirement elicitation. Such documents to be studied are mostly Software Requirement Specification, Company's policy document and Market information as well. THE Pros and Cons of this technique is given below in the table 9

TABLE 9
PROS AND CONS OF DOCUMENTATION STUDIES

Pros	Cons
Lesser Time consuming.	Requires domain knowledge.
Subjective technique.	Not Suitable for all kind of projects
Ethical issues some times.	Difficult to draw Useful Scenarios.

b) Requirement Reuse

Requirement Reuse follows the Analytical methodology. In Requirement Reuse we restudy the glossaries of the documents of the legacy system or some time the systems as a whole which lie in the in the same product family in order to find the requirements of our desired products [1]. The Pros and Cons of Requirement Reuse are given below in the table10

TABLE 10
PROS AND CONS OF REQUIREMENT REUSE

Pros	Cons
Domain Requirements are clear.	Time Consuming.

c) Laddering

Laddering is a technique which mainly involves three main phases: Creation, Reviews and Modification [4]. It is a kind of structured interview which used in application domain to elicit requirements from the user. Above mentioned three phases are performed in hierarchical manner often in the form of a tree. The Pros and Cons of this Technique are given below in the table 11

TABLE 11
PROS AND CONS OF LADDERING

Pros	Cons
We get familiar with organizational structure.	Variable results.
We get familiar with domain knowledge [4] [5] [7].	Tiring
Ethical issues some times.	Difficult to draw Useful Scenarios.

TABLE 12
PROS AND CONS OF ALL TECHNIQUES WHICH FALL UNDER THE ANALYTICAL METHOD

Techniques	Pros	Cons
Documentation Studies	<ul style="list-style-type: none"> ➤ Low cost and detailed. ➤ Address the difficult subjects. ➤ Economical 	<ul style="list-style-type: none"> ➤ It can be time consuming for complex systems. ➤ Users resist change. ➤ Efforts and cost estimation is always high
Laddering	<ul style="list-style-type: none"> ➤ We get familiar with organization al structure.. 	<ul style="list-style-type: none"> ➤ Variable results.
Brain Storming	<ul style="list-style-type: none"> ➤ Natural and easy environment for sharing the ideas among steak holders. ➤ Creative and innovative solutions. ➤ Helpful in generating new ideas and solutions. 	<ul style="list-style-type: none"> ➤ Fights, Arguments and Counter Arguments. ➤ Not necessary that it's always effective. ➤ Not a right technique for every particular person.

4.4 Synthetic Methods

Synthetic method is basically a combination of all elicitation techniques and their elicitation methodologies as well. This system forms comprehensible whole by methodically combining all the techniques in a single method. The existing techniques in this method are

- Prototyping
- JAD
- Scenarios

a) Prototyping

Prototyping is an iterative process. In this process a small-scale dummy product is launched to get the user opinion and to check that what the user understands in that particular product and to get their feedback [3]. The product is updated again and again according to the user feedback. It is the most simple and effective way to get user feedback [4]. It can be used in collaboration with other techniques. The Pros and Cons of this technique are shown below in the table 13

TABLE 13
PROS AND CONS OF PROTOTYPING

Pros	Cons
End user is involved.	It can be time Consuming for Complex systems.
Continuous feedback by the end user.	Efforts and Cost estimation is always high.

b) JAD

JAD is a workshop usually 4-5 days long. The best part of this technique is that we can achieve the exact set of user requirements. JAD helps us to achieve most precise set of user requirements in a very short period of time [3]. The Pros and Cons of this technique are given below in table 14

TABLE 14
PROS AND CONS OF JAD

Pros	Cons
Lesser time taking Process.	If not planned properly can be the wastage of resources.
User Feedback on regular Basis.	Planning and efforts are required.
Creative Outputs	Expensive technique.

c) Scenarios

Scenarios are elicitation technique in which we check that how and end user will interact with the system in the real world. Scenarios can be successful when all the initial requirement about the system are collected.

TABLE 15
PROS AND CONS OF SCENARIOS

Pros	Cons
Proactive	Do not Cover all activities.
Lame person can understand it.	Requires domain knowledge.
Easy to understand.	Not Suitable for all kind of projects

TABLE 16

PROS AND CONS OF ALL TECHNIQUES WHICH FALL UNDER THE SYNTHETIC METHOD

Techniques	Pros	Cons
Prototyping	<ul style="list-style-type: none"> ➤ End user is involved. ➤ Continuous feedback from the end user. ➤ Time and cost saving technique. 	<ul style="list-style-type: none"> ➤ It can be time consuming for complex systems. ➤ Users resist change. ➤ Efforts and cost estimation is always high.
JAD	<ul style="list-style-type: none"> ➤ Lesser time taking process. ➤ User feedback on regular basis. ➤ Creative outputs. ➤ More satisfied end user. 	<ul style="list-style-type: none"> ➤ If not planned properly can be the wastage of resources. ➤ Planning and efforts are required. ➤ Expensive technique. ➤ Trained facilitator is required.
Scenarios	<ul style="list-style-type: none"> ➤ Proactive. ➤ Lame person can understand it. 	<ul style="list-style-type: none"> ➤ Do not cover all activities. ➤ Requires domain knowledge.

5 NEW TECHNIQUES

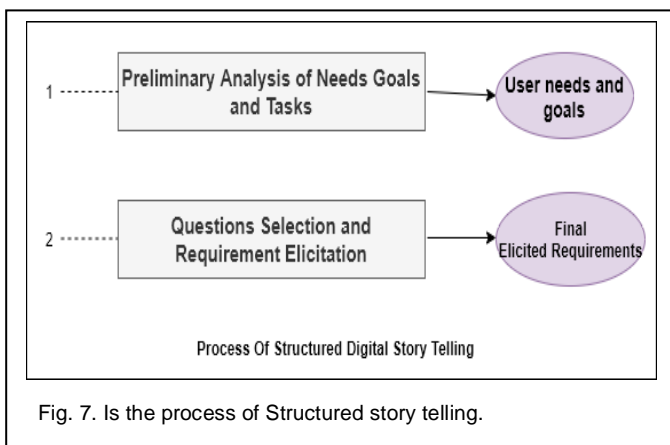
5.1 Structured Digital Story Telling

Story telling is considered as one of the finest means of conveying something for the people having limited knowledge. Story telling is one of the easiest means in which a person tells a story and whole narration is recorded. By the means of latest digital technology, we can broadcast our story over a large no. of audiences. This technique uses Interactive Voice Response (IVR), which uses structured dialogues to ask questions and some other technique to record the user response. Structured digital story telling uses "what if Scenarios" to collect user requirements. Other than that, it can use also use the "neighbors' opinion" about what kind of problem do they face and how can we generate a solution.

One of the biggest advantages of Structured Digital Story Telling is that the end users are free as there is no interviewer present to perform the whole scenario and the end user can specify and interpret the questions and they can submit their experiences and answers in their regional language. The structured story telling is a two-step process

1. Preliminary Analysis of Needs, Goals and Tasks
2. Questions Selection and Requirement Elicitation

1. Preliminary Analysis of Needs, Goals and Tasks
Requirement Engineering in general is a complex process as it involves the uncertain set of problems and to select a specific set of problems to address. In order to apply the SDS, it is necessary to target the appropriate topic so that we can get the exact user needs and understand their problem. The end result of this activity is the high-level user needs, goals and the tasks which stakeholders have to perform.
2. Question Selection and Requirements elicitation
As the user need and goals are known, we formulate the questions, keeping in mind the activities and tasks an end user may have to perform. Each Question can may consist of multiple sub question comprising of syntax "Please tell us ... ". Once the questions have been formulated, we use a digital medium such as any digital app to ask these questions in a synchronized manner and the end user response can be recorded [8].



5.2 Ontology Based Requirement Elicitation

Ontologies are a mean for representing the relation between the concepts and to present the knowledge in formal way related to a particular field [9]. The use of ontologies in Software engineering is very well known and used specifically when developing the domain models [11]. The Ontology driven Requirement elicitation basically uses a concept called Opacity that if two concepts are occurring in a requirement, is there any relation between them in domain ontology. There are mainly attributes of a domain which are stored in domain ontology

- 1) Concept (an entity in the problem domain)
- 2) Relation (Labeled connection between two concepts)
- 3) Axiom (Sub-class and equivalence axiom)

The Ontology based requirement engineering is very useful in terms of eliciting and specifying the quality requirements such as Completeness [11].

6. CONCLUSIONS

Requirement Elicitation is the pivotal activity in the Software Engineering Process. In this article we have drawn the in-depth analysis of all the existing requirement elicitation techniques and their co responding methods. Every technique has its own Pros and Cons. This article provides a thorough and in detail analysis of all the existing techniques and overviews some empirical techniques. The end reader will be able to understand each technique and to choose them according to their need and choice. topic under the Special Sections link.

REFERENCES

- [1] Tabbassum Iqbal, "Requirement Elicitation Technique: - A Review Paper," International Journal of Computer & Mathematical Sciences, Volume 3, Issue 9, November 2014.
- [2] Shadab Khan, Aruna B Dulloo and Meghna Verma, " Systematic Review of Requirement Elicitation Techniques, Volume," International Journal of Information and Computation Technology, Volume 4, Number 2, 2014.
- [3] Masooma Yousuf and M. Asger, "Comparison of Various Requirements Elicitation Techniques," International Journal of Computer Applications, Volume 116 – No. 4, April 2015.
- [4] Joseph Elijah, "Survey on Requirement Elicitation Techniques: It's Effect on Software Engineering," Vol. 5, Issue 5, May 2017.
- [5] Muhammad Ali Ramdhani, Dian Sa'adillah Maylawati, Abdusy Syakur Amin and Hilmi Aulawi, "Requirements Elicitation in Software Engineering," International Journal of Engineering & Technology, Volume 7, Number 2, 2018.
- [6] Fazila Shams, Hafiz Ammar Mazhar Bhutta, "Selection of Software Requirements Elicitation Techniques- A Systematic Review," Journal of Multidisciplinary Approaches in Science, Volume 1, Number1, 2019.
- [7] Zheyang Zhang, "Effective Requirements Development - A Comparison of Requirements Elicitation techniques," Department of Computer Sciences, University of Tampere.
- [8] Daniel Sinnig, Kristina Pitula and Peter Forbrig, "Structured Digital Storytelling for Eliciting Software Requirements in the ICT4D Domain," Concordia University, Montreal, Canada.
- [9] Katja Siegemund, Edward J. Thomas, Yuting Zhao, and Je Pan, "Towards Ontology-driven Requirements Engineering," University of Aberdeen.
- [10] J Daniel Sinnig, Kristina Pitula, Richard Becker, T. Radhakrishnan and Peter Forbrig, "Structured Digital Storytelling for Eliciting Software Requirements," DOI: 10.1007/978-3-642-15231-3_7.
- [11] Stefan Farfeleder, Thomas Moser, Andreas Krall, Tor St'althane, R.L. Michell, and Herbert Zojer, "Ontology-Driven Guidance for Requirements Elicitation," DOI: 10.1007/978-3-642-21064-8_15.