

# Selecting Requirement Elicitation Techniques for Software Projects

Saurabh Tiwari, Santosh Singh Rathore, and Atul Gupta

Indian Institute of Information Technology, Design and Manufacturing, Jabalpur, INDIA

Email: {saurabh.tiwari, santosh.rathore, atul}@iiitdmj.ac.in

**Abstract**—Software development process consists of many knowledge intensive processes, among which requirement elicitation process is perhaps the most critical for the success of the software system. Requirement elicitation process is intended to gain knowledge about user's requirement or need. Usually, the selection of requirement elicitation techniques is based on the company practice or on the personal experience. Moreover, there is a little guidance available on how to select elicitation techniques for a new software project. In this paper, we first provide a brief overview of the techniques available to support requirement elicitation process and identify their contextual applications. Next, we developed a framework to select elicitation techniques for a given software project based on the alignment of project's contextual information and the elicitation techniques. We demonstrate the applicability of the proposed framework by using illustrative examples and show how the framework uses the contextual knowledge of the software being develop to select useful requirement elicitation techniques.

**Keywords**—Requirement elicitation; Elicitation techniques; Elicitation technique selection; Evaluation Framework.

## I. INTRODUCTION

The opportunities to exploit the internet services, computerized businesses, computer-savvy consumers, the exponential decline in the cost of computation and communication, and the increasingly dynamic environment for longer-living systems are pressing software developers to come up with better ways to create and evolve systems. Over the years the process of software engineering has become increasingly demanding in terms of the quality control requirements. It leads the practitioner and researchers to devise new ways for optimizing the process of develop a quality software system.

It is a well know fact that the cost of rectifying errors in software increases exponentially in the later phases of software development. Hence, if one identifies the missing and incorrect requirements in the requirement elicitation process itself, then the cost of rectifying these errors in the software would reduce dramatically. The effort required to determine all the missing and incorrect requirements in requirement gathering phase is huge and time consumable. Thus, all we can do is optimizing the process of requirement elicitation thereby doing it in a better and faster way.

Requirement elicitation is a process of collecting the requirements of a software from users, customers and stakeholders. It is a non- trivial process because it is not a practice of just collecting the requirements from the customer but it require the involvement of the customers, stakeholders and

the requirement analyst to collect good and consistent set of requirements that will actually solve the problem. This process require some important questions to be answered that includes-

- what are the functional and non-functional requirements of the system?
- what are the characteristics of the system?
- what are the expected outcomes from the requirement elicitation process?
- what are the constraints applicable for the system in context with the hardware or software?
- which type of users/stakeholders are involved in the system?

The selection of suitable requirement elicitation techniques for a specific domain of a software project is a challenging issue. A number of variables influence this selection process. A wide variety of methods or techniques have been proposed by various authors [3-10][20-25] to acquire the information (requirements) from the customer and the stakeholders, such as: interview, protocol analysis, repertory grid, work groups etc. There are variations upon these methods and the combinations of techniques are used to gather the requirements [32]. In view of the diversity of techniques and the fair few summary papers there are, one might think that there is a sound scientific foundation for carrying out elicitation. This could not be further from the truth, however, as there is absolutely no agreement among experts on how best to elicit information or knowledge.

In software development life cycle identification of the efficient software requirements is one of the key challenges to develop high quality software system. The success or failure of a software development effort is greatly influenced by the quality of the requirements. In their study Bell et al.[1], observed that 'The requirement for a system do not arise naturally; instead, they need to be engineered and have continuing review and revision'.

To overcome this problem, we propose a framework for selecting effective elicitation techniques, i.e., choosing a small subset of requirement elicitation techniques from the set of all available techniques. In this paper, we propose a five-fold framework to select the set of elicitation techniques by considering the influencing parameters of the software like situational characteristics of the project, sources of domain knowledge, a list of elicitation techniques, available knowledge base data and particular domain of the software. Using all

these parameters, we applied a mapping mechanism on the framework for the evaluation and selection of requirement elicitation techniques.

The rest of the paper is organized as follows. The Next section provides an overview of the requirement elicitation problem. Section 3, provides information about the available techniques for requirement elicitation. In Section 4, describes an overview of the proposed framework. Section 5, describes a research approach, which provides the guidance of about technique selection. Section 6 explains our approach and framework via illustrative examples. Subsequently, discuss the applicability of the proposed approach and other related issues in Section 7. We present related work in Section 8, and finally summarize our conclusions in Section 9.

## II. PROBLEM DESCRIPTION

Requirement elicitation is a process of determining the problems and needs of the customer, so that software developers can construct a system that actually resolve customer problems and address their needs. Understanding requirements is a difficult task because it involves natural language to interact with the end-users, and end users may provide incomplete and ambiguous requirements. Requirements are volatile in nature, and they may change over the period of time. There are some social issues also, which affect requirement elicitation task. The process of selecting elicitation technique is affected by a number of other parameters as well.

Often requirement analysts choose a technique based on the some assumptions [11]. That are:

- This is the only technique that they know.
- Because this technique works effectively last time, so it will also work at this time.
- The analyst intuitively understands that the technique is effective in current circumstance.
- The analyst is following some explicit methodology, and that methodology prescribes a particular technique at the current time.

Number of author study about requirement elicitation problem [9][10][11][12], and they confirm that the problem is at much larger scales. Surveys revealed that one third of the projects started were never completed, and one half of them succeeded only partially. The reason behind such failure is poor requirement elicitation - more precisely, the lack of user involvement, requirement incompleteness, ambiguity in requirements, unrealistic expectations and unclear objectives[17].

The problem of requirement elicitation cannot be solved in a purely technological way because social content is much more crucial than the technical one [19]. Requirement elicitation process involves users of different background and to bring all of them together and elicit requirement is a difficult task.

## III. BACKGROUND

Many articles and books describe a way to performing requirement elicitation task. Most of the time practitioners are looking for a simple recipe that will solve all their elicitation

problems. However, because of the nature of this problem, one elicitation technique cannot work in all situations. Therefore, the number of authors describe multiple requirements elicitation techniques [20][21][22][23][24][25].

Requirement elicitation techniques can be divided in to four categories according to their nature of communication - traditional, contextual, collaborative and cognitive. The categorization of requirement elicitation techniques by refereeing the lecture of requirement elicitation at the university of Toronto, Department of computer science.

### A. Traditional Techniques

**Interview** is a method of identifying facts and opinions of users and other stakeholders of the system under development by face to face conversation. There are two different kinds of interviews: The closed interview, where the requirement elicitor has a pre-defined set of questions and is looking for their answers. The open interview, where requirement engineer and stakeholders discuss in an open-ended way to find out their expectation from a system.

**Questionnaire** is a technique of eliciting requirement from a large number of people in lesser cost and time. A well designed questionnaire can be useful to elicit the unambiguous and consistent requirements from the stakeholders. The success of questionnaire is depending on how well the session of questionnaire is design and on the skill of facilitator who conduct the session.

**Data gather from existing system** is use when we gather data for a system to replace an existing one. It is useful technique to collect the depth knowledge of system. When we use this technique we have to very careful that we are not over analyze the existing system for fear that the new system will become too constrained.

**Survey** is a technique of eliciting requirement from large number of people. It covers the entire region of users and customers to collect huge set of requirements. It is generally used for collecting requirement for general purpose software.

### B. Collaborative Techniques

**Focus Group** is a technique where a group of four to nine users from different backgrounds and with different skills discuss in a free form and concerns about the features of a system that will be created. Focus group help to identify user's expectations from the system, what things are important to them and what are their expectations from the system. They often bring out spontaneous reactions and ideas.

**Brainstorming** provides an open environment of discussion, where users are free to give their requirement and expectation of system. The data (ideas) collected after this process is then discussed and analyzed. Brainstorming contains two phases - the generation phase where ideas are collected without criticizing and evolution phase, where collected ideas are discussed.

**JAD** (joint application development) is a requirement engineering methodology in which stakeholders, subject matter experts (SME), end-users, software architects and developers

attend intense offsite meetings to work out on a system's details. JAD focuses on the business problem rather than technical details. Its success depends on effective leadership of the JAD sessions, on participation by key end-users, executives, developers, and on achieving group synergy during JAD sessions. The focal point of the JAD process is a series of workshops that are attended by stakeholders, executives, SME's, end-users, software architects and developers.

**Prototyping:** A prototype of a system is an initial build up of the system, which often used to validate system requirement. There are two different types of prototype are used: Throw-away prototypes help to understand difficult requirement. Evolutionary prototypes deliver a workable system to the customer and often become a part of the final system.

**Work shop** is a collection of different types of meeting conducted with the stakeholders to collect the requirements for the project being developed. Workshop provides the complete set of requirement. It is very useful to elicit requirement for complex and large system.

**Story boarding** is uses image, text, audio, video, animation diagram to visualize the concept of the software system to the stakeholders. This technique is allowing the stakeholders to come into common understanding of about the functionality of the system being developed. Storyboard is very easy to share with large groups, and do not give the false impression that the system is already developed.

**Models** include diagram such as DFD, state chart, UML diagram to elicit requirements. The models use for the purpose to help the customer to thought the process. Models are useful for eliciting requirements and to resolve conflict between stakeholders.

**Use cases/Scenarios:** Use cases describe interactions between users and the system to find user's need. It specifies a sequence of interactions between a system and an external actor. Use cases represent functional requirements of the software system. Scenarios are examples of interaction sessions where a single type of interaction between user and system is simulated. **Scenarios** should include a description of the state of the system before entering and after completion of the scenario, what activities might be simultaneous, the normal flow of events and exceptions to the events.

### *C. Cognitive Techniques*

**Document Analysis** is the process of analyze the documents related to the problem domain to gather the information, which is flow with in the organization. It is a useful technique to find in-depth knowledge about a particular task.

**Card sorting:** The card sorting method is used to generate information regarding to the association and grouping of a set of data items. Participants in a card sort are asked to organize individual, unsorted items into groups. Card sorting may be conducted as a series of individual exercises, as a concurrent activity of a small group, or as a hybrid approach where individual activity is followed by group discussion of individual differences. Card sorting is usually conducted as a specific activity in the early design phase of a project

for defining architecture, but can similarly be used during a product evaluation to determine if usability issues are due to problems with grouping or group labels. Card sorting can be used to:

- Identify themes or patterns from qualitative data.
- Develop the information and navigational architecture for a Web site or application.
- Design or redesign a site or application.
- Organize icons, images, menu items, and other objects into related groups.
- Determine how a specific individual classifies items from a particular domain.
- Examine how different groups (users versus developers, for example) view the same subject matter.
- Rank or rate items on specific dimensions.

The above mention techniques are the traditional technique of requirement elicitation. Numbers of other methods are also developed by organizations to make requirement elicitation task more effective. Some of them are discussed below.

**Protocol analysis** is a method of conducting a meeting where stakeholders and analyst to discuss the requirements of the system. Protocol analysis also provides the required actions to be taken for fulfilling the user requirements by using rationale.

**Laddering** is a form of structure interview in which a limited set of standard questions are asked to the stakeholders. The set of questions are arranged in hierarchical order. The success of this technique is depend on the domain knowledge of the stakeholders.

**Repository grid** is a technique of developing a grid of the form of a matrix stores the requirements are involves asking stakeholders to develop attributes and assign values to a set of domain entities. It is a good technique to provide the distinction between different information domains.

### *D. Observational Techniques*

**Observation:** This techniques involve an investigation of user's work and taking note on the activities that take place. Observation may be either direct or indirect. Observation allows the observer to view what users actually do in context, overcoming issues with stakeholders, describing idealized or oversimplified work processes.

**Ethnography/Social analysis** is the process of interacting with stakeholders and users of different background to find out political environment within organization. The observers go through the in depth observation of organization to understand working and cultural environment.

### *E. Other Techniques*

**SSM:** Soft System Methodology is a systematic approach for tackling real world problematic situation. It contains a set of principles that facilitates investigation efforts. It can be used whenever, in human/user/role centric situations, the feeling arises that this could/should be improved. The outcome of SSM analysis helps to understand the context and underlying

issues when investigating a given situation. To describe the process of SSM, we define a mnemonic CATWOE.

- **Clients** - Who are the beneficiaries or victims of this particular system?
- **Actors** - Who are responsible for implementing this system?
- **Transformation** - What transformation does this system bring about?
- **World view** - What particular world view justifies the existence of this system?
- **Owner** - Who has the authority to abolish this system or change its measures of performance?
- **Environmental constraints** - Which external constraints does this system take as a given?

**QFD:** Quality Function Deployment is a method for developing a design quality that aimed to satisfy the customer's need and then translating the customers demand into design targets and major quality assurance points to be used throughout the production phase. QFD is a way to assure the design quality while the product is still in the design stage. The three main goals in implementing QFD are:

- 1) Prioritize spoken and unspoken customer wants and needs.
- 2) Translate these needs into technical characteristics and specifications.
- 3) Build and deliver a quality product or service by focusing everybody toward customer Satisfaction.

**IBIS:** Issue-Based Information System is a method, which allows the rationale underlying requirements to be organized and tracked. The IBIS method is used to capture dialogue information by keeping track of the issues being discussed, the positions on these issues, and the arguments in support of or objecting to positions. IBIS consists of three main elements:

- 1) Issues (or questions): these are issues that need to be addressed.
- 2) Positions (or ideas): these are responses to questions. Typically the set of ideas that respond to an issue represents the spectrum of perspectives on the issue.
- 3) Arguments: these can be Pros (arguments supporting) or Cons (arguments against) an issue. The complete set of arguments that respond to an idea represents the multiplicity of viewpoints on it.

**FODA:** Feature Oriented Domain Analysis is a method for modeling variability. It is often used to express requirements on different possible configuration of a discussed concept. It is used to build the bridge between configuration Model and actual implementation of the software system. FODA exhibits the six traits of an ideal problem analysis technique:

- 1) Facilitates communication.
- 2) Provides a means of defining the system boundary.
- 3) Provides a means of defining partitions, abstractions, and projections.
- 4) Encourages analyst to think and document at the problem level, not the Software level.

- 5) Allows for opposing alternatives but alert the analyst to their presence.
- 6) Makes it easy for the analyst to modify the knowledge structure.

**ARM:** Accelerated Requirement Method is designed to elicit, categorize, and prioritize security requirements. The ARM method includes the three phases: Preparation Phase, Session phase and Deliverable phase.

**CORE:** Controlled Requirement Expression method is based on functional decomposition approach. CORE is explicitly based on viewpoints. Viewpoints are of two types: Defining viewpoint sub-processes of the system, viewed in a top-down manner and Bounding viewpoints, entities that interact indirectly with the intended system. The CORE method is made up of 7 iterative steps: Viewpoint identification, Viewpoint structuring, Tabular collection, Data structuring, single viewpoint modeling, Combined viewpoint modeling, Constraint analysis.

**CDA:** Critical Discourse Analysis is a way of approaching and thinking about a problem. It is a manner of questioning the basic assumptions of quantitative and qualitative research methods. Discourse Analysis does not provide a tangible answer to problems based on scientific research, but it enables access to the ontological and epistemological assumptions behind a project, a statement, a method of research, or - to provide an example from the field of Library and Information Science - a system of classification. Critical discourse analysis will enable to reveal the hidden motivations behind a text or behind the choice of a particular method of research to interpret that text. Critical discourse analysis is nothing more than a deconstructive reading and interpretation of a problem or text discourse analysis aims at allowing us to view the problem from a higher stance and to gain a comprehensive view of the problem and ourselves in relation to that problem. It is meant to provide a higher awareness of the hidden motivations in others and ourselves and, therefore, enable us to solve concrete problems - not by providing unequivocal answers, but by making, we can ask ontological and epistemological questions.

## F. AGILE Development Methods

According to Agilemodeling.com, "Agile is an iterative and incremental (evolutionary) approach to software development, which is performed in a highly collaborative manner by self-organizing teams within an effective governance framework with "just enough" ceremony that produces high quality solutions in a cost effective and timely manner, which meets the changing needs of its stakeholder."

Agile methods are adaptive in nature, they were developed to adapt and succeed on frequent changes. Agile methods are people-oriented; they rely on people's expertise, competency and direct collaboration rather than on document-centric processes. Agile methodology follows these principles:

- 1) Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.

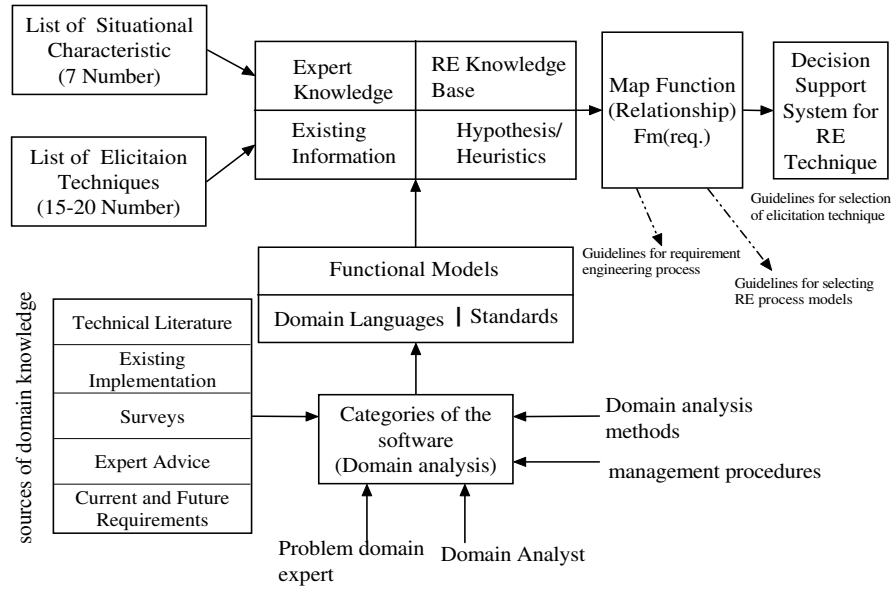


Fig. 1. Overview of the proposed framework

- 2) Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
- 3) Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
- 4) Business people and developers must work together daily throughout the project.
- 5) Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
- 6) The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
- 7) Working software is the primary measure of progress.
- 8) Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
- 9) Continuous attention to technical excellence and good design enhances agility.
- 10) Simplicity—the art of maximizing the amount of work not done is essential.
- 11) The best architectures, requirements, and designs emerge from self-organizing teams.
- 12) At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

#### IV. FRAMEWORK OVERVIEW

This section summarizes the guidance of using the requirement elicitation (RE) techniques. As we know, requirement elicitation is performed in a wide variety of conditions, which include many dimensions representing various combination of

participants, problem domains, and organizational context. It is also performed by wide varieties of way.

##### Assumptions

First, let us consider the basic assumptions for successful execution of our approach.

- A team of requirement analysts is available for performing the task of applying the proposed approach.
- List of situational characteristics will be identified by the analysts.
- On the basis of analysts experience and the knowledge available in the requirement database, decision is made by the analysts to choose the set of techniques using the mapping function.

Here, we give a list of situational characteristics, which is commonly occurring when we try to elicit requirements and also the list of available techniques, which we can use with these situational characteristic contexts. Figure 1 shows the proposed framework for eliciting the requirements and evaluating them too. The proposed framework acts as a decision support system for the analyst to take the decisions. The main advantage of the framework is that it may be used for selecting RE process models for the whole requirement engineering process instead of only selecting the elicitation technique. The framework is in five-folds:

- 1) Identify the list of situational characteristics of the software under development.
- 2) Using the source of domain knowledge like technical literature, surveys to identify the categories of the software in each domain.
- 3) Identify the list of available elicitation techniques.
- 4) Using the experts knowledge, existing information, RE knowledge base and hypothesis we identify the relevant information for mapping the information extracted in

| Name of situational characteristics  | Description of characteristics   |
|--------------------------------------|--|
| Type of stakeholders                 | Stakeholders are heterogeneous; homogeneous depends on nature of them. Some of them contain domain knowledge while other not contains any knowledge of domain. We divide them into four categories. Homogeneous, heterogeneous, domain expert, not domain expert but decision maker. |
| Social environment                   | Social environment play a crucial role in the process of requirement elicitation. We divide this attribute in to three categories: low, medium, high, according to the impact of social environment on the RE process.   |
| Domain of the system being developed | Domain of the project means whether it is build for a new system or there is existing systems are available. This is of two types: new system domain, existing system domain.  |
| Type of end users                    | Domain knowledge of system user effect the selection of RE technique. They are of three types: new user, some knowledge of domain, domain expert.  |
| Scope of system                      | The system which will develop is of two types: customize system use within an organization, generic product use publicly.  |
| Analyst ability/skill                | Analyst skill for eliciting requirement by using specific technique is a prime attribute for RE technique selection. They are of four types: new, less experience, experienced, expert.  |
| Approach to be followed out          | Some organize use specific methodology for RE, Which guide them for selecting RE technique. Like agile, IBIS, FODA etc.  |

Fig. 2. Situational Characteristics of the Project

| Technique name                | Applicability of the technique  | Data available at output | Conductor/facilitator                                  |
|-------------------------------|---|--------------------------|--|
| Brain storming                | Collect ideas from everyone, generate as many ideas as possible, natural interaction with people without criticize, want to collect opinion from everyone.  | Small                    | Experienced  |
| Interview                     | Want to elicit detailed information from an individual, group session is not possible, getting requirements on new system, heterogeneous stakeholders.  | Small to large           | Experienced analyst with application domain knowledge. |
| Focus groups                  | Assemble experts together and discuss the problem, heterogeneous stakeholders, and some specific issues to be planned and resolved.   | Small                    | Experienced, skilled full facilitator                  |
| Workshop                      | Gather all key stakeholders together for a short but intensely focused period, completed interviews and have written note of each interview.  | Small                    | Outsider, unbiased experienced facilitator.            |
| Observation                   | Existing system available for observation, want to understand the end user goes through in their job, generate some instant requirement.  | Medium                   | A person accepted by people being observed.            |
| Ethnography , social analysis | Knowledge about social & cultural environment, high heterogeneous stakeholders, to collects the quality attribute requirements such as usability and efficiency, want to determine social impact. | Medium                   | A person accepted by people being observed.            |
| Survey                        | Collect data from large number of people, want to collect general opinion.  | Large                    | Experienced facilitator                                |
| Prototyping                   | Helpful for developing new systems for entirely new applications, useful when developing human computer GUI interfaces, provide detail information by prototyping requirements.                   | Small                    | Representative of analyst                              |
| Protocol analysis             | Want actively participation from stakeholders; gather specific information of target system, good understanding of the process for problem solving.   | Medium                   | A person accepted by people being observed             |
| Document analysis             | Detail knowledge of data flow within organization, organization standard, policies, and existing system available.  | Medium to large          | Any analyst representative                             |
| Card sorting                  | Detail knowledge of domain, have items needed to categories, most use full for web site structure application, to know the knowledge of customer about the problem domain.                        | Medium                   | Expert analyst   |
| Scenarios, Storyboard         | Knowledge of data flow for a task, interaction between system & user,   | Small to large           | Analyst representative with stakeholders.              |
| Models                        | Uncover missing requirements, find inconsistency in gather requirements.  | Medium                   | Experienced  |
| Questionnaire                 | Quickly gather data from large group of stakeholders, to collect fundamental requirements at early stage,   | Medium                   | Experienced with domain knowledge                      |
| Analysis of existing system   | Detail domain knowledge, applicable for existing domain application.  | Small to medium          | Domain expert  |
| Laddering                     | To priorities requirements of stakeholders, Domain knowledge, hierarchical structure of knowledge   | Small to medium          | Domain expert  |
| Repository grid               | Requirements have noted down from earlier techniques, used to store the requirements involve asking stakeholders to develop attributes and assign values to a set of domain entities.             | Small                    | Domain expert  |
| JAD/RAD                       | Large number of heterogeneous stakeholders, use in Agile development for quickly elicits requirements, direct communication with stakeholders.  | Medium                   | An experienced facilitator with domain knowledge.      |

Fig. 3. Summary of Requirement Elicitation Techniques

Step 1, 2 and 3.

- 5) Provide a mapping mechanism to choose the set of elicitation techniques to gather the requirement on the basis of situational characteristics, sources of domain knowledge, list of elicitation techniques and knowledge base for analysts to make a decision regarding selection of elicitation techniques from the big set of elicitation technique.

First, we identify the list of situational characteristics of the software irrespective of its domain knowledge. In the proposed approach, the situational characteristics are seven in number that are shown in Figure 2. Next, using the sources of getting the knowledge about the requirement engineering process like technical surveys, research papers, we identified the categories of software in different domains, they are :Business software; Medical Software (for medical utilization); Simulation software (for simulating behavior of something); Mathematical software (for mathematical analysis); Educational Software (for use of it in education); security related software; Database management software; Web based software; E-commerce software; E-governance software; Utility software; Program software; Game software for gaming; Banking software; Operating system and many more depending upon the domain knowledge. Next, we have provided a brief introduction to show when, which, why and how to use the elicitation technique as shown in Figure 3. The mapping function used in the proposed approach takes these information as an input and resulted best suited techniques as an output.

## V. RESEARCH APPROACH

This section summarizes the guidance of using the requirement elicitation techniques. As we know, requirement elicitation is performed in a wide variety of conditions, which include many dimensions representing various combinations of participants, problem domain, and organizational context.

In this paper, we have presented an approach where we maintained the database for (1). Situational characteristics of the software project, which may be applicable to all the available domains; (2). Available elicitation techniques; (3). Knowledge based database; (4). Categories of the software projects. BY maintaining all this information in the database, it is easier to identify the set of elicitation techniques on the basis of these databases.

Here, we describe the list of identified seven situational characteristics for the software project. These characteristics will provide the more systematic and sequential approach to conduct requirement elicitation process.

- 1) Type of stakeholders: For elicitation of requirements, identification of stakeholders is very important task. Because most of the stakeholders are from different background, some of them have knowledge about the domain, while most of them are not having any knowledge. Therefore, to include all the stakeholders in elicitation process is required, so that any conflict between them is resolved and the requirements, which will elicited are consistent and reflect the actual needs of the customer.

- 2) Social Environment: The process of requirement elicitation cannot be done purely in technological ways, because social context is playing a crucial role. Most of the computer-based system are developed without any systematic help of social science, the result of this is that the needs of users are not addressed completely and there are often serious misconceptions are occurring. So for choosing any elicitation technique, analysts must also keep social science in their mind.
- 3) Nature of the system which will develop: Selection of elicitation technique is influenced by the nature (domain) of the system, which will develop, i.e. It means that whether we developed system for a new domain or for an existing one domain. Most of the experts recommended that observation of users should always be done when they are available and there is an existing system.
- 4) Type of user: The type of users for which system will develop also affects the selection of elicitation techniques. If the user has knowledge about the domain then always ask from users about their expectation of the system or about functionality otherwise try to understand users need by some other mean.
- 5) Scope of the system (Generic or Customize): The scope of the system mean whether it is customized (use of an organization inside) or generic (use by common users generally) is affecting the selection of elicitation techniques.
- 6) Analyst's ability/skill: Analysts (elector) skill is one of the key factors for selecting requirement elicitation techniques because the requirement elicitation process is highly affected by the skills of analysts. Most of the time analysts are new and they don't have much experience to use elicitation techniques.
- 7) Approach to be followed out: Selection of elicitation technique is also affected by the methodology, which is used by an organization for the development of software because these methodologies force the analyst to select a particular elicitation technique for elicitation process.

The research approach utilizes the extracted information about the software project to identify the set of elicitation techniques. This helps the analysts to gather quality requirements from the stakeholders that results a good quality software. Getting an optimal set of techniques from the larger set of elicitation techniques will help the system analysts to concentrate only on the identified techniques instead of choosing the technique on the basis of personal experience of analysts. Choosing the right technique, on the right project and at the right time leads to quality software development. Since, last 60 years of experience in software development, about the success or failure of the software project. It seems that if we collect the information about the project success, failures, methods, techniques applied, dos and Don'ts etc., We would achieve a very strong knowledge database of the software. This database would be very helpful in achieving the goals in context with the software and we are in the positions to

minimize the error/bugs in the software development life cycle.

## VI. ILLUSTRATIVE EXAMPLES

In this section, we present the applicability of our proposed approach by giving illustrative examples of three real world project. They are - online shopping mall project, E-governance project and monopoly (RealEstate) game project. Here, we select the projects of three different domains to evaluate the generalized applicability of our approach. The first project is a web based portal of a shopping mall, the second is a government project, which provide information of about roads and lands of a state and the last one is a desktop based game project. In these examples we analyzed the problem domain of each project and identify the characteristics of the project. Next, these identified characteristics are used as an input to our framework to develop a relationship between the requirement elicitation techniques and the characteristics of the projects. For these examples we make some assumptions based on our best knowledge to find the characteristics of the project.

### A. Online shopping mall project

The Online Shopping Mall (OSM) is a web application that intended to provide complete solutions to vendors as well as customers through a single get way using the internet as the sole medium. It will enable vendors to setup online shops, customer to browse through the shop and purchase them online without having to visit the shop physically. The administration module will enable a system administrator to approve and reject request for new shops and maintain various lists of shop category.

This project has three types of user- Administrator, Customer, and Employees. This project has following situational characteristics.

- Type of stakeholder: This project is an online web portal that has two types of stakeholders. The first type is administrative person and employees. Second type are of end users/customers. The first types of stakeholders are easily available for requirement elicitation process but the second type of users are not available for the process. To collect the requirement from the end users we need some other mechanism to elicit the expected requirements.
- Scope of project: This system has been used by many number of users, both the customer as well as by the employees of the shopping mall. This system is a generic product, so we have to consider these characteristics while selecting any requirement elicitation technique.
- Social impact: social impact is always being an important factor for any problem domain. Here the web portal is used by a number of customers of different background, which has a social impact on this, so we always consider this characteristic for selecting any requirement elicitation technique.
- Type of users: This web portal is a web based application, so for eliciting requirement from the customer side we have to consider the type of user while selecting elicitation technique because some of them have knowledge

about internet while others not have any knowledge of internet.

- Domain of the system being developed: The web portal is not a new domain project. Similar types of systems are already exists, we can use available system documents and software to know about the shortcomings of the existing systems.

For eliciting requirements from administrators and employees Group discussion, Brainstorming is two effective techniques because it is feasible to bring all the employees and administered in a single discussion to collect their opinions, ideas and expectations from the system and also any conflict between their requirements can also be resolved. Interviews can also be used to gather individual requirements. To collect requirements about the information flow within the shopping mall Document Analysis is an effective technique. To collect customer requirements we can use Observation and Social Analysis and Interview. By using Observation we can find the activities, which are performed by the customer during the shopping and by using interview we can address the requirements of customer by asking them their expectation from the system. We can use Ethnography if there are no budget and time constraint to know about the end user environment.

### B. Project Bhoomi E-governance project

The purpose of Project Bhoomi is to present a highly scalable, extendable, robust, user-friendly, easily deployed and cross-platform prototype of a software system for managing the city land record of a State. The objective is to provide free flow of information and better governance through the use of technology (e-Governance). A person should be able to access the desired information any time- any where. On the administration/governance side, the software solution should provide an easier and effective editing (addition/removal/change) of records and a better control and monitoring of the land records, apart from the requirements above.

This project has two types of user - Citizen of state, administrator and employees. This project has following situational characteristics.

- Social impact: This project is a government project, and so it is highly affected by social impact. Lots of influencing factors are there that have an indirect impact on this project. So for selecting any elicitation technique we have to consider this characteristic.
- Different stakeholders: This project has numbers of stakeholders from different background, some of them have knowledge about this project while others not have any knowledge about this but have their indirect involvement in making decision about the project. Therefore, we have to choose the technique in such a way that it can involve all the stakeholders in elicitation process.
- Type of user: This project is a web based portal, so for eliciting requirements we have to consider the intended user having knowledge of internet.
- Scope of project: This project is a generic system, which is used by many numbers of users. So we have to



consider this characteristic in making choice of elicitation technique.

There are two types of stakeholders. The stakeholders in the high level, and in the low level within an organization. For eliciting requirements from high level stakeholders, Interview and Workshops can be used and for low level stakeholders Observation and Focus Group techniques can be used. It is very difficult to bring all the stakeholders in a single discussion for group session. By using a focus group technique we can identify important people, which play an important role in making decisions and any conflict between is also resolved. For collecting individual requirements Interview can be used. For finding knowledge of information flow within the organization Document Analysis is a very good technique. It provides all the knowledge of about information flow within an organization. For collecting citizens' requirements Interview is an effective technique, by interviewing them we can identify their need and expect from the system.

### C. RealEstate monopoly game

This project is a Monopoly like game computer game called RealEstate. RealEstate provide several features we can see in the Monopoly game. This project has only one type of user i.e. Player. This project has following situation characteristics.

- Scope of project: This is a generic system which is use by any user.
- Type of stakeholders: This project has only one type of stakeholder i.e., people from the organization for which the system is being developed.
- Nature of the system: This system is build from an existing game called monopoly.
- Type of users: This system is containing only one type of user. That is, who which play this game.

For eliciting requirements Observation and Data Gather from Existing System are two useful techniques. By using observation we can gather all the knowledge about the game. Since, Monopoly is a very common game we can also gather requirements from existing systems of similar types. The Interview can be useful for eliciting requirements of the organization for which this system is designed. So that any special requirement related to the project performance can be collected.

## VII. DISCUSSIONS

Identifying a set of requirement elicitation techniques for the software development is an important task, as requirements directly influence the quality of the software to be develop. In this paper, we discussed two perspective to select a set of requirement elicitation techniques. The first one is to identify the characteristics of the software to be developed and the another one is to determine the contextual application of requirement elicitation techniques. Then we presented a framework that combined these two sets of information to select a optimized set of requirement elicitation techniques for performing better and effective requirement gathering process. This information (characteristics) of the software to be develop will easily be

extracted by analyzing the domain of the software system. This obtained information is then combined with the information of the available set of techniques to identify a set of requirement elicitation techniques.

The proposed approach has some limitations. This approach is a heuristic because we have taken some assumptions to identify the requirement elicitation techniques, due to the lack of information or guidance related to requirement engineering. We have taken the help of various research papers to maintain the database and for filling the relevant information required to gather the requirement. Though we know that the mapping function used by the approach is theoretical one, but it will help the analysts to choose the optimal set of requirement elicitation techniques.

## VIII. RELATED WORK

The selection of suitable RE techniques for a specific domain of a software project is a challenging issue. Number of variables influence this selection process. To overcome this challenge, several solutions have been proposed by many authors in different perspectives: Method engineering [3][4][5][6][7][8][20] provides approaches to develop or adapt existing methodologies to the new problem domain. Maiden et al. [9] proposed a framework, which provides guidance to selecting technique for requirement elicitation. Hickey et al. [10][11] proposed a model that helps to understand the RE process and the selection of elicitation techniques. Bickerton et al. [12] provide a framework for the classification of elicitation techniques based on the social assumptions. Macaulay [2] proposes a list for the selection of elicitation techniques. Kotonya et al. [13] proposed characteristic attributes, which can be helpful for the selection of elicitation techniques. Davis et al. [14] also proposed a process for elicitation technique selection based on four strategies of the requirements determination model and focuses on the selection of RE elicitation techniques. Browne et al. [15] also proposed guidance for the selection of elicitation technique. Lobo et al. [16] developed an approach for elicitation technique selection based on a predefined RE process model. Lausen [18] discusses several techniques, which can be used in the RE process. He also provides an idea for elicitation technique selection. After of many studies and research, the problem of RE is not addressed properly and there is still a lack of proper contextual information for selecting elicitation is available.

Viviane et al., [26] proposed a collaborative approach for requirement elicitation process. Their approach consists of a knowledge model based on the stories about the system and a tool to support interaction. Suranjan et al., [27] describes an approach to provide a guide for the process of requirement engineering. Their study collaborates based on the four states and identifies important factors that tend to trigger from one state to another state. Ruben et al., [28] provides a framework based on the need of modeling primitives and it supported by the mean of theoretical and modeling foundation of a social science framework. Yan Tang et al., [29] proposed a framework to provide the guidance for the selection of requirement

elicitation technique. Sumaria et al., [30] introduces a way and the guidance for selecting requirement elicitation techniques. They analyzed different elicitation techniques in the context of different project settings. Zhying [31] provides a comparison of different requirements elicitation techniques and concludes his findings.

In this paper, we focus our efforts to identifying the situational characteristics for any problem domain and try to find out the relationship between characteristics and available techniques to provide a guidance of selecting requirement elicitation technique. So we could improve the average analyst's abilities to select a proper elicitation technique, and we will most likely to improve the success rate of the software systems.

## IX. CONCLUSIONS

In this paper, we presents a meaningful insight to exploit the characteristics of the different type of elicitation techniques to choose a significant and useful set of. As discussed above each elicitation technique has a predefined set of specific and unique situational characteristics and a context of the their application. In this paper, we present some situational characteristics that can commonly occur in any domain of software development. We present the examples of three projects to guide the user to select a elicitation technique for requirement elicitation process.

The framework presented in this paper can be influenced by the scope of elicitation techniques, which we are included and our understanding of these techniques. The state-of-the-practice in RE is still one of the major problems in software development, as it is very difficult to reach to any conclusion for selecting requirement eliciting techniques. But by analyzing the domain of the problem we can find some characteristics of the system, which can help us to making the decision of selecting requirement eliciting techniques. In the future, we are planning to implement a mapping function that provides a guidance for the selection of requirement elicitation techniques in a better way to optimize the requirement gathering process.

## REFERENCES

- [1] T. E. Bell and T. A. Thayer "software requirements: are they really a problem" Proceedings of the 2nd international conference on Software engineering p 61-68 IEEE Computer Society Press, 1976.
- [2] Macaulay, L.A "Requirements engineering" Requirements Engineering Macaulay, L.A., Springer-Verlag, Berlin, Heidelberg, New York p 206, 1996.
- [3] Kumar, K., Welke, and R.J "Methodology engineering: a proposal for situation specific methodology construction" in Challenges and strategies for research in systems development p 257-269, 1992.
- [4] Brinkkemper, S "Method engineering: engineering the information systems development methods and tools" Information and Software Technology Method Engineering and Meta-Modelling vol 38, Issue 4, 1996, p275-280, 1996.
- [5] Rossi, M., Tolvanen, J.P "Using reusable frameworks in development of a method support environment" Proceedings in the WITS RTWH, Aachen ,vol. 95, no. 15, p 240-249, 1995.
- [6] Lyytinen, K., Welke, R "Meta modeling and method engineering" Special issue on Meta modeling and method engineering. Information System International Journal vol 24, no. 3, 1999.
- [7] Tolvanen, J.P "Incremental method engineering with modeling tools: theoretical principles and empirical evidence", PhD thesis, Computer Science, University of Jyväskylä, 1998.
- [8] Saeki, M "Software specification, design methods and method engineering" International Journal on Software Eng. Knowledge Eng, Citeseer, 1994.
- [9] Maiden, N., Rugg, G. "ACRE: selecting methods for Requirements acquisition" software engineering journal vol 3, no. 11, may 1996.
- [10] Hickey, A.M., Davis, A.M "Requirements elicitation and elicitation technique selection: a model for two knowledge-intensive software development processes". Proceedings of the 36th Annual Hawaii International Conference on System Sciences, p 96-105, Jan 2003.
- [11] Hickey, A.M., Davis, A.M "Elicitation technique Selection: how do experts do it?" Proceedings of the 11th IEEE International Requirements Engineering Conference, P169 - 178, 2003.
- [12] Bickerton, J.M., Siddiqi, J "The classification of requirements engineering methods" Proceedings of IEEE International Symposium on Requirements Engineering p182-186. San Diego, CA, USA, Jan, 1993.
- [13] Kotonya, G., Sommerville, I."RE, Processes and Techniques" John Wiley and Sons Ltd, New York, 1998.
- [14] Davis, G.B "Strategies for information requirements determination" IBM System Journal vol 21, no.1, p4-31, 1982.
- [15] Browne, G.J., Ramesh, V "Improving information requirements determination: a cognitive perspective" Information and Management vol 39, No. 8, p625-645, Sep, 2002.
- [16] Lobo, L.O., Arthur, J.D "An objectives-driven process for selecting methods to support requirements engineering activities" In 29th Annual IEEE-NASA Software Engineering Workshop, p118-130, April, 2005.
- [17] Standish Group. CHAOS Demographics and Project Resolution, 2004.
- [18] Lauesen, S "Software Requirements: Styles and Techniques" Addison Wesley, New York, 2002.
- [19] Goguen, J.A.; Linde, C. "Techniques for requirements elicitation" Proceedings of IEEE International Symposium on Requirements Engineering, p152-164, Jan 1993.
- [20] Brinkkemper, S., Lyytinen, K., Welke, R "Method Engineering, Principles of Method Construction and Tool Support", Chapman and Hall, London, 1996.
- [21] Kotonya, G. and Sommerville, I. "Requirements Engineering: Processes and Techniques" John Wiley and Sons, 1998.
- [22] Leffingwell, D. and Widrig, D. "Managing Software Requirements - A User Case Approach" 2nd Edition Addison- Wesley, 2003.
- [23] Maiden, N.A.M. and Rugg, G. ACRE "Selecting Methods for Requirements Acquisition" Software Engineering Journal, vol. 11 No. 3 p183 - 192,1996.
- [24] Nuseibeh, B. and Easterbrook, S. "Requirements engineering: a roadmap" Proceedings of the Conference on The Future of Software Engineering, ACM Press, p35 - 46, 2000.
- [25] Rugg, G. and McGeorge, P "The concept sorting techniques" The Encyclopedia of Library and Information Science, vol. 65 No. 28, p43 - 7, 1999.
- [26] Viviane Laporti, Marcos R.S. Borges and Vanessa Braganholo, "Athena: A collaborative approach to requirements elicitation" Computers in Industry 60 Page 367380, 2009.
- [27] Suranjan Chakraborty, Saonee Sarker and Suprateek Sarker, "An Exploration into the Process of Requirements Elicitation: A Grounded Approach", Journal of the association for information systems, Volume 11, Issue 4, pp. 212-249, April 2010.
- [28] Rubn Fuentes-Fernandez, Jorge J. Gmez-Sanz, and Juan Pavn, "Requirements Elicitation and Analysis of Multiagent Systems Using Activity Theory", IEEE Transactions on systems, man, and cyberneticsPart A: Systems and Humans, Vol. 39, No. 2, March 2009.
- [29] Yan Tang, Kunwu Feng, Kendra Cooper and Joo Cangussu, "Requirement Engineering Techniques Selection and Modeling An Expert System Based Approach", International Conference on Machine Learning and Applications, 2009.
- [30] Sumaira Kausar, Saima Tariq, Saba Riaz and Aasia Khanum, "Guidelines for the Selection of Elicitation Techniques", 6th International Conference on Emerging Technologies, 2010.
- [31] Zhying Zhang, "Effective Requirements Development- A Comparison of Requirements Elicitation techniques", SQM 2007.