CHAPTER 3

AN EFFECTIVE FRAMEWORK FOR REQUIREMENT ELICITATION

3.1. Introduction

Requirement Engineering (RE) is one of the most important process of software engineering. RE process starts from gathering and capturing of requirement and is also known by the term requirement elicitation. According to various reports it is evident that poor requirement engineering is the most prominent factor for the failure of the software projects. The surveys [1][16][18][30] shows that in all the failed projects the 50% reasons is the poor requirement engineering where as the rest of 50% is due to other reasons. During RE phase requirements are elicited through consultation with stakeholders. The stakeholders not only refer to human being, such as end users, customers, decision-makers or developers, but also refer to the physical, organizational, or legislation environment where the desired system is to be used [141]. Because different stakeholders have distinct ways to store, recognize and express their knowledge about the problem domain, a single method is unlikely enough to elicit requirements from different stakeholders. Requirement Elicitation is all about determining the needs of stakeholders and learning, uncovering extracting and discovering needs of the users and other potential stakeholders. Requirement elicitation is recognized as one of the most critical knowledge intensive activity of software development. It is evident from various surveys [16][18] and reports that improper, incomplete requirement elicitation leads to software project failure. So there is a need to improve effective requirement gathering [20] and more attention is required in elicitation process. Understanding requirement elicitation methods and foreseeing the need to use them in different contexts are essential for requirement elicitation. Many frameworks regarding requirement elicitation are designed but most of them lack practical knowledge [21]
In order to support elicitor for effective requirement elicitation, an efficient framework is needed. In this research study an efficient Requirement Elicitation framework is proposed that address the core problems faced by the elicitors. The proposed Requirement Elicitation Framework addresses some of the issues in requirement elicitation that can lead to software project failure, by enabling domain knowledge as base, stakeholder input early in the development process, by encouraging selection of elicitation technique based on neural network and prioritize requirements as post elicitation phase using fuzzy systems.

3.2 Problem Definition

The failure of the software projects is one the major issue of the software industry from many years. Many surveys and studies have been done to investigate the cause of software projects failure statistics. Empirical analysis and research in many software organizations has demonstrated that having a well-defined requirement engineering process and adopting suitable requirement engineering techniques has a positive impact on the overall quality of software and the overall savings of project cost, compared to those projects that did not have well defined process models and did not use suitable techniques. A more recent Chaos Report [16][18][30] has suggested that the problems of delayed, over-budget and failed software are still pressing issues. The major concern of software industry is to develop quality software. The researchers suggest that poor requirement engineering especially ineffective requirement elicitation lead to 50% of the software project failure [27][30]. Even though tremendous efforts have been made in requirement engineering research, a significant gap still exists between theory and practice. So to improve in software success rate an efficient framework is needed for effective requirement elicitation.

3.3 An Outline of Requirement Elicitation Framework

The discussions and analysis shows the impacts of requirement elicitation on project failures. An efficient framework for effective requirement elicitation process is needed. In this research study an efficient framework for Requirement Elicitation is proposed. The proposed requirement elicitation framework addresses core issues of requirement elicitation that leads to software project failure. The core problems discussed in the
proposed framework are pre-domain development, stakeholder management, selection of requirement elicitation techniques and early requirement prioritization. The proposed requirement elicitation framework starts with the problem of Pre-Domain development. This involves a series of activities where elicitor may understand the domain, acquire domain knowledge, analyzes the domain knowledge and after that domain knowledge can be verified and validated. The next issue discussed in the proposed framework is stakeholders management. In this step key stakeholders[24] are identified using genetic algorithm ,stakeholder profiles are recorded and finally stakeholders are classified by observing NVC model proposed by [23].Another issue highlights the problem ,selection of requirement elicitation technique from a wide variety of techniques .This problem is discussed by [23][99][22] and an approach is proposed for requirement elicitation technique selection based on neural network .The elicited requirements are then organized and this process is known as requirement organization. Requirements are prioritized as early requirement prioritization by applying fuzzy logic. Finally the framework is implemented by developing ReqElic tool and validated by using finite state machine design. Test cases are generated for the validation of the framework.

3.4. Highlights of Proposed Framework

- To define and identify key issues and problems of requirement elicitation and their impact on the projects.
- To propose an approach for pre-domain development.
- To create and manage stakeholder profile.
- To identify key stakeholder using Genetic Algorithm.
- To classify stakeholder based on NVC Model
- To select elicitation technique from a set of techniques using Neural Network
- Early requirement prioritization using a fuzzy logic based system
- Implementation of proposed framework by developing ReqElic tool
- To validate framework using FSM and SPSS tool
3.5 Requirement Elicitation Framework

Fig 3.1: Proposed framework for requirement elicitation
3.5.1 Stages of Requirement Elicitation Framework

Various stages of proposed framework shown in fig 3.1 are as follows:

- Understanding Problem Domain
- Pre-Domain development
- Stakeholders Management
- Selection of Requirement Elicitation technique
- Requirement Organization
- Early Requirement Prioritization

3.5.1.1. Understanding Problem Domain

The problem domain can be defined as the difference between things perceived and features as desired. If the user perceives something as a problem its real problem can be addressed. The process of understanding real world problem, user needs and proposing solution to meet the needs is known as problem analysis. The problem domain can be analyzed and understood. A variety of solutions are explored from domain and our job is to find the solution that is optimum fit for the problem being solved.

3.5.1.2. Pre-Domain development

Pre-Domain development is one of crucial factors to get a great success in requirement elicitation process of high quality. Pre-Domain development plays an important role to understand domain knowledge of problem domain. In this research direction, one of the major issues is the technique to model and to represent domain knowledge for effective requirement elicitation.

The auxiliary stages of Pre-Domain development may include the following:

- Identification of Domain Stakeholders
- Domain knowledge acquisition
- Domain analysis
- Domain verification & validation
3.5.1.3. Stakeholders Management

A stakeholder can be defined as any individual, group, or institution who has a vested interest in the natural resources of the project area and/or who potentially will be affected by project activities and have something to gain or lose if conditions change or stay the same. In the field of software engineering, requirement elicitation is the activity in which stakeholder needs are understood. Inadequate stakeholder input is a natural outcome of current practices. Existing stakeholder management methods are likely to overlook stakeholders. In addition, stakeholders are often sampled during requirement elicitation. As requirements are elicited from stakeholders, omitting key stakeholders results in missing requirements, which leads to the wrong product being built. Omitting stakeholders is one of the most common mistakes in software engineering. In software projects four problems related to the stakeholder’s management are stakeholders profile management, identification of key stakeholders, stakeholders interaction and stakeholders classification. Proposed requirement elicitation framework addresses these problems using genetic algorithm and NVC model. Stakeholder’s management involves the following steps.

1. Create and manage Stakeholders Profile
2. Stakeholders Identification
3. Stakeholders Interaction
4. Stakeholders Classification.

3.5.1.4. Selection of Requirement Elicitation Technique

Requirement elicitation is the first stage of requirement engineering that requires the use of certain techniques. Accurately capturing system requirements is the major factor in the success of most of software projects. Due to the criticality and impact of this phase, it is very important to perform the requirement elicitation in no less than a perfect manner. One of the most difficult jobs for elicitor is to select appropriate technique for eliciting the requirement.
It is uncertain on how to select the appropriate techniques for specific situations under certain conditions. Although several selection guidelines do exist, they are mainly theoretical rather than pragmatic. With the availability of various techniques elicitor must be able to decide which technique is best suitable for which situation. Inappropriate selection of technique leads to wrong selection of requirement which results in utter failure of projects. Due to the heterogeneity of stakeholders, requirement elicitation process must be carefully handled by effectively applying the appropriate techniques. In this work important factors are identified that contribute to selection of requirement elicitation techniques from the perspective of practitioners in the industry. These factors are used as input and an approach is applied for selection of requirement elicitation technique. In requirement elicitation framework a neural network based approach is proposed for selection of requirement elicitation technique.

3.5.1.5. Requirement Organization

After successful requirement elicitation process requirements are elicited from different stakeholders. These requirements are stored in requirement repository. These requirements are organized in such a way so that they can easily understand by the developer. A template is designed for requirement organization.

3.5.1.6. Early Requirement Prioritization

Early Requirement Prioritization is the process to prioritize the requirement according to need and requirement of the stakeholders [138] after successful requirement elicitation. This technique is performed as post elicitation technique. There are various factors on the basis of which the requirements are prioritized. In early requirement prioritization process, after successful requirement elicitation the gathered requirements are prioritized so that the requirements with high priority are implemented first than low priority requirements. The factors of requirement prioritization on the basis of which the requirements are prioritized are Complexity Level, Degree of Reusability and Importance to customer. In this work a fuzzy logic based system is proposed in which these factors are used as input in fuzzy system and on the basis of these factors the priority of each requirement is computed.
3.6. ReqElic: A Requirement Elicitation Algorithm

ReqElic algorithm has five functions to show the actual working of framework. These are as follows

- PreDomainDevelopment()
- StakeholderManagement()
- RequirementElicitation()
- Early_RequirementPrioritization()
- RequirementElic_Validation()

**ReqElic Algorithm**

Input:

Domain is specified using the following representation: \( D = (S, R) \)

A set of stakeholders for a project denoted by

\[ S = \{ s_1, s_2, \ldots, s_m \} \subset R. \]

The set of relative weights associated with each stakeholder is denoted by a weight set:

\[ W = \{ w_1, w_2, \ldots, w_m \} \]

Software requirements elicited from each stakeholder is denoted by:

\[ R = \{ r_1, r_2, r_3, \ldots, r_n \}. \]

\[ T = \{ t_1, t_2, \ldots, t_m \} \] represents different elicitation techniques:

**PreDomainDevelopment ( )**

Input:

DCS where \( S = (s_1, s_2 \ldots, s_n) \) representing viewpoints of abstract stakeholders dealing with sub-problems of domain;

D: Problem Domain should be decomposed into finite sub-problem domains.
D = \{d_1, d_2, \ldots, d_n\} 

Where \(d_1, d_2, \ldots, d_n\) represents sub Domain of D.

do {
    Domain_Stake_Identification(); // Identification of domain stakeholders
    Domain_Acquisition(); // Acquire Domain Knowledge
    Domain_Analysis(); // Analysis of Domain
    Domain_Verification(); // Domain verification
    Domain_Validation(); // Domain validation
} While (Domain is Analyzed);

StakeholderManagement();
{
    StakeholderProfile();
    {
        Input: String Stakeholder_name
        Stakeholder_Id
        Stakeholder_Role
        Stakeholder_Status
        Stakeholder_Type
        Stakeholder_Significance
        Stakeholder_Importance
        Stakeholder_Expectation
    }
Db_Conn ( )

{ // Stakeholders Profiles are entered and managed considering the inputs and enter the data to the database.

Step 1: Import required packages

Step 2: Register database driver

Step 3: Open a connection

Step 4: Execute a query

Step 5: Extract data from result set

Step 6: Clean-up environment

}

Stakeholders Identification ( )

{ 

Input:  S //List of stakeholders

   W // The set of relative weights associated with each stakeholder S

   Si = Pw + Prw + Uw

   // Si is the rating provided by stakeholder i known as stakeholder Index.

   // Pw = Weight associated with the Power level of the stakeholder

   // Prw = Weight associated with the Proximity level of the stakeholder

   // Uw = Weight associated with the Urgency level of the stakeholder

   Stakeholder Priority_{i} = \sum_{i} S_{i} * Si // Each Stakeholder is assigned a stakeholders

   priority denoted by (Sp)


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//Stakeholder Influence, is a value denoting stakeholder i\textsuperscript{th} influence in the project.

// SI, Stakeholder Influence, can be calculated by using genetic algorithm

**GeneticAlgo ( )**;

}

**StakeholdersClassification ( )** //In this function stakeholders are classified by observing NVC

{

Input: Behavioral Aspects of Non-verbal communication

Cues of Non-verbal communication

Signals of Non-verbal communication

StakeClass = (C\textsubscript{1}, C\textsubscript{2}, C\textsubscript{3})

//The stakeholders are classified into three classes (C\textsubscript{1}, C\textsubscript{2}, C\textsubscript{3}) by observing Non-Verbal communication during stakeholder interaction.

//Stakeholder is not aware about his own Requirements (C\textsubscript{1}).

//Stakeholder knows requirements but unable to express (C\textsubscript{2}).

//Stakeholder knows his requirement but doesn't want to reveal it (C\textsubscript{3}).

}

**RequirementElicitation ( )**

{

Input: (elicit\textsubscript{1}, elicit\textsubscript{2}, . . . ,elicit\textsubscript{n}) //Each of which creates new requirements by applying an elicitation technique.

elicit (R\textsubscript{i}, Ps, t\textsubscript{i}) //Each step of elicitation can be defined as a triplet of requirements to be elicited, project situation and the technique used for elicitation.

R\textsubscript{i}= R\textsubscript{i}+1;

Ps=Ps\textsubscript{i}+1;
At step i of the elicitation process, elicitation applies technique $t_i$ when situation $S_i$ exists and $R_i$ captures the current state of knowledge of the requirements need to understand. The result is a new state of the requirements $R_{i+1}$ and a new situation $S_{i+1}$.

$t_i \in T$  // $t_i$ is the technique selected from the set of all known elicitation techniques $T$.

//Let P Project selected for requirement elicitation.

Elicitation technique selection for project P considering the attributes A can be modeled as a function.

$$\mathcal{E}(R_i, P_i, \text{Ev}(T)) : \mathcal{T} \mathcal{C} t \quad // \quad \text{Ev Evaluating factors for elicitation technique}$$

$$R_i = T(P_i) \cup \text{Re} \text{ where } \text{Re} = \{R_1, R_2, ..., R_n\}$$

$\text{NNRegEli ( ) } \quad // \quad \text{Neural network approach for requirement Elicitation Technique Selection}$

{  
Step1: Assign input vector (v) values // Based on Elicitation Technique Evaluating Factors
Step2: Assign target values (t)
Step3: Create neural network  // Feed Forward Neural Network
Step4: Training of neural network  // Back-propagation technique
Step4: The result of training
Step6: Simulating the neural network
Step7: Analysis of result obtained

}
Early_RequirementPrioritization ( )

{ 
Input: R = \{r_1, r_2, \ldots, r_n\}. Assume that the set of possible software requirements elicited form each stakeholders.

S = \{s_1, s_2, \ldots, s_n\} //Assume that the set of possible Stakeholders denoted by S
s_1 = \{r_1, \ldots, r_n\} //For each stakeholder is associated with a set of requirements.

s_2 = \{r_2, \ldots, r_n\}

……………………

s_n = \{r_i, \ldots, r_n\}

FuzzyReqPrior ( )

{ 
Step1: Defining FIS variables and fuzzification of the input variables using membership function editor

Step 2: Specifying rules for Fuzzy inference system using Rule Editor for requirement Prioritization Problem

Step 3: Rule Evaluation

Step 4: Aggregation of the rule output

Step 5: Defuzzification of the output value

} }

RequirementElic_Validation ( )

{ 
Step 1: Framework is analyzed

Step 2: UML Diagram of the defined framework is designed

Step3: The paths defined in UML are further graphically represented by Finite State Machine (FSM)
Step 4: Transformation of states in FSM are recorded in State transition table

Step 5: The various productions can be induced from finite state machine

Step 6: For verification some test cases are generated

\} End of Algorithm

3.7 Conclusion

Requirement Elicitation is a critical and important activity of requirement engineering. According to the various surveys studied in the thesis “poor requirement engineering leads to project failure and requirement elicitation is one of the major factors”. The proposed framework in the research work provides support for effective requirement elicitation. Requirement elicitation framework addresses the core problem area faced by the analysts during requirement elicitation. The proposed framework supports both types of requirement, functional and non-functional. There is no distraction among functional and non-functional requirement in the proposed requirement elicitation framework. Requirement elicitation framework is categorized into three stages, Pre-elicitation, Elicitation and Post-elicitation. Pre-Domain development and Stakeholders Management are the pre-elicitation activities. In this step the domain is thoroughly studied, analyzed, verified and validated to understand the problem domain. If the problem domain is analyzed properly, the analysts can easily identify the functional and non functional requirements related to the problem domain. In stakeholders management, the key stakeholders are identified to gather the functional and non functional requirement from stakeholders during elicitation phase. In Requirement Elicitation step both the functional and non functional requirement are elicited from the stakeholders and selection of elicitation technique is based on neural network. In Post – Elicitation stage both functional and non functional requirements are stored in repository for further analysis and finally the requirements are prioritized as early requirement prioritization using fuzzy system. The activities and processes proposed in the requirement elicitation framework supports both functional and non functional requirements and effective requirements are elicited.