

# Towards a Comprehensive Survey of the Requirements Elicitation Process Improvements

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## ABSTRACT

Good quality of requirements is considered as one of the most critical parts of software development projects. The main objective of any project is to get the right requirements in order to be successful. Requirements elicitation is the process of gathering the right requirements from different sources (e.g. users, stakeholders) using the right techniques to achieve the users and system needs. There is not much attention and focus on the requirements elicitation process modeling in general. Most of existing models study the elicitation techniques in specific. This paper conducts a comprehensive survey of the requirements elicitation literature. We propose a model that illustrates the elicitation process activities. Features captured in this model: (1) cover almost all and the most important activities in the elicitation process, (2) concentrate on the improvement of the requirements quality by applying requirements tracking and refinement.

## Keywords

Requirements; Requirements Elicitation; Requirements Tracking; Quality.

## 1. INTRODUCTION

Requirements refer to the statements that describe what the system or software should do [1]. In other words, the services and needs provided by the system. Requirement Engineering (RE) is the process of determining the services required by the customer and the constraints that the system will develop and work with.

Requirement engineering encompasses number of activities such as requirement definition, elicitation, analysis, specification, modeling, validation, and management [2]. Out of these, requirement elicitation is the most critical activity in the RE process; since serious errors that occur during this phase can't be avoided in next phases, and through the whole software development life cycle (SDLC) [3].

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Requirements elicitation is the first stage of the SDLC, and plays a crucial role in the requirements engineering process. Oscar Dieste et al. [4] describes the requirements elicitation as "getting the right requirements" in the sense it should be considered to better understand the requirements rather than just collecting it [5]. Requirements elicitation goes through several phases in order to collect the required information whereby the users' wishes will be accomplished [6]. It usually starts with discovering the requirements about the users' expectations after identifying the requirement sources such as stakeholders. The elicitation phase is an iterative process depends on the management expertise and communication skills possessed by stakeholders and even all the project team [7]. The main problem that may hinder the elicitation process is misunderstanding between analyst and stakeholders or among stakeholders themselves.

Requirements elicitation is concerned with gathering desired information among the list of user demands [8]. It needs to be taken into consideration that any omission or misinterpretation of the customer's requirements will be difficult to modify in the future, which in turn increases the costs of development process, thus the project might fail.

The main goal of any organization is to collect good quality requirements to guarantee quality products. Many techniques are available to elicit the requirements; the chief techniques are interviews, brainstorming, Joint Application Design (JAD) and workshops [9]. The type of the system to be developed, size of the project, time, cost, schedule, and many other factors put constraints on the selected elicitation technique.

The requirements elicitation process must be carried out carefully to ensure the quality of requirements, which is essential to the success of the project. Getting the correct requirements is a supreme goal in elicitation process and is considered a challenge for the analysts and software engineers. Therefore, requirements elicitation should be given more attention.

As mentioned before, few models present the requirements elicitation in general [10]. Most of the existing models address the elicitation techniques or a particular technique.

In this paper we survey a wide variety of studies regarding requirement elicitation modeling. We propose a model that includes the fundamental steps followed in performing the elicitation process for any software development project. The proposed model focuses on improving the quality of the requirements being collected. The rest of this paper is structured as follows: Section 2 introduces the related work of this study. Section 3 presents an overview of the requirements elicitation definitions, activities, and reviews some existing models. Our motivation of this study is presented in Section 4. Section 5

provides the proposed model. Finally, the conclusion is presented in Section 6.

## 2. RELATED WORK

Over the years, requirements elicitation has received considerable attention. Zowghi et al. [7] introduces five different activities performed during the requirements elicitation process; they start by defining the application domain and end with gathering requirements from different requirement sources. Prasad Rajagopal et al. [3] proposed a methodology that includes new activities to improve requirements elicitation such as: Quality Function Deployment process (QFD) and

Capability Maturity Model (CMM). QFA intends to satisfy the users' needs, while CMM relates to the systems' risk analysis that the requirements should include.

Requirement elicitation techniques have received the most attention. Sharma et al. [11] present a general review that almost covers all the important elicitation techniques. Zowghi et al. [7] present different types of techniques and methods used in requirements elicitation. The chief set of eight techniques is selected to compare. Some of these techniques have been used together as "complementary" to get the required outcomes and hence meet the users' wishes. Hickey [12] proposed a mathematical model to help the analysts in selecting the appropriate requirements elicitation technique. Choosing the best technique will optimize the quality of requirements elicitation process, thus the project will succeed. Many challenges and issues may face the elicitation techniques, Sharma et al. [6] present the main five classifications of requirements elicitation techniques with the common problems and issues they might face; for instances, time and effort required, size of project, implicit knowledge, and others. Hardar et al. [13] conduct an empirical study by using interviews to assess the impact of analysts' prior domain knowledge on the requirements elicitation process. The domain knowledge may have either a positive or negative impact. The analyst with prior knowledge can easily collect information about the new project. However similar solutions for different problems may be used. Hickey [8] proposed a unified model that includes the elicitation process in general and the selection techniques process. This model is intended to assist analysts in understanding the process and in choosing the suitable technique. An empirical study is conducted to evaluate three of the elicitation techniques; interviews, brainstorming and JAD in terms of usability, user friendly, easy to understand, and easy to communicate [9]. The scores are approximately close, and the results show that interviews have got the highest score. Tiwari et al. [14] present a framework to select a suitable requirement elicitation technique for a specific software project.

User involvement has been taken into account in many researches as an important factor in the success of elicitation process. Yozgyur [15] proposed an online tool with easy to use interface with regard to increase the involvement of stakeholders in elicitation process in order to improve the quality of the requirements, and to handle some common issues in requirements elicitation process such as cost, risk, etc. Duarte et al. [16] proposed a collaborative method using visualization techniques to increase users' input in requirements elicitation, and to involve their visions in the process. Sustar et al. [17] conduct a case study that involves the older adults of the stakeholders in an elicitation activity. The results show that the older adults need to

use a tangible and detailed prototype rather than sketchy prototype so they can easily capture their needs.

## 3. REQUIREMENT ELICITATION PROCESS

This section presents an overview of the requirements elicitation definitions, its activities, and discusses some of existing models in the literature.

### 3.1 What is the Requirements Elicitation?

By surveying a variety of related studies, it is obvious that there is no standard unified definition for requirement elicitation. Different authors have presented different definitions. Furthermore, most definitions include specific terms seem to be associated with the concept of requirement elicitation; Information Gathering/Extracting [18, 8, 19, 14], and User / Stakeholders needs [7, 18, 16, 15]. Dieset et al. [16] describe the elicitation process as "Getting the requirement right" which refers to finding the appropriate technique during the elicitation process; they prefer to use structured interviews in such process. In other hand it is also important to acquire the right and desired requirements [18]. The analyst must understand the users and stakeholders needs in order to develop the project in the right way [7]. It is observed that the core elements included in the requirements elicitation concept are users' needs, requirements' sources (e.g. stakeholders), and elicitation techniques. Accordingly, we can define requirements elicitation as "a process of collection and perception of systems and users' needs by communicating with different sources (users, stakeholders, system sponsor, domain experts, etc.) and using appropriate techniques".

### 3.2 Requirements Elicitation Activities

Requirement elicitation is usually performed by following a set of activities. These activities may vary from one project to another depending on the type of the system, project objectives, and some other factors. However, most of these activities seemed to be similar among the existing researches. Zowghi et al. [7] describe five activities of requirements elicitation that are commonly performed. Rajagopal et al. [3] found that the requirements elicitation process requires more activities; therefore they divided the elicitation process into 11 phases. Sharma et al. [6] present a model for requirement elicitation process which includes 10 different activities. Sajjad et al. [1] followed [20] to represent the requirement elicitation process. Table I illustrates the requirement elicitation activities considered by the above mentioned literature. Based on the table, it is observed that there are specific activities that have been performed in almost all the elicitation processes. Identify stakeholders, collecting users' needs, selecting elicitation methods are considered the core activities that every elicitation process must contain, while the remaining activities can't be ignored.

### 3.3 Requirements Elicitation Models

As stated by, there are few general models for requirement elicitation process. Browne et al. [10] proposed Task Characteristics model of requirements elicitation. The model was effective in eliciting more requirements than other techniques, and helps analysts and users to understand the problems. However, the concentration on the quantity of requirements rather than quality is one of the drawbacks of this model. Hickey [8] proposed a unified model which includes both of the elicitation and selection

techniques processes. This model helps analyst to choose the appropriate technique during the elicitation activities. Nevertheless, the model depends on the knowledge about the project and domain in selecting the techniques, but not the knowledge of stakeholders or users which may also affect the selection process. Another model is proposed by Isabirye [21] that handles the difficulties faced the elicitation in rural environment. The model is proposed to be applicable in a specific context (i.e. Dwesa in South Africa).

**Table 1. Requirements Elicitation Activities.**

Activity	Author		
	Zowghi et al. [18]	Rajagopal et al. [5]	Sharma et al. [9]
Understanding Application/Domain Area	×		×
Collect User/ Stakeholders Needs	×	×	×
Identify and analyze stakeholders	×	×	×
Classify Stakeholders	×		×
Interviews conducting		×	×
Selection of techniques	×		×
Write a description about user needs		×	×
Mapping key words		×	
Requirement Classifications		×	
Fitting requirement to the domain		×	×
Prototyping and confirmation		×	×
Overall analysis		×	×

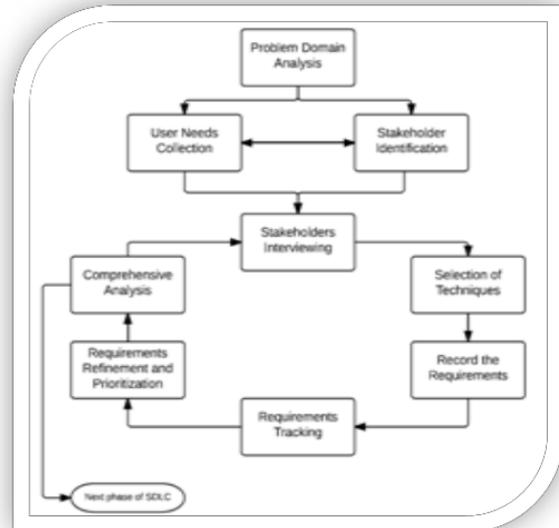
#### 4. RESEARCH MOTIVATION

As mentioned earlier, there are *several models for requirement elicitation process*, and most of the existing models have been proposed to elicit techniques [8, 12]. The success of any software development project reflects *the quality of the requirements* collected [7]. The good quality can be achieved by performing the right elicitation process. Nevertheless, it is not taken into account in most of general models of elicitation, but in techniques models specifically. This motivates to propose a model that highlights the most important phases of the requirements elicitation activity, as well as the quality of these requirements.

#### 5. THE PROPOSED MODEL

Currently, the software development process sets the project goals and identifies the functions being conducted within the project scope. Identifying and classifying the project goals and scope will approximately promise that the project will be successful. Nevertheless, identifying the objectives of the same project early is still a challenge, while regularly loose, ambiguous, and/or inconspicuous enough. Software engineers have the ability to extract the project goals, objectives and the project scope as well as identifying what the system is expected to do (i.e.

the system functional requirements) throughout interviewing the sponsor or project stakeholders. In order to improve the methodology of requirements elicitation process and the quality of requirements, we propose a new elicitation model (see Figure 1).



**Figure 1. Requirements elicitation model.**

The proposed model clarifies that the main phases of the requirements extraction process is to get the appropriate products or expected outcomes. After surveying the previous studies, the most important concepts used by researchers in academia are as follows:

- Defining the problem domain analysis
- Stakeholders identification
- Users' needs collection
- Stakeholders interviewing
- Elicitation techniques selection
- Requirements recording
- Requirements tracking
- Refining and prioritizing the requirements
- Comprehensive analysis

##### 5.1 Problem Domain Analysis

In the problem domain analysis the goal that is expected to be achieved is defined. Defining the problem is the most important step in the elicitation process.

Understanding the problem domain ensures that requirements will be clear, consistent, and unambiguous [1]. It is also necessary to identify the problem domain boundaries depending on the environments where the problem will be solved [22]. Scenarios and use cases help software analysts to express their ideas about the requirements and scope of the project [7].

## 5.2 Stakeholders Identification

There are many types of requirements sources in the software development process. Stakeholders are an important source of requirements. Stakeholders represent any person or group, internal or external of system, who has a concern in the project such as users (who will use the system and provide analyst with their needs), sponsors (who support the system with services and financially), clients (services recipients), software engineers, etc [23]. Stakeholders are identified according to their roles in the system (see Figure 2). The higher stake is the higher priority.

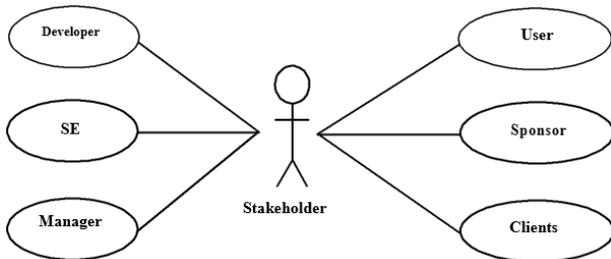


Figure 2. Stakeholders' Types.

## 5.3 User Needs Collection

Gathering information about the needs of different users' classes. Users include power user, average user, users from external or internal organization, etc. [23]. Each user writes a description of what goals he/she wishes to accomplish based on their understanding of the problem [3, 6]. Recent researches in the requirements process increase the involvement of the user in the elicitation process in order to get desired outcomes [15].

## 5.4 Stakeholders and Users Interviewing

Based on the expression of the users' needs in the previous step the analyst conduct interviews with stakeholders and users to get more information and solve any conflicts about particular requirements. Interviews are conducted in several forms; formal or informal interviews [3, 6]. Formal interviews include closed-ended questions such as formal meetings or social surveys. Informal interviews include open-ended questions which are not prepared in advance. Furthermore, multimedia may also be used when communicating with stakeholders as phone interviews and screen interviews. The importance of interviews lies in extracting users' requirements and eliciting more information.

## 5.5 Elicitation Techniques Selection

Selecting the appropriate technique is a critical step in the elicitation process. A wide interest towards developing elicitation techniques is recognized by many researches. Choosing the elicitation method has a significant impact on the quality of the requirements, and hence the success of the project being developed. There are many requirements elicitation techniques (see Figure 3) available to elicit the requirements, such as interviews, JAD, observation, etc. [14, 22]. Selecting the appropriate technique depends on the type of the system being developed, context of the project, resources available, types of users/stakeholders and so on. Many techniques can be used together as complementary techniques to get the best results

in eliciting the requirements, or replace it with another appropriate one [7].

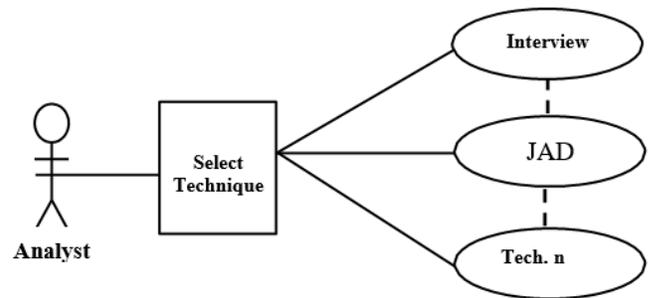


Figure 3. Elicitation techniques' selection

## 5.6 Requirements Recording

The requirements collected during the elicitation process should be recorded in well-defined, clear, and complete statements. This step is a challenge reveals the analysts' poor understanding of the users' or systems' needs. Simple tools such as lists, text can be used in such activity [15]. Yozgyur [15] proposed an automatic tool to assist requirements recording.

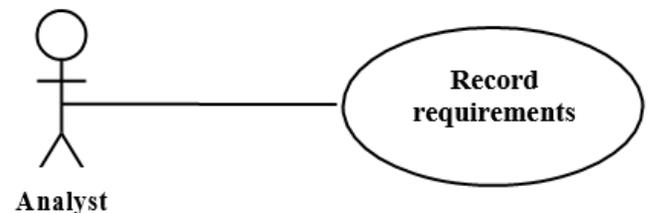


Figure 4. Requirements recording.

## 5.7 Requirements Tracking

Archer [24] sets the rule of requirement tracking as "each concrete software requirement must be linked to a single business requirement". With regard to requirements elicitation, requirements tracking intends to assign each requirement to a relevant stakeholder or user who requests it. This step is useful to ensure the users' satisfaction, and the requirements will be performed as required. This step contributes to the improvement of requirements' quality as well as the success of the requirements elicitation process.

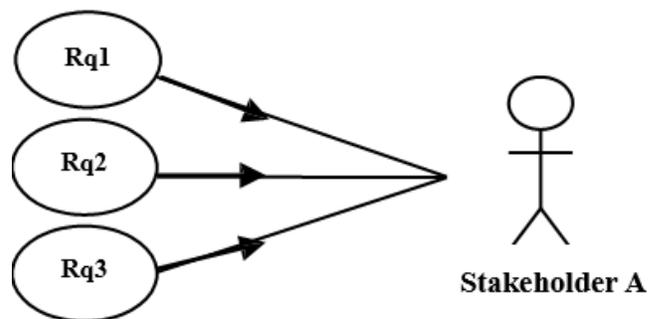


Figure 5. Requirements tracking.

## 5.8 Refining and Prioritizing the Requirements

In this step any unnecessary or unrelated requirement should be removed. Creating well-defined statements in order to build clear system requirements and the inconsistency between stakeholders should be resolved. Thereafter, prioritize the requirements according to the most important ones. Some factors recognized to prioritize requirements such as risk, time, cost, and so on [25]. However, deciding which the best requirement is should include a challenge. This requires involving the stakeholders, developers and others who have the stake in the project in making decision. Techniques like AHP and numerical assignment are used for prioritizing the requirements [25]. This step improves the quality of the requirements.

## 5.9 Comprehensive Analysis

The last step of this process is to check the accuracy of the systems' requirements as whole [3]. Analyst and system experts review all the stages to make sure that the process has been implemented correctly.

## 6. CONCLUSION

The process of requirements elicitation includes a series of activities that are performed to get the requirements from different sources. These activities may vary, more or less, depending on the type of the system being developed, application area, experience and skills of analyst, and so on. In all cases the quality of the requirements still is a critical part in the projects software development process. In this paper, we survey a wide variety of studies regarding requirements elicitation.

The goal of this study is to propose an elicitation process model that encompasses almost all the steps necessary to get the right requirements, and hence achieve the users' and stakeholders' satisfaction. When the requirements are clear, consistent, complete, unambiguous, and meet the users' needs, whereupon the requirements are right. The model concentrates on the improvement of the requirements quality by applying the requirements tracking and refinement.

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