Issues and Challenges of Requirement Elicitation in Large Web Projects

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ABSTRACT

Requirement elicitation is a critical activity in the requirement development process and it explores the requirements of stakeholders. The success or failure of this process is based on identifying the relevant stakeholders and discovering their needs as well as the quality of requirements. The quality of the requirements is greatly influenced by methods applied during requirements elicitation process. Only complete and structured requirements make these projects more reliable. The common challenges that analysts face during elicitation process are to ensure effective communication between stakeholders as well as the acquisition of tacit knowledge. Mostly errors in the systems are due to poor communication between user and analyst, and these errors require more resources (time and money) to correct them. The understandability problems during elicitation process of large web projects can lead to requirements ambiguous, inconsistent, incorrect and unusable. Different methods (Conversational, Observational, Analytical and Synthetic) are available to deal with the problems during requirement elicitation process. The challenge for analysts is to select an appropriate method or set of methods and apply them for the clear, consistent and correct requirement gathering.

This study based on the results of interviews conducted to the professionals, who have industrial experience in development of web systems. The elicitation problems that are identified in literature and interview along with applicability of elicitation methods for requirement gathering in large web projects development are documented in this report.

Keywords: Requirement Engineering, Requirement Elicitation, Elicitation methods, Web projects, Web Engineering
1. INTRODUCTION

This chapter of thesis consists on the background of the research domain, problem area and aims and objectives, readers will also find the research questions and research methodologies for the thesis work.

1.1 Background

The software requirement process including the tasks of eliciting, analyzing, and specifying the functional and behavioral properties of a system, represents one of the most critical phases of the software development lifecycle (Castro-Herrera et al., 2009). The basic concern of a software system is how it meets the requirements for which it was built? In general words requirement engineering is a process of stakeholders’ identification and their needs, purpose and consequence of system development. The most critical thing in system development is to find what to build? (Nuseibeh and Easterbrook, 2000). Many requirements errors are skipped to the later stages of the development life cycle and rectifying these errors during or after the implementation have been found to be exceedingly costly. This is the point where requirement analysts pay more attention, because getting ambiguous idea of user’s requirements may lead to wrong thing done which could be impossible to rectify later on.

The success or failure of a system development effort depends heavily on the quality of the requirements (Jones, 1996). The quality of the requirements is greatly influenced by techniques employed during requirements elicitation because elicitation is all about learning the needs of users, and communicating those needs to system builders. How do we select an appropriate elicitation method out of the plethora of available methods which greatly affects the success or failure of requirements elicitation process(Hickey and Davis, 2002). The requirement elicitation is a part of the requirement engineering process, usually followed by analysis and specification, integration and validation of the requirements. It is most critical phase of software development cycle. The purpose of this process is to identify the system boundaries and specify the functional and behavioral properties of a system. The success of this process bases on identifying the relevant stakeholders (end users, customers, decision-makers or developers) and discovering their needs. The stakeholders are mostly from different background and have different goals, so it is vital to include the all stakeholders in information gathering otherwise certain viewpoints are never exposed. There are number of difficulties in achieving the requirement elicitation goals and it is important for the analyst to consider all relevant factors to better understand the application domain, system constraints, business needs and stakeholders (DeMarco, 1979; Nuseibeh and Easterbrook, 2000)

In recent advancement in technology, the web projects have become more popular for business solutions. Many companies want to cover global market, so web systems can be a way to solve their problems. Today world has become a global village; people want to purchase the products at home or avail services remotely. So, it could only be possible to give some access to your consumer by a web system. When we talk about the web, it means we consider the whole cyberspace. There are several issues in developments of these web projects, e.g. information management, global customer requirements, customer attraction, security, service availability, risk assessment etc (Li, 2008). But in this thesis our concern is to discuss the issues regarding the requirements acquisition for development of these large systems.

Analysts have different challenges regarding requirement elicitation process that involve in large web projects, only complete and structured requirements make these projects more reliable. The key issue
for an analyst is to provide the system that fulfils the need of the end user. Furthermore these projects consume more time and has high development cost, so the failure of these projects lead to user dissatisfaction, increase maintenance cost and loss of reputation of project team (Al-Salem and Samaha, 2007).

### 1.2 Purpose

The purpose of this thesis is to find out major problems in requirement elicitation process during development of large web projects. Furthermore, figure out how communication affects the elicitation process and what are the communication problems do the analysts face while communicating with systems users? What kind of elicitation methods available to tackle these problems and how they help to analysts in requirement gathering.

### 1.3 Problem domain

Large projects require high resources for development. If the requirements of such projects are unrefined and inconsistent, it may cause full project failure or would not meet the user requirements. So, the problem is how to elicit the user requirements and how to overcome the barriers in communication in requirements gathering? What methods/ techniques should be used for requirement identification and web content organization?

The process of requirement elicitation is very crucial in project development, because unstructured requirements can easily lead to large amounts of rework when the customer simply cannot accept a system the way it was developed. That’s why it is important to get structured and consistent user requirements for successful system development.

### 1.4 Aims and Objectives

The research goal is to identify the obstacles in requirement elicitation process in large web projects, map these barriers to the requirement elicitation methods, and apply appropriate method(s) for requirement identification to assist the system builders of web projects. The success or failure of a system development effort depends heavily on the quality of the requirements. The quality of the requirements is greatly influenced by methods employed during requirements elicitation, because elicitation is all about learning the needs of users, and communicating those needs to system builders. How do we select an appropriate elicitation method out of the plethora of available methods greatly affects the success or failure of requirements elicitation. More than 50 percent projects fail due to bad or inconsistent requirement identification, so our research contribution would be a roadmap to consistent requirements gathering to build quality system(Yarmouth, 2003).

### 1.5 Research Questions

A research question is a statement that exposes the purpose of studies or research. Below mentioned three questions will cover the boundaries of our thesis.
**RQ1:** What are the communication obstacles in requirement elicitation and how do you tackle them in large web projects?

Many errors and inconsistencies in projects are due to ineffective communication among the users (end users, customers) and the requirement analysts in the whole process of requirement gathering. These errors can lead to requirement unclear, incomplete, inconsistent and incorrect and take much time to recover them. So our first research question is to find out the communication barriers in requirement elicitation process.

**RQ2:** Which method or set of methods of the requirement elicitation process are appropriate for large web projects?

There are many elicitation methods for requirement gathering from users. This research question related to method selection for requirement elicitation process in large web projects.

**RQ3:** How do these methods help the analysts in requirements gathering, evaluation and integration in large web projects?

Now how these methods helps the analysts when they have done the identification of the requirements. How these methods contribute in later phases of the requirement development activities. So, third research question aims to find the reasons, how selected method(s) help the analyst in requirement gathering, integrate them with earlier requirements and conflict resolution.

### 1.6 Research Methodology

Research can be defined as the study that goes beyond the personal ideas and experiences. To cross these boundaries of personal ideas, researchers follow some methods/techniques for their research. Creswell mentioned three types of research methods, quantitative, qualitative and mixed research methods (Creswell, 2002).

All approaches are scientific way of doing research, but quantitative approach is more statistical, it starts with hypotheses and theories, uses formal instruments, experimentation, component analysis, and reduces data to numerical indices. The quantitative approach has different methods e.g. experiment, while a qualitative approach is systematically collection of data with qualitative methods, it is more about the field research. The qualitative approach has different methods e.g. case study, interviews, survey, ground theory, phenomenology, ethnography and historical data collection. By using one are few methods researchers collect data for their research. The mixed methodologies consist on both qualitative and quantitative (Creswell, 2002).

In our research study we decided to apply qualitative methods to achieve the study results. An online interview will be performed with persons working in development organizations. The motivation behind the selection of qualitative method is that the requirement elicitation process lies under requirement engineering domain, so collecting data from real environment will provide realistic mean to achieve the results.

In literature study, search strategy is very important. We used two well known research databases IEEE Xplore and ACM digital library for our literature study because school provides us an access to material of these search engines. The search was performed with various key points related to domain. We tried to minimize the chance of overlooking literature material with the help of above mentioned search engines. Furthermore manual search of relevant material were also performed in local school library. For general concepts we also used other search engines like Google scholar and Bing etc.
We extracted material from different sources (articles, Journals, books etc.) that we found relevant to our domain by referring to actual author(s). The way in which we went through the articles was reading few sections, an abstract, introduction, conclusion and references and then assessed the relevance of particular material to literature. Several books were also consulted for literature study.

1.7 Research Design

The selected topic is related to the field of requirement engineering. We decided to use qualitative approach because it helps to answer certain important questions more efficiently and effectively in descriptive way and also provides a systematic way to get study results. A descriptive procedure will be followed to reach the results; several stages of our study procedure are shown in figure 1.1.

![Study Design](image)

Figure 1.1 Study Design

Start with entrance in problem area and then identify and state the specific problem with the help of literature study. Make a plan for study that would be followed to achieve the desired results. After planning actual work will start, data is being gathered from different sources (literature, interviewees) and processing of collected data. The final phase consists on results evaluation and reporting; the achieved results will be analyzed and documented and final contribution in the area will be presented.

1.8 Validity threats

"Validity is the best available approximation to the truth of a given proposition, inference or conclusion" (Trochim, 1999).

There are several validity threats that will raise potential issues about the research study. Internal validity examines whether correct inferences are derived from the gathered data(Creswell, 2002). The threat to internal validity is reduced to an extent by referring to multiple perspectives on a relevant topic. Furthermore, these perspectives are presented in their original form to the extent possible to further minimize the internal validity threats. Also an effort is made to provide a solid discussion on topics.
External validity addresses generalizing the results to different settings (Creswell, 2002). Threats to external validity are reduced to some extent by generalizing our study results on different situations in small scale. Threats to external validity at large scale are not handled because of cost and time limitations.

Construct validity which evaluates the use of correct definitions and measures of variables. An effort is made to mitigate the construct validity threats by analyzing the some knowledge of particular domain, collected literature material from research databases (ACM, IEEE, ScienceDirect etc.) and books.

Conclusion validity is the degree to which the relationships reached in the conclusions are reasonable or not. A search criterion was used to reduce the conclusion validity threats. In search criterion, the achieved results were analyzed with authentic results from previous similar research.

1.9 Thesis Structure

The distribution of study consists on several chapters,

Chapter 1 (Introduction): Introduces the problem domain and presents purpose, research aim and objectives, and methodologies that will be used in this study.

Chapter 2 (Requirement Engineering): elaborates the requirement engineering concepts, requirement development process and its importance in software development.

Chapter 3 (Web Systems and Elicitation barriers): Starts with web projects and their characteristics, essential steps that can help in development, application of engineering concepts in web domain and possible requirement elicitation barriers in large web projects are discussed.

Chapter 4 (Elicitation Planning and Methods): Presents the elicitation planning and procedures followed by the methods that are used for requirement gathering.

Chapter 5 (Research Design): The research methodology implemented in this study is given in this chapter. Steps in research method preparation, execution, and analysis are presented in this chapter.

Chapter 6 (Result Analysis): Study results that are achieved during literature review and interviews are analyzed and presented in conclusive way. The answers to research questions and comparison of results between literature and interview are presented in this chapter.

Chapter 7 (Epilogue): Presents our study conclusion along with future suggestions for research work in this domain.

Chapter 8: References
2. Requirements Engineering

The concept and overview of requirement engineering process and each step of requirement development process is briefly discussed in start of the chapter. Furthermore, requirement engineering process model are discussed and chapter ends with highlighting the importance of requirement engineering process in overall project development.

2.1 What is a Requirement?

Requirement is a statement that identifies a capability, characteristic or quality of system in order for it to have value and utility to a customer or user (Young, 2003). Requirement is an important factor for the development of any project and it defines what different stakeholders (users, customer, manager and developer) need and how system will fulfill these needs. They are generally expressed in natural language for the reason that everyone can well understand it. It helps the analyst to better understand which element and function are necessary in the development of particular project. Requirements are used as input in a design, implementation and validation stage of product development. So, a project can be succeed or failed at any time during project life cycle because of poor requirement gathering and managing process. A survey conducted by Standish group in 1995 and 1996 shows that large number of project were failed to satisfy the required stakeholder because of poor requirements. Every software application has a user and the time spent understanding the user needs will help to make a successful project. So because of its importance, requirement analyst should develop a plan to determine how requirement will be evolved and addressed in system life cycle (Hull et al., 2004).

Brooks defined the requirement as

“The hardest single part of building a software system is deciding precisely what to build. No other part of the conceptual work is as difficult as establishing the detailed technical requirements, including all the interfaces to people, to machines, and to other software systems. No other part of the work so cripples the resulting system if done wrong. No other part is more difficult to rectify later.”

(Brooks, 1987)

2.1.1 Functional requirements

Functional requirements of the system are a statement of services or functionality that system should provide and how the system should react in a particular situation. Functional requirements are the interactions between the system and its environment independent from implementation. Sometime functional requirements are also stated as system constraints (Lauesen, 2002). These requirements generally depend on user of the software and type of system being developed.

2.1.2 Non Functional requirements.

These are the constraints on the services or functions offered by the system such as timing, development process and standards. These requirements define system properties like reliability of the system, response time and storage requirements etc. Process requirements may also be specified mandate a particular system, programming language or development method. Non-functional requirements may be more crucial than functional requirements if these are not met, the system is
useless. User visible aspects of the system not directly related to functional behavior. Also known as quality attributes of the system (Lauesen, 2000).

2.1.3 Constraints
These are also known as Pseudo requirements, imposed by the client or the environment in which the system will operate. They can be input/output device capability, system representation in the environment (Lauesen, 2000).

2.2 Requirement Engineering Concept
Requirement Engineering is the branch of software engineering and the earliest phase of the software development life cycle. Zave defines the requirement engineering as (Zave, 1997):

“The branch of software engineering concerned with the real-world goals for, functions of, and constraints on software systems. It is also concerned with the relationship of these factors to precise specifications of software behavior, and to their evolution over time and across software families.”

In broad context, the requirement engineering deals with not only technical issues but it also supports the managerial, organizational, economic, and social issues. It is used to design software that meets the goal for which it was intended. By identifying the need of stakeholders, understanding the context in which the developed software will be used, modeling, analyzing, negotiating, and documenting the stakeholders’ requirements; validating that the documented requirements match the negotiated requirements; and managing requirements evolution (Betty et al., 2007). The end users, customers, decision makers and developers are involved in a requirement engineering process as stakeholders. These stakeholders are from different backgrounds and have different individual and organizational goals due to the environment in which they work. It is not easy to produce a complete, consistent and well-structured set of requirements from incomplete, imprecise and conflicting sources. Stakeholder not only means human being but it also refers to the environment in which the system will operate. So the requirement is incomplete without considering the physical and organizational environment in which the system will be used.

Requirement engineering is a difficult process because challenges faced by requirement engineering communities are distinct from those faced by software engineering community as requirements reside in problem space whereas software resides in solution space. Furthermore, the requirement engineering deals with defining those problems that the software has to solve whereas software engineering concerns with defining and refining proposed software solution (Betty et al., 2007).

Requirement engineering process has a great impact on software quality because the most expensive, frequent and dangerous type of software errors are related to poor requirements. These errors affect the cost of software development because the cost to correct these errors increases as the time delay in finding them. In view of such difficulties, requirement engineering process should be more disciplined.
2.3 Requirement Engineering Process

The requirement engineering development process consists of feasibility study, requirement elicitation, analysis, specification, integration and validation. The purpose of these activities is to identify the stakeholders’ needs follow by specifying these in a form that is amenable to analysis and validating the documented requirement. Figure 2.1(Kotonya and Sommerville, 1998) demonstrates requirement engineering development process. It starts from the feasibility study of the system. All results of the feasibility study are documented in feasibility report. The next phase of this process is requirement elicitation and analysis. Some authors stated this phase into two separate phases as requirement elicitation and requirement analysis (Hull et al., 2004; Kotonya and Sommerville, 1998; Young, 2003). The requirement specification and validation followed by elicitation and analysis process. Our major focus in this process will be the requirement elicitation. These activities are described in more detail below based on description and technique found in literature.

![Feasibility Study Diagram](image.png)

Figure 2.1 Requirement Engineering Process

The purpose of figure is not to give the impression that each process is separated from other but rather present an overview of the whole process.

2.3.1 Feasibility Study

Feasibility study is earliest step before proceeding toward requirement engineering process. Some authors include it in requirement engineering process (Hrvoje et al., 2005) but some say it is a pre-requisite for process(Kotonya and Sommerville, 1998). It is an analysis of the practicality of an idea and focuses on trying to answer the essential question of “Will the idea work and should you proceed with it?” (Hofstrand and Holz-Clause, 2009). All activities of the study are directed toward helping answer this question. Feasibility studies can be used in many ways but primarily focus on proposed business ventures. E.g. farmers and others with a business idea should conduct a feasibility study to determine the viability of their idea before proceeding with the development of a business. Determining early that a business idea will not work saves time, money and heartache later (Hofstrand and Holz-Clause, 2009). Feasibility study is done on the basis on the following factors; technology...
2.3.2 Requirement Elicitation

Requirement elicitation is most important activity in the requirement engineering process which cannot be separated from the subsequent activities. It is used to explore the requirement of customers, users, decision makers, developers and other stakeholders and to identify the system boundaries and specify the functional and behavioral properties of a system in order to meet the goal for which the intended system is developed (Zhang, 2007). The success or failure of this process is based on identifying the relevant stakeholders and discovering their needs. Stakeholders are mostly from different background and have different goals, so it is vital to include the entire stakeholders in information gathering otherwise certain viewpoints are never exposed. The most common sources for this phase are:

- End users, customers
- Customer requirements specifications
- Documentation related to pre-existing systems
- Users of pre-existing systems
- Users of the new system

There are number of difficulties in achieving the requirement elicitation goal and it is important for the analyst to consider entire relevant factors to better understand the application domain, system constraints, business needs and stakeholders. The common challenges that analysts face during elicitation process are to ensure effective communication between stakeholders as well as the elicitation of tacit knowledge. The output of this process is a collection of elicitation notes that describes the elicited requirements. Several methods are used for elicitation process; some are given in literature (Lauesen, 2002; Wiegers, 2003; Zhang, 2007)

- **Conversational Methods**
  Conversational methods consist on interview, survey and questionnaires to gather data from stakeholders and other sources.

- **Observational Methods**
  Observational methods are used to explore the non-tacit (those requirement that are apparent but difficult to verbalize) requirement from the stakeholder. Social analysis, ethnography and protocol analysis are approaches for observational methods.

- **Analytical Methods**
  In analytical methods requirements are gathered by exploring the existing documentation and knowledge. Requirement reuse, Content Analysis, Documentation Studies are common approaches of analytical method.

- **Synthetic Methods**
  Instead use of combination of individual methods, the synthetic methods form a coherent whole by systematically combining above methods into single method. Stakeholders and analysts use different ways to explore the requirements. Joint Application Development, Scenarios, Passive Storyboards are common approaches of synthetic method.
2.3.3 Requirement Analysis

Requirement analysis is used to analyze and model those requirements that are captured in requirement elicitation process. Requirement elicitation process is an input to requirement analysis and the output of this process is a consistent and complete set of requirements. It is used to detect the inconsistence and missing requirements provided by the stakeholders for the purpose of necessity, consistency, completeness and feasibility. The main goal of this process is to answer the question “have we got the right requirement” (Maciaszek, 2005). Different techniques are used for requirement analysis but JAD sessions, Prioritization, and Modeling are the most important and common (Paetsch et al., 2003).

- **Joint Application Development (JAD)**

  JAD is a process that consists of workshop and group sessions in which the knowledge workers and IT specialists meet to discuss the desired product features. This type of discussion is very productive because it resolves difficulties between two parties while developing a system for a company.

- **Requirements Prioritization**

  Requirement prioritization is used in a situation where most valuable features are delivered as early as possible within tight schedule. Both the customers and developers provide input to this process by mentioning their priority for the system. Technique like Pair-Wise Comparison and Analytical Hierarchy Process are used to access the prioritization of software requirements (Wiegers, 2003).

- **Modeling**

  Modeling is another important technique of requirement analysis that acts as bridge between the analysis and design phase. Techniques like data-flow models, semantic data models and object-oriented approaches are used to describe system requirements (Kotonya and Sommerville, 1998).

2.3.4 Requirement Documentation

Once a requirement is elicited, modeled and analyzed it should be documented in clear and unambiguous terms. Requirement analysis is an input to requirement documentation and the output of this process is a well-structured and defined specification. It is used to communicate the requirements between stakeholders. A good requirement document should be correct, complete, consistent and feasible because it is used as a baseline for evaluating subsequent process of system. An unambiguous, concise and clear stated document is also used as a base for validating the stated requirements and resolving stakeholders’ conflicts. Both the functional and non functional requirements are represented in requirement specification. Set of use cases are used to describe all the interaction that the user have with system. The most common approaches for requirement specification are (Maciaszek, 2005)

- Natural language
- Structured natural language
- Design description language
- Requirements specification language
- Graphical notation
2.3.5 Requirement verification and validation

This process is used to clarify that the requirement documents are unambiguous, consistent and complete and that the stakeholders are satisfied with the final requirement specification. This process is used to validate that each stage of development process follow processes and standards as well as the process and product meets user needs. It is performed a bit later in the process because it concerned with validating the final draft rather the raw data gather in requirement elicitation process. Requirement documentation, organizational standards, and organizational knowledge are inputs to requirement verification and validation and the output of this process is the finalized requirements specification document agreed and authorized by all stakeholders. The goal of this process is to answer the question ‘have we got the requirement right’ (Cook, 2002). Techniques like requirement inspection, requirement checklist and requirement testing are used to find the defect to improve the quality of a requirement as well as to make sure that certain criteria meet regarding information elicited and specified.

2.3.6 Requirement Management

Requirement management is used to identify, organize and track the entire changing requirement in a project as well as impact of these changes. It is a continuous process whose goal is to make sure that organization meets the expectation of stakeholders (Paetsch et al., 2003).

2.4 Importance of Requirement Engineering Process

Requirement engineering process gives much about the project development. It indicates several things; first, it highlights the importance of goals that motivate the development of a software system. Second, it refers to "precise specifications". These provide the basis for analyzing requirements, validating that they are indeed what stakeholders want, defining what designers have to build, and verifying that they have done so correctly upon delivery. Finally, the definition refers to specifications "evolution over time and across software families", emphasizing the reality of a changing world and the need to reuse partial specifications, as engineers often do in other branches of engineering (B. Nuseibeh et al, 2000)
3. Web Projects and Elicitation Barriers

The first part of the chapter contains the concepts of web projects and differentiation from conventional software systems in development context. The importance of implication of engineering concepts into web development will be presented under web engineering heading.

3.1 Web Project

Web systems are globally available systems with thousands of distributed users. Each group of users has its usage roles. There are several key points of web projects that differentiate development from traditional projects. More distinct factors of large web system are rapid growth in their requirements and heavy contents management. Web systems need to be developed in such ways that support scalability and maintainability issues because such features cannot be handled later. A web system needs to meet the need of many types of stakeholders, diverse range of system users (persons who maintain the system, the organization that need the system and also those who fund the system development). This makes the design and development of the system further complex and difficult (Al-Salem and Samaha, 2007).

3.1.1 Difference between Web System and Conventional Software

The development of web based systems is different from traditional software systems in several areas. These areas affect the entire web development and maintenance processes. They also encompass the people involved in development, the intrinsic characteristics of web systems, and the users for which they are built (Mendes et al., 2006).

The development of conventional systems remains dominated largely by IT specialists where a good knowledge of programming, database design, and project management is necessary. In contrast, web development covers a much wider variety of developers, such as web coders, graphic designers, technical writers, database designers, and IT professionals. More characteristics are of web systems are given in later part of this chapter. Web systems use communications technologies and have multi-platform accessibility as they are available globally. Furthermore, they are non-sequential by nature, using hyperlinks to interlink web pages and other documents. Therefore, navigation and pluralistic design become important aspects to take into account. The multitude of technologies available for developing web systems means that developers can build a full spectrum of applications, from a static simple web application using HTML (Hyper Text Markup Language) to a fully fledged distributed ecommerce system (Taylor et al., 2002). Conventional applications can be developed using several programming languages running on a specific platform e.g. Components/Commercial Off The Shelf (COTS). The communication technologies can also be used in traditional systems to connect and use different database systems. However the speed of implementing new technology is faster for web development relative to conventional systems. Web systems encompass a wide range of users; they may be unknown or known ahead of time (e.g. systems serve within the boundaries of local area network). However, it is more often the case that large web systems are developed for an unknown group of users (Deshpande and Hansen, 2001). In contrast, conventional software applications are generally developed for a known user group (e.g. specific department or organization) making the explicit identification of target users an easier task.
3.1.2 Characteristics of Large Web Project.

In literature study some authors (Deshpande and Hansen, 2001; Troyer, 2001) stated the characteristics of large web systems with development point of view.

- Large projects are obviously complex so they need multi-disciplinary development team; they require diverse skills in different areas.
- The requirements of the web projects are diverse and volatile: Requirement analysts do not need to explore only functional and non-functional requirements; they also have concern with structuring, navigations, contents and access issues.
- These systems must have the capability to handle the vast number of different users with diverse in geography, age, culture, norms and values.
- Large number of stakeholders with different background and experience.
- Contents management is the basic aspect of web projects. These systems have heavy contents that can be in the form of images, texts, audio/video depending on the nature of the system.
- Integration with backend databases and third party application is another critical aspect of web systems. Most of them are integrated with backend systems such as heterogeneous databases (Deshpande and Hansen, 2001). They are built using number of diverse components from disparate sources including custom built special purpose applications, COTS and third party products (Kappel et al., 2004)
- Multi-tier design architecture with server side technologies (PHP, ASP, and Java Servlet), database servers and application servers is used in large web projects.
- Most web systems are facing the outside world have no room for error (Lang, 2001)
- The consequence of errors and downtimes in web systems that interface with customers or supplier are major issues and simply cannot be tolerated.

3.1.3 Essentials for successful web project development

There are some essential steps mentioned by some authors (Al-Salem and Samaha, 2007; Ginige, 2002) in literature. Figure 3.1 illustrates the essentials steps for a successful project development.

![Figure 3.1 Essential factors for web system development](image)

- Understandability is an essential step in project development. The clear understandability of functions and operational environment of the system including the business objectives and needs.
- Clear identification of the stakeholders.
• Identification and specification of all possible technical, non-technical, users and system requirements.
• Build appropriate architecture (multitier) for the web based system that meets above mentioned requirements.
• All non-technical issues e.g. business promises, organizational policies, human resource development, legal, cultures and social issues must be addressed satisfactorily.
• Identification of sub components of the system for implementation designed architecture.
• Manage the evolution and maintenance issues of the system.

There are several stakeholders involved in completion of above mention steps. These could be requirement analyst, architecture designer, database designers, developer etc.

3.2 Web Engineering

“The use of scientific, engineering, and management principles and systematic approaches with the aim of successfully developing, deploying and maintaining high quality Web-based systems and applications” (Murugesan and Deshpande, 2001).

This is a similar definition to that used to describe software engineering; however, both disciplines differ in many ways as described earlier. Mostly Industries (travel, hospitality, shopping, manufacturing, banking and education etc.) utilized web-based systems to improve operation and increase their productivity (Ginige, 2002). Furthermore, the web allows for the development of corporate intranet (Local area network or Metropolitan area network) web systems, for use within the boundaries of their organizations. Distinct coverage of web applications in communication and commerce fields makes it important leading branch of the software industry (Offutt, 2002). It has been dealt the development of web system in general ad-hoc, resulting in poor quality applications, which create difficulties in maintenance (Murugesan and Deshpande, 2001). The main reasons for such problems are unsuitable design and development processes, and poor project management practices. A survey on web-based projects revealed a number of problems with outsourced large web projects (Ginige, 2002).

• 84% projects did not meet business needs.
• 53% projects did not provide the required functionality.
• 79% projects presented schedule delays.
• 63% projects exceeded their budget.

As the reliance of the global businesses on larger and complex web systems increases. There is a great need of methodologies/standards for best practice guidelines to develop these systems to make on time delivery, within budget, high quality level and maintainable (Lee and Shirani, 2004; Ricca and Tonella, 2001). To develop such applications web development teams need to use sound methodologies, systematic techniques, quality assurance, rigorous, disciplined and repeatable processes, better tools, and baselines. Web engineering aims to meet such needs (Ginige, 2002).

3.3 Elicitation Barriers

In most cases stakeholders cannot explain what they really want? E.g. the stakeholder feels a problem but cannot express and sometimes user does not feel anything but requirement analyst can see several problems. There is also a trend of exaggeration of today’s issue and underestimate crucial problems, even if stakeholder sees the problem but cannot express it as a requirement. Another barrier to requirement elicitation is that, sometimes stakeholders have the problem of explaining what task they
perform and why they need to perform such tasks. Some users specify a solution instead of a demand, e.g. a manager might state that "we should have a computer-based decision support system." It takes almost a long time to figure out that the real problem is not to discuss and to decide, but to implement what has been decided. The decision support system would not help with that (Lauesen, 2002).

The users may find it difficult to think about new work procedure of imagine the consequences of doing a familiar task in a proposed new way. For example, in a multi-national organization, it took a long time to realize that the ever-growing problem of getting through to people on the phone could partly be solved with instant messaging/discussion board/forum in a web system. Later, the commencement of these features in web systems change the work pattern in an emerging way (Lauesen, 2002). In large projects there are several stakeholders attached to the same project and may be distributed at different locations. Often different stakeholders have confliction in their views. E.g. In a large e-commerce system the marketing personnel promise optimistic delivery times to ensure they get more order, while the production staffs dislike this because of continues work load on them. A production feasible system may irritate the marketing personnel. So, these conflicts must be resolved for successful project development.

Sometime user refuse proposal due to general resistance to change. The problem behind this barrier may only the difficulty of imaging new work structure in an organization. When a requirement analyst work with stakeholders involved in exploring requirements, she/he faces too many requirements come up altogether. Some of them are vital, others are fancy ideas. It can be difficult to have all stakeholders agree on what is essential and what is luxury. Maturation problem also arise in elicitation process, when stakeholders have a meeting with requirement analysts at first time, they might not have the distinct view of system. After some time when they work through with experts and see the new ways. Demands changes over time to time with maturation of stakeholders ideas. External factors may also affect the change the demands. When one benchmark has over new demand arises. So, accomplished tasks can also come up with new demands. System solution providers (system builders) like the maturation idea and new demands trend, because it creates new business opportunities for them (Lauesen, 2002).

Further classification of the problems in requirements elicitation process of large web projects is categorized into three areas (scope, communication, volatility), listed below.

### 3.3.1 Scope Barriers

Scope problems related to boundaries of target system because they may be ill defined. By ignoring the contextual issues (of organization) can lead to requirements unfinished, unverifiable, unnecessary and unstable and collected information may address too narrow or too broad scope of the system. There are also problems of understandability of the organization and environmental factors. The scope barriers arise from abstraction level requirements gathering and requirement sources.

- **Abstraction level Problems**

  The abstraction level of requirement gathering involves the problem analysis and the system specification. Problem analysis is to perceive the problem domain by understanding the situation of concern and setting system boundaries (Avison and Fitzgerald, 1995). Lack of generic knowledge of problem analysis makes harder further proceedings. These problems could be in vision of the project, scope area, and constraints. Problems can also arise at defining the project specifications, lack of
specific knowledge of the project may lead to failure. The specific knowledge refers to system features like functional, non-functional and business requirements.

- **Problems of Requirement Sources**

  The human beings are the main sources of the requirements; each stakeholder brings some knowledge and cognitive limitations into the elicitation process. They vary from person to person, due to diverse social positions in the organizations; it is difficult to explore all needed knowledge from stakeholders. A common error is that the team of users and the developers do not have adequate domain knowledge, so they make wrong decisions and actual needs of the user cannot be transformed into the requirements. Incorrect or irrelevant stakeholder may provide the vague needs that cannot be implemented in the system. The environment where system will operate is another source of requirements. It includes legislation, organization structure, standards, and characteristic of system with co-existing systems. These issues cannot be solved by not only asking from users, they require analysts’ observation to the environment and organizational structure.

  3.3.2 **Communication Barriers**

  The information that has been gathered from the communication between the user and the analyst represents the base of information systems design. It becomes the key factor in determining success or failure of a project. The communication barriers are the problems of understandability between/among stakeholders in requirement gathering. Mostly errors in the systems were due to poor communication between user and analyst, and these errors require more resources (time and money) to correct them. The understandability problems during elicitation process of large web projects can lead to requirements ambiguous, inconsistent, unstable and unusable. Valusek and Fryback classify the commutation barriers into three categories “within”, “between” and “among” (Valusek and Fryback, 1985). Zheying mapped these barriers as individual culture limitations, organizational cultures limitations and national culture limitations respectively (Zhang, 2007).

- **Problems “within” User**

  The “within” barriers are also known as individual culture limitations. It refers to cognitive shortcoming of human as information receiver, information processor and problem solvers. "Within” problems refer to the ability of comprehension, the capacity of human memory and recalling facts, the information processing activities and the decision making processes(Zhang, 2007). So these are the cognitive and behavioral limitations within the individual users.

- **Problem “Between” Users**

  The “between” barriers are also known as organizational culture limitations concern with the interaction between user and analyst. Organizational culture covers different aspects of the organizational operations. For examples management style, organization chain structure, nature of work place, norms and values, terminologies used within the organization. These areas have their own work plans and working methods. So, confliction may arise because requirement analyst may not familiar with hierarchy of the organization and their operations. Psychological limitations also lie under these barriers because they related to organizational behavior.
Problem “Among” the users.

The “among” barriers are also known as national culture limitations. These problems arise when different users describe their needs that are inconsistent or that conflict either in contents or priority and they require a referee for resolution. In large complex project, peoples involve from different culture backgrounds and have diversity in language, norms and values, attitudes and believes and priorities. Sometime the cooperation of these users in requirement elicitation may become hindrance. When several users provide the same information needs in different and inconsistent ways, then requirement conflicts arise. It is challenge for development organization to resolve such conflicts.

3.3.3 Volatility Barriers

Volatility barriers are also known as requirements maturation problems. Requirements are not completely known at the start of the project development and they cannot be specified completely upfront in one huge document. Changing nature of the requirements over time is another barrier to elicitation process of large project development. During the system development the users need may change because of requirement maturity. In start of the project discussion, the users were uncertain about the project vision. By the passage of time users requirements evolve and they get familiar with system goals and operations, then their requirements change. If such amendments are not treated, the original requirements set will become incomplete, inconsistent with present situation, and potentially unusable because they detain information has become outdated.
4. ELICITATION PLANNING AND METHODS

In previous chapter we have seen the overview of web project and communication barriers. The goal of this chapter is to discuss the different categories of methods used for requirement elicitation along with the importance of user involvement in project development and guideline for elicitation process.

4.1 Ground Step for Elicitation

Elicitation process starts from eliciting overall goal of the system, then information about the working environment and current problems. A detailed description of issues that system shall deal with, possible solutions for the system and transformation of the issues into the proper requirements. The process cannot be done in a semantic way because current working situation may cause the goals to change. Finding the possible solution and vision of new work procedures may also affect on the system goals.

Overall requirement engineering process has been already discussed in chapter 2, deeper operation of this process given in figure 4.1(Kotonya and Sommerville, 1998). After the feasibility study (discussed earlier) the requirements are gathered in elicitation process from the knowledge sources (stakeholders/view points) by using different elicitation methods. When requirement gathering process over, next step is to analyze the gathered requirements (different stakeholders are involved in this phase). Then remaining steps requirements specification and verification are performed. But these phases of requirement development process are not discussed in this thesis. We have only considered the elicitation process (marked in figure 4.1) and related activities (Kotonya and Sommerville, 1998).

![Figure 4.1 Requirement Development Process](image-url)

4.2 Choosing method

There are many elicitation methods stated in literature, but application of all these methods simultaneously is a hard pill, due to time and cost constraints it is not possible to try all available methods for one system. Choose the ones that produce better result for the specific system. For example if two methods give similar results for same system, then less expensive (refers to that...
method complete in short time with minimum resources) method will be adopted. For full requirement coverage, both methods can be used because if first method skips something, the other will recover it. This strategy is feasible for large projects but in small projects due to cost constraints it may not possible.

Some methods can be used parallel for efficiency, working with several elicitation methods simultaneously beneficial in time context. There is another reason for working with several methods simultaneously; it does not matter to wait the results of first method before starting the other one. Mostly requirement analysts spend much time discussing whether to use several methods or not. It could be possible to try several methods in small scale. Some techniques can be tried in few hours, so, it is better to try several methods instead of discussing whether use several or not. Although we could not get full requirements in few hours but the workout of these few hours may give a distinct indication whether the concerning method covers something useful or not. If we are not sure brainstorming or storycards is a feasible method, find few users and try it. This strategy is only feasible in large projects, where time and cost could be spent for high quality of work(Lauesen, 2002).

4.3 Elicitation Process Guideline

It is impossible to capture requirements from root; the requirements are the end step of the elicitation process. Many intermediate work products are required for requirement elicitation process accomplishment. Start with planning of the project’s requirements elicitation activities, because a simple course of action can increase the chance of success and sets realistic expectations for the shareholders(Wiegers, 2003). Some requirement elicitation planning guide given in literature (Lauesen, 2002) is listed below.

- **Present Work**
  A detailed description of present work in specific domain helps to reach the root cause of why a system is being replaced? It also explores the promises that the users expect from follow-on system. As with any improvement activity, dissatisfaction with the present situation gives tremendous feed for the new and improved future state.

- **Present Problem**
  A detailed list of the current problems in the particular domain should be prepared. It raises challenge to requirement analysts to build requirement plan for future system for solution of problem. This list should include all minor problems which present domain has now. Understand the users’ present business processes and to see how the new system could improve their performance. Ask about possible changes in the user tasks that the users might face and ways that other users might work with the system. Think about the user’s job, or do the job under users’ direction(Hickey and Davis, 2003).

- **Goals and critical issues**
  A list of goals and critical issues or initial requirements for future system should also be prepared. When present problems have been identified, then goals and critical issues of the system must be defined. Such as analyzing market data, exploring use cases, or developing a detailed set of system constraints (functional requirements).

- **Large scale structure**
  The requirements should be gathered for large scale structure of the system. The elicited requirements will be useful in system evolution and maintenance. In future, these requirements documents will help the maintainer in code comprehension. This will reduce the maintenance cost of the system.

- **Realistic possibilities**
  Think and discuss possible realistic solutions for the system, description of some combination of surveys, workshops, customer visits, individual interviews and other methods. Possibly use different approaches for different stakeholders
- **Consequences and risks.**
  All consequences and risks related to the system must be discussed. Identify factors that could resist your ability to accomplish the elicitation process as proposed, estimate the severity of each risk and decide how can diminish or control it.

- **Commitment from stakeholders.**
  All stakeholders should be committed with system development team. The analyst can only start the working on specific system when the commitment has been done on specific solution. This is important that all concerning parties are committed.

- **Conflict resolution among stakeholders**
  All conflicting ideas must be resolved before system development. All stakeholders in a project have same degree of importance. Requirement analyst cannot refuse ideas of stakeholders without any justification. So, conflict resolution must be a win, win solution.

- **Final requirements**
  A list of use cases, a detailed SRS (software requirements specification), an analysis of results (results of used methods for elicitation process), or performance and quality attributes specification should be exiting criteria of the requirement elicitation process.

- **Priorities of requirements**
  Identified requirements must be prioritized to decide the severity level. If the requirements are prioritized, then high priority needs can be addressed first, and the subsequent requirements changes defined and reexamined, before the low priority requirements are implemented.

- **Complete and necessary requirements.**
  After requirement identification and prioritization all collected material should be validated to check authenticity of requirements. Address the completeness, validation of the requirements that are stated in project goals agreement.

- **Interaction diagrams, class model.**
  After requirements identification and validation, next phase to draw these requirements into such a fashion that they could give some physical behavior. Requirement sketching could be possible with the help of UML (Unified Modeling Language) diagrams. Each UML diagram is designed to let developers and customers view a system from a different perspective and in varying degrees of abstraction (Atlas, 2009).

  Interaction diagrams are used for modeling the behavior of different objects in use cases. They demonstrate how the objects collaborate for the behavior. It does not give an in-depth representation of the behavior. For full coverage of specific objects a state diagram can be used. An activity diagram can be used to see a particular behavior over many use cases or threads. The class model shows static class objects in a system and the relationships between them. Two particularly important relationships are generalization and aggregation (Atlas, 2009). Although implementing the UML on requirement is subsequent part of elicitation process.

### 4.4 Users’ involvement

Some requirement analysts suggest that involvement of users in a project is a key of success in project development. But users’ involvement is no guarantee of success, as we have seen several failed projects (Lauesen, 2002); (Wiegers, 2003). The users can play different roles in project development if they get involve in project development. The users’ involvement can be in the following areas.
• Members of design team or workshops where the user interface is designed.
• Knowledge sources how tasks and business procedures are currently curried out.
• Brainstorm participants who produce ideas and identify problems.
• Test users who exercise the system at acceptance time to check that everything works.
• Reviewers who assess the user interface.
• Test users in usability tests, where they try to carry out tasks with the new user interface.
• Members of the steering committee for the project.

4.5 Elicitation procedure

The common kind of requirements elicitation effort is one that gets information directly from the users who will use the system. The elicitation procedure defined by given in figure 4.2(Coral, 2006). The steps involved in elicitation process are

• Entry criteria: before entering in the elicitation process the objective and scope of the system should be understood.
• Identify, analyze and document the stakeholders.
• Develop questions for each stakeholder or group of stakeholders.
• Choose an elicitation method or set of methods
• Plan the elicitation session, develop and send material to stakeholders
• Execute the elicitation session.
• Document all requests/suggestions of stakeholders.
• Create/update the requirements glossary (if some requirements have been collected already)
• Confirm your understanding of the requirements with users.
• Prioritize, verify and validate the requirement

Since the elicitation procedure can be performed in iterative way, several methods can be applied for requirement acquisition. During the development activities the requirement elicitation procedure can be reactivated to capture a current requirement and possibly more accurate requirements of a system for better understanding (Valusek and Fryback, 1985).

![Figure 4.2 Requirement Elicitation Procedure]
4.6 Requirements elicitation methods

Requirement elicitation is the most critical step in a requirement development process. The success or failure of any large project depends on the quality of the requirements and the involvement of stakeholder in defining the requirements. This quality is greatly achieved by the selection of appropriate methods out of available methods for requirement gathering process. As the stakeholder involved in requirement elicitation process belongs from different background with different organizational and individual goals and have distinct way to store, recognize and express their knowledge about the problem domain. A single method is unlikely to deal with all types of stakeholders in large project (Zhang, 2007).

The combination of methods are selected based on project characteristics because sometime one method that address a particular problem is used together with other methods that deal with such issues that the former methods do not address (Mishra et al., 2008). Furthermore, the development of web system is different than the construction of traditional software for many reasons. For example, it involves more heterogeneous stakeholders and has additional requirements of navigational and multimedia aspects. So to acquire high quality information for web application from diversity of people, the analyst must have the overall knowledge about the different requirement gathering methods.

Several methods are available to support different requirement issues and each has an advantage over other in term of simplicity, complexity and maturity (Jiang et al., 2007). So the selection of suitable methods for the purpose of requirement elicitation in large web project is a challenging issue for the analyst. These methods have been divided into four basic categories as shown in figure 4.3 according to the means of communication: Conversational, Observational, Analytical and Synthetic (Zhang, 2007).

Figure 4.3 Requirement Elicitation Methods
4.6.1 Conversational Methods

The conversational methods provide the verbal communication between one or more stakeholders and help to effectively communicate with others. They are also called verbal methods and verbally express demands are called non-tacit demands. These methods provide the natural way to express the needs and ideas and elicit the product requirements. Conversation is the best way to form the social interaction and peoples feel happy to discuss their feeling through it. Methods like interviews, questionnaire, focus group and brainstorming fall in the conversation categories (Zhang, 2007). These methods are discussed in detail below.

- **Interviews**

Interview is the traditional and the most common approach for requirement elicitation which based on the conversation between two or more stakeholders (Liete and Gilvaz, 1996). The analyst asked question to different stakeholders, to obtain the detail information about the present work, problems and the objectives they have to fulfill in a large web project. It is useful to solve the misunderstanding about a particular domain. Only the experienced interview that used structure process is helpful in collecting the information from different stakeholders. There are two basic types of interviews (Paetsch et al., 2003).

*Closed Interviews*: In these types of interviews the analyst has a pre-defined set of questions and tries to get the answer from stakeholders.

*Open Interviews*: In this type of interviews the analyst does not have pre-defined set of questions and they discuss in an open ended way.

Generally the best way to conduct interview is to use both techniques. The analyst should start the interviews with some predefined questions and during this process a lot of considerable things may arise which may lead to open discussion. Interviews are used to discover the facts and opinions from many potential users which help the analyst to get the rich collection of information.

As it is an easy way to understand the problem in the existing system but on the other hand it is not as such helpful to decide the boundaries of any proposed system and organization procedures. To make the interview more effective the analyst must have to consider the following things.

*Choose the right stakeholder*: The selection of stakeholder is an important and critical factor in any interviewing process for large web projects. Because these projects have large number of stakeholders and the selection of those who have detailed knowledge about the domain is very important factor.

*Prepare yourself*: Always prepare yourself by writing a list of questions to ask and also have sufficient knowledge about the domain because the problems you trying to understand are from large domain.

*Prepare good questions*: Through a list of good questions that cover the whole domain the analyst can be able to gather the required information from the interviewee.

*Be patience during interview*: Analyst should be open minded and show patient when listening the stakeholders’ views.

- **Questionnaires**

Questionnaire is another important method that analyst used for the purpose of information gathering from the stakeholders in large web project. It is a multistage process that begins with definition of the aspects to be examined and end with interpretation of the result. It has some advantages over other methods as it is inexpensive way to gather data from a large number of stakeholders and also the extracted result is easy to analyze. The result gathered from questionnaire techniques depends upon the quality of question design and the honesty of the respondent (Manskil and Molinari, 2008).
As in this method the analyst has limited control over the environment so the validity of result highly depends upon the honesty of respondent. Well designed and effective questionnaires influence the users to answer honestly and make possible to decide the actual user requirement, objectives and the constraints. To achieve the best response rate, question should flow from least sensitive to more sensitive and from more general to more specific. This method can be used under following conditions (Gump, 2009).

1. When meeting is not possible with selected stakeholders.
2. When wider base for soliciting requirement is required.
3. When you want that intended person to be prepared to discuss the certain aspects in the problem domain.

• Focus group

Focus group is a form of qualitative research and powerful mean to evaluate the group of people’s need and feelings. The goal of this method is to come up with a problems in a current work procedure, identify their needs and ideal way of doing things. This method is effective because it involve people in data analysis as well as help to get the rich data in participant own words. It helps the analyst to observe some group dynamic and organizational issues through user spontaneous reactions and ideas. Several groups of stakeholders involve in focus group with in-depth knowledge of domain. Moderator play important role with a preplanned script of specific issues and set of goals for the type of information to be gathered.

It is somehow helpful for web project development by involving the advertising and marketing people in understanding how your site is used by your target audience (Nielsen, 2009b). Moderator should be careful in selecting the participants of focus group because in web development the number and type of participants depends on target audience and goals.

• Brainstorming

Brainstorming is another requirement elicitation method used by analyst to generate large numbers of ideas for the solution of problem. It is a way to generate new ideas and possible solutions. It is very similar to focus group and conducted as a conference with six to ten members. Members are from different background and have in depth knowledge of their domain. It is conducted by facilitator who defines the problem area for which idea will be generated prior to the meeting. Each member has equal opportunities to explain their ideas. At the end of session, the best idea is selected by members voting as a solution to the issues discussed in the meeting. Brainstorming is not useful for such project where there is a small group of stakeholders with disparate needs (Nielsen, 2009a).

4.6.2 Observational Methods

Observational methods are helpful in understanding the application domain by observing human activities. Sometime the stakeholders feel difficulties in explaining such requirement that are even apparent to them because generally people do not thinks about such routine and working environment about which they are very familiar. Such requirements are tacit and these are difficult to collect through verbal communication and observing how people carry out their routine task are helpful in collecting such requirement.

It is very helpful to get the initial understanding about a particular domain through observational methods especially when the development team is lacking in such domains. Observational methods are inefficient when the project have very tight schedule at requirement stages. Method like ethnography and protocol analysis methods fall under this category (Zhang, 2007).
• **Ethnography**

Ethnography is the common method used to capture the tacit requirement. It is helpful in understanding about how customers use their system in real world situation. Deep understanding of work is developed by spending some time along with stakeholders by observing what they do without directing the outcomes. An analyst can get a detailed information about the work in stakeholder own language and terminology. Ethnography is useful in complex projects because both the analyst and stakeholder work together throughout the whole process which can help the analyst to develop the in-depth understanding about project routine. And it can enhanced the understanding of complex problems that the stakeholders faced during their daily routine work as well as can very clearly understand how the information flow in an organization. In ethnography the data is collected through different source such as passive observation, participant observation.

Traditionally the ethnography was developed to understand the human culture but the technology researchers have decided to use it to understand how professionals act, think and feel during their daily work(Hartmann et al., 2009). Ethnography is a lengthy process so it is not suitable in a situation when requirement elicitation team have very short time.

• **Protocol analysis**

Protocol analysis is a form of requirement elicitation method in which the analyst analyzes the stakeholders when they are engaged in some type of tasks. The stakeholders speak aloud during performing some tasks and the analyst records stakeholders’ activities in the form of video, audio or written notes. The analyst uses these recording to extract the meaningful structure and rule in order to find the user requirement for the designing of any application (Nurmuliani et al., 2004). Before the protocol analysis session is started the analyst should has enough knowledge about the domain in order to better understand the stakeholder’s tasks. Otherwise the analyst may completely fail to record the complex part of stakeholder’s behaviors. Furthermore, if the stakeholder is not inhabit of talking aloud then analyst should arrange one or two short training in which a simple task is used as an example.

It is important for the analyst to know when to use the protocol analysis as a requirement elicitation method because different methods elicit certain kind of information differently and protocol analysis is useful to determine what people says is what they do. In large web project where there are large number of stakeholder, it is not possible for the analyst to run protocol analysis session and observe different stakeholder for problem solving as it take relatively long time and only few problems can be addressed. Furthermore, it deliver unstructured transcript which are hard to analyze and also the scope of knowledge produced is very limited (Nurmuliani et al., 2004).

4.6.3 **Analytical methods**

In observational and conversational method requirements are extracted from stakeholders’ behavior and their verbalized thoughts but in analytical methods requirements are gathered by exploring the existing documentation or knowledge. By using this method the analyst capture information about application domain, the work flow and the product feature with the help of studying organizational charts, survey reports and documentation of existing projects. Methods like requirement reuse, laddering and card sorting are used for analytical purpose(Zhang, 2007).

• **Requirement Reuse**

Requirement reusing is a common method in the field of requirement engineering for requirement elicitation and a key to improve the software development productivity and quality. Even in industries
half of the requirements are acquired from existing projects. By using the requirement of a system similar in functionalities will bring the economic saving and this is more useful in case of large web projects where development costs are very high and even a small amount of reuse bring large financial saving.

For large project requirement reuse is one of the most potential and major fueling factor for software productivity because building software out of available requirements not only reduce development time but also enable companies to save on the production cost. According to Montabert the reusability reduces the development cost from 10% to 35% (Montabert, 2006). This method is useful when the development team have very tight schedule and low budget.

- Laddering

Laddering method is a form of structured interview that is widely used in the field of knowledge elicitation activities to elicit stakeholder’s goals, aims and values (Rugg et al., 2002). Analyst used laddering method to create, review and modify the hierarchical contents of expert’s knowledge in the form of tree diagram. It was first introduced by the clinical psychologists in 1960 to understand the people’s core values and beliefs (Hawley, 2009). Its success in the fields of psychology allows other researchers in the industries to adapt it in their fields. Specifically software developers have adapted the laddering techniques for gather the complex user tacit requirements.

By using one-on-one interviewing techniques the analysts try to use the limited set of standard questions to elicit stakeholders requirement and their answer based around a limited set of probes.

Laddering method models the elicited knowledge in the form of tree by using a small set of probes (Rugg et al., 2002). It has several advantages over other requirement elicitation methods such as (Chen et al., 2002).

- It covers the broad domain for requirement elicitation.
- Less time consuming in term of preparation and elicitation sessions.
- Require less expert guidance during requirement elicitation.
- Provides standardized format which is suitable for computerized automation.

As the laddering method is used to elicit hierarchically organized complex knowledge but is also important to note that not all type of requirements are extracted in this way. So, it is necessary for the analyst to ensure that particular domain is appropriate for laddering (Rugg et al., 2002).

- Card sorting

Card sorting is one of the effective ways for capturing information and eliciting the domain expert’s ideas about the requirement structure. It is widely used in the fields of knowledge engineering, software engineering and web site design. In this method stakeholder sort the set of card into a group where each card is printed with the description of domain entities. During sorting process stakeholders have to explain the criteria for sorting as well as the name assigned to groups (Nurmuliani et al., 2004).

Web applications have a phenomenal growth but still the user face problem finding the useful information they needs like understanding web site contents, identifying relevant sources etc. The problem is that users have different mental models of content as compared to analysts because they do not thinks in the same way as the analyst. So to design the web system that support user more effectively, the analyst should requires to understanding the indented stakeholder requirements more comprehensively. To do so, card sorting helps the analyst to gather the requirement closer to the thinking of intended users and organize information about domain (Zimmerman and Akerelrea, 2002).

Card sorting have several advantages over other elicitation methods as it helps the stakeholder to recall the domain concepts and distinguish between high level and low level problems. Furthermore, the
result generated from card sorting can be used as an input for other techniques and further analysis. Card sorting method is helpful for web development because it provides a methodology to enhance the overall structure and the potential information for web sites (Barrett and Edwards, 1995; Zimmerman and Akerelrea, 2002).

4.6.4 Synthetic methods

Sometimes in complex projects a single requirement elicitation method is not useful in gathering the detailed requirements. To overcome such problems analyst tries to use different methods even within one requirement elicitation sessions. For example it is good for analyst to start with interview before he/she start with ethnography study. Instead of combining the different methods of observation, conversation and analytical the analyst can use the synthetic methods. They are formed by combining all these methods into single methods. So the analysts and users communicate and coordinate in different ways to reach common understanding. JAD, contextual inquiry and prototyping are the approaches of synthetic methods (Zhang, 2007).

- **Joint Application Design**

JAD is a modern requirement elicitation method that consist of workshop and group session in which the stakeholders and analysts meet to discuss the desired product features. Its goal is to involve all stakeholders in the requirement gathering process through structured and focus meeting (Wood and Silver, 1995). It was developed by IBM and has been applied successfully on hundred of projects for the purpose of identifying system requirements, package requirements and modification requirement for existing systems. Basically the JAD method is used for software design but as the design effort based on the set of requirement that are well understood by both the analyst and stakeholder so the JAD process is divided into two major steps, JAD plan and JAD design where the first step is used for requirement elicitation and the later address the software design.

The success of JAD depends on the leader of JAD session and the involvement of stakeholders (Yihwa, 1993). As it is a useful method for requirement elicitation but it is also important to note that not all projects are good candidates of JAD. An appropriate project should have at least some of the following characteristics for this method applicability (Rottmann, 2009).

- Involves large numbers of stakeholders whose responsibilities cross traditional departments or divisions boundaries.
- First time project for organization and considered critical to the future of the organization.
- Involves willing users.
- Require more resources as compare to traditional methods.
- Best suit for complex and large projects.

The JAD process consists of three main phases: customization, session and wrap-up (Sridhar et al., 1994). In customization, the analyst prepares the task for sessions such as organizing the teams, preparing the materials and tailoring the process for the particular system to be built. In session phase, the analyst arranges one or more structured meeting with stakeholders. At the start of JAD session the requirement engineer provides the general overview of a system and the discussion continuous with the stakeholders until the final requirements are achieved. This type of discussion is very productive because it resolves difficulties between two parties while developing system for a company. In wrap-up phase, all collected requirements in previous sessions are converted into requirement specification documents (Wood and Silver, 1995).
• **Contextual Inquiry**

Contextual inquiry allows the analysts to gain the true understanding of their needs and collect the detailed information by observing and interacting with people in their work context. In contextual inquiry an analyst studies a few selected individuals in-depth for the purpose of complete understanding of work practice across all customers. Beyer and Holtzblatt defined four basic principles of contextual inquiry in their study (context, partnership, interpretation and focus) which help the analyst in interacting with stakeholders and highlight most important aspects of this interaction (Beyer and Holtzblatt, 1998). An analyst uses contextual inquiry to get the deep understanding of how and why something is done or something is not done. There are various ways to conduct this method like work-based interview, post observation inquiry and artifact walkthrough. Selection of these techniques depends on the type of project (Raven and Flanders, 1996).

Traditionally analysts use focus group, questionnaires or interview to obtain knowledge about the customers and their requirements but such methods provide only the useful demographic and opinion data but they rarely provide such data that is at the sufficient level of details (Wixon and Raven, 1994). Several researchers have used this method to gather data for complex projects. For example Rosenthal uses the contextual inquiry method to gather customer requirement for redesigning CivicInfo.bc website. (Rosenthal, 2007)

• **Prototyping**

Prototyping is another important requirement elicitation method used by analysts in the early stage of implementation of the project. It helps stakeholders to develop a concrete sense about the application which has not yet been implemented. By visualizing the application to be built, stakeholders can identify the true requirements and work flow of actual system. It is useful when the analyst requires the early feedback from stakeholders. Analyst uses the prototype in a situation when the stakeholders are unable to express their requirements or if the project is new and the stakeholders have no experience with the system. Prototyping has several advantages over other methods such as it reduces both cost and time because the errors are detected in the early stages and provides high level of user satisfaction. But on the other hand it has several disadvantages such as it is expensive than other method and it may not developed quickly because of system complexity and technical limitation (Fu et al., 2008).
5. Research Design

This chapter introduces the reader to the research methodology implemented in this thesis. The design parameters of interviews, importance and reasons of selection of online interview method are presented. The selection criteria for interviewees, preparation and execution of interviews and the validity of study are also discussed in last part of the chapter.

5.1 Research Approach

According to Brilliant and Knight the empirical research is an observation of software development activities in an experimental sense. It includes range of experiments, qualitative studies, archival analysis and case studies. The objective of empirical studies is to find out unknown information by conducting the qualitative and quantitative analysis(Brilliant and Knight, 1999).

In our study we used qualitative research approach to figure out how professionals overcome the communication barriers and apply the requirement elicitation methods to gather the requirements for large web projects in industry. An online interview procedure is selected for data collection instead of any other available techniques because of time and cost constraints. It helps us in collection of in-depth information of particular questions from geographically distributed respondents. Furthermore, interview approach gives us an opportunity to interact and gained knowledge from experienced professionals working in industries. Our research design consists of following parameters.

- Online interviews
- Rationale behind the selection of online interview method
- Online interview Structure
- Selection of Subjects
- Interview Questions
- Interview Preparation and Execution

5.2 Online Interviews

As the development of Computer Mediated Communication (CMC)(Mann and Stewart, 2000) tools make it possible to communicate with different people both in synchronous and asynchronous setting. Due to CMC tools the online interviews has become more popular in recent years as it supports to collect data from individual or groups whose are geographically distant. An online interview is a form of online research method which can be conducted in two different ways such as; synchronous and asynchronous. Synchronous interviews are closely resembled to traditional face to face interviews and they take place in real time environment such as internet chat room or through telephone. Asynchronous interviews take place in non-real time environment in which the interviewer email questions to interviewees who respond at their own convenient time. We used both synchronous and asynchronous approaches in our online interview in order to collect data from different professionals. The purpose of using both mediums is to reduce the limitations of research design. We will use words experts, professionals and industry practitioners interchangeably. They all refer to the people who were interviewed in our study.

5.3 Rationale behind the selection of method

Although online interview is a new research method but there are several reasons behind the selection of online interviews methods.
As the experts were busy in their organization and it was difficult to have informal meeting with them in a comfortable environment.

They are geographically distributed so due to limitation of cost and time it is difficult to reach them for face to face interview.

Provides great flexibility as compared to in-person/face to face interview because in email interviews the respondent can respond at any convenient time.

As the interviewees are located at different locations so because of time difference it was difficult to have the face to face interviews with them.

5.4 Interview Structure

It is believed that interview is an easy way to acquire necessary information from interviewee. But on the other hand it is problematic and time consuming process especially when exact information is required. Sometime the result collected from interview is insufficient and unsatisfactory because of poor interviews structure. So it is important to structure the interviews in an appropriate manner for the purpose of eliciting required information from the interviewee. We tried to design the interview in such a way which helps us to acquire the appropriate result for our study. To make the interview more structured we consider following point in interviews design.

- **Selection of software:** We used such software package (Communication medium e.g. MSN, Skype) especially in case of synchronous interviews which all interviewees can easily access and use.

- **Conducting the interviews:** As in face to face interviews the interviewer start by providing the brief introduction which includes the overall purpose of conducting interviews, explanation of interview procedure and so on. But the online interviews lack in these early interaction so to overcome this we used the telephone as medium.

- **Designing the interviews script:** For a successful online interview, we designed interviews script before commencing the interviews which defines the goal and objective of interviews, length of interview and types of questions.

- **Establishing respondent identity:** We try to make sure that the respondents are exactly the one with whom we want to interact.

- **Sample Size:** The total number of respondents is an important factor to achieve a reliable result. In our study we interviewed five professionals from two different countries (Denmark and Pakistan). Because of time and cost constraints and purpose of our study we think five respondents are reasonable to achieve reliable results at this stage.

- **Reliability:** As the nature of our study is to know how these professionals use requirement elicitation methods in developing large web projects as well as how they handle the problems during requirement acquisitions. So we made sure that the interviewees should have a concrete knowledge about elicitation methods and have experience of working on large projects.

- **Designing of the questionnaire:** To cover the whole domain we designed the questionnaire after a detailed literature study.

- **Time Constraint:** As the interview is conducted between the professionals who were distributed geographically. So, to save time and cost, we applied the online methods in which the telephone and Chat (Skype/MSN) were used to introduce the basic purpose of our study and further discussion. Email service was used for questionnaires distribution given in Table 5.2.

- **Analysis of the data:** Qualitative analysis need some creativity, for the challenge is to transform the raw data into logical, meaningful categories; to examine them in a holistic
fashion; and to find a way to communicate this interpretation to the readers. An open coding method of grounded theory is used for data analysis (Strauss and Corbin, 1990). Because after interviews execution we received sufficient amount of information in textual form. With the help of open coding we have drawn these results in a conclusive form to provide better understanding to the readers.

### 5.5 Selection of Interview Subjects

This study is based on the information collected from academia, literature reviews and interview results from software industry. The interviews are performed with software related personnel working in requirement engineering domain, especially with requirement elicitation process. Following selection criteria is used in the selection of interviewees.

- A subject should be a part of requirement elicitation team.
- A subject should be a part of development team e.g. as system analyst, senior web developer, project manager, quality assurance officer and have some experience with relevant domain.
- The designation of the subject should be equivalent to criteria described in 2, in all selected companies.
- The subject should have experience working with development of the medium and large web projects.

### 5.6 Interview Questions

We designed the interview questions with the help of literature review as well as from past industrial interview experiences. For creating interview questions related to requirement elicitation methods and communication barriers. We started our work from brainstorming and tried to identify the possible areas of requirement elicitation. It helped us in designing the interviews questions. After that we wrote down such questions which covered our domain in detail. In our group meeting we discussed each and every question and tried to make sure that they are covering our whole theme of study and removed the redundant questions. To check the reliability and validity of interview’s questions, we performed dummy interviews where one of the member acted as interviewee while the other as interviewer. This interview practices helped us to further improve our questionnaires and we removed some irrelevant questions and added few new questions which were necessary. At the end we forward interview questions to the advisor and after comments and feedback from him, interview questions were finalized.

### 5.7 Interview Preparation and Execution

After finalization of interview questions we started correspondence with different persons which are working in different software companies, through email and telephone for the purpose of conducting the interview. As a result we reached five professionals from two different countries, Pakistan and Denmark. The brief description of five professionals including their job titles and experience is given in Table 5.1. We got in contact with these professionals with the help of our friends who are already working in the same organizations. As interviewees are geographically distributed and because of time and cost constraints we used the online interview method and applied all the three modes (telephone, chat and email) for the interview conduction.
### Professionals, Job Description, Experience

<table>
<thead>
<tr>
<th>Professionals</th>
<th>Job Description</th>
<th>Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>System Analyst</td>
<td>6-7 years</td>
</tr>
<tr>
<td>E2</td>
<td>Project Manager</td>
<td>6-7 years</td>
</tr>
<tr>
<td>E3</td>
<td>Senior Web Developer</td>
<td>5-6 years</td>
</tr>
<tr>
<td>E4</td>
<td>Quality Assurance</td>
<td>4-5 years</td>
</tr>
<tr>
<td>E5</td>
<td>Technical Writer</td>
<td>3-4 years</td>
</tr>
</tbody>
</table>

Table 5.1 Interviewees Description

In our first interaction with interviewees we informed them that our interview base on two separate sessions; telephone (for the brief introduction of domain) and chat (for overcoming any confusion face by interviewees in answering the questions). We also assured them not to disclose their identities in our study and as result we used the alphabetic letter such as E1, E2, E3, E4 and E5 instead of their names. The steps and modes of medium involved in interviews execution is in Table 5.2.

<table>
<thead>
<tr>
<th>S.no</th>
<th>Steps</th>
<th>Description</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Get contact with interviewees</td>
<td>Get in contact with interviewees for the purpose of interview conduction</td>
<td>Colleagues, Telephone</td>
</tr>
<tr>
<td>2</td>
<td>Brief Introduction</td>
<td>A short period of informal discussion</td>
<td>Telephone</td>
</tr>
<tr>
<td>3</td>
<td>Go through with Domain</td>
<td>A brief introduction of our domain, purpose of study interview style and importance of interview.</td>
<td>Telephone and Skype</td>
</tr>
<tr>
<td>4</td>
<td>Send questions</td>
<td>A list of open/close ended questions based on our literature review.</td>
<td>Email</td>
</tr>
<tr>
<td>5</td>
<td>Response</td>
<td>Answers given by interviewees</td>
<td>Email</td>
</tr>
<tr>
<td>6</td>
<td>Further clarification</td>
<td>A detailed discussion on ambiguities.</td>
<td>Telephone and Skype</td>
</tr>
</tbody>
</table>

Table 5.2 Interview Execution

We started the interview by using the telephone to provide the brief introduction of our domain, purpose of conducting the interview and nature of questions etc. Then we mailed our questionnaires to each interviewee and they assured that they would respond us shortly. In their reply they had answered most of the questions in detailed and only few questions were left unanswered. So as a result we arranged a second session of interview through chat which consist of approximately 30-40 minutes and tried to solve the ambiguities and made sure that they respond the remaining questions.

### 5.8 Validity Threats

There are several validity threats that can affect the results that are collected by online interview methods. Because of the importance of the study we tried to overcome all these factors to make our study more authentic.

**Distracted Participants:** There is a possibility that during online interview there may be some factors that caused the interviewee to not pay full attention to the questions. It is difficult for the interviewer to realize such factors in an online interview. In face to face interviews; the interviewer has the ability to respond these factors immediately. In e-mail interview these factors do not affect as such but in synchronous communication (telephone or chat interviews), this is a potential problem and it affect quality of result. To avoid this, we discussed earlier with participants whenever they do not feel...
comfortable in communication (Telephone & Chat) due to any reason. We can re-arrange schedule with accordance to their convenient time and availability.

**Participant interest and motivation:** In virtual interview, it is difficult for the interviewer to realize the interest and motivation of an interviewee than a conventional interview as the interviewer will not be able to read the facial expression and body language. To achieve required result it is necessary for the interviewee to show proper interest and motivation in your study. To overcome this problem we had set a detailed discussion with interviewee through telephone. We provided a brief introduction of our domain, objective of our study and importance of their fair participation and made sure that they are really interested in our study.

**Language use:** Mostly the online users used paralinguistic expression such as “*lol*” (laugh out loud), (😊, 😁)emotions etc. to express the feeling instead of facial expression and voice quality. If either side is unfamiliar with such expression then it will definitely affect the result. To overcome such problems both parties were agreed on not to use paralinguistic expressions.

**Late Reply:** There is possibility that in e-mail interview respondents may take longer time to respond than face to face interview. To reduce this problem we discussed with interviewees in our initial conversion about the time constraints and they assured us that they would reply us as early as possible.

**Lack of visual clue:** In online interviews it is difficult for both the participants to assess the questions and their replies because of lack of visual clues. So to avoid any uncertainty we have arranged an additional session with interviewees to clear the ambiguities.
6. **RESULT ANALYSIS**

We have conducted personal interviews with five personnel, working in the different development organizations. The purpose of this interview was to identify the possible communication barriers in requirement acquisition process of large web projects. And find out elicitation method(s) for requirement gathering of these projects. In this chapter, we will present the results of our study and try to answer the research questions based on the findings from this study. The data of interview results is presented in the form of figures along with explanations. The comparison of results from interview and literature study is also presented in this chapter. Interview questionnaires are given in Appendix A1.

### 6.1 Elicitation Barriers

The barriers in requirement elicitation process are already discussed in previous chapters. In interview when it was asked to the interviewees about the elicitation problems and their importance in web projects. All respondents pointed out three major elicitation problems (scope, understanding, volatility). Four out of five (E1, E2, E3 and E5) respondents stated that understandability problems (communication obstacles) are more crucial. Because when users have incomplete understanding of their needs so they cannot express their tacit knowledge and when analyst has unclear idea of problem domain then resulting requirements will be inconsistent, ambiguous and incorrect. If the users understand their needs properly, it would help to overcome scope problems. A good understanding of the problem domain will decrease the effect of volatility.

Two out of above four (E1, E5) respondents argued that scope issues relate to the problem of understandability because of poor communication and insufficient knowledge of the domain. If a project is being started with very few information of the problem domain, later on it may cause to reconstruction of the requirements which may affect the time and cost of the project. Similarly, too much information may lead to extra work load on development team and useless information may increase the project budget and project may fail to meet the deadline.

One respondent (E4) emerged the importance of volatility problems and argued that user do not familiar with project in starting phase and continuous interaction with development team may matures his/her knowledge which leads to change the requirement in middle of project development that can cause cost and time factor. Table 6.1 shows that how the communication problems are critical in large web projects according to industry professionals.

<table>
<thead>
<tr>
<th>Problem / Experts</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>E4</th>
<th>E5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Understandability</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Volatility</td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.1 Barriers in Requirements Elicitation Process.

To find the solution of above identified problems, we asked further questions to identify the methods/techniques to deal the problems. In response to solutions of these barriers especially understandability problems, two out of five respondents (E2 and E5) highlighted the effectiveness of ethnography for tackling the understanding problems. They justified their opinions by stating that ethnography helps to observe the users working in real working situation and they are unable to express their needs because of insufficient knowledge and lack of communication. And it also helps to understand the structure and work flow of the organization.

The rest of interviewees (E1, E3, and E4) argued that, it could be hard to tackle communication problems with ethnography working in a distributed environment. They described their experiences working with large web based systems and supported the JAD and prototyping methods for these
problems. JAD helps the stakeholders to express the mission and vision of the project by group discussion under supervision of a moderator. Group sessions can be conducted in a distributed manner to overcome the affect of geographical distribution of the stakeholders. Today’s emerging technologies (Video conferencing, Chat rooms, discussion forum) can be used for JAD sessions. And prototyping provides an overall design of the project that helps to reduce the volatility problems by representation of actual system because it helps the stakeholder to develop a concrete sense about the system which has not yet been developed.

The results are obtained from questions regarding the solution to the elicitation problems shown in Table 6.2. The emphases of some respondents were toward the observational (Ethnography) and other recommended synthetic (JAD, Prototyping) methods, but the importance of other methods cannot be neglected.

<table>
<thead>
<tr>
<th>Methods/ Experts</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>E4</th>
<th>E5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Questionnaires</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Ethnography</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prototype</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scenarios</td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brainstorming</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Card sorting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JAD</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>

Table 6.2 Methods for Elicitation Problems

Most of them stated that these problems could be reduced by the use of synthetic methods (JAD, Prototyping) but two of them (E3, E4) also gave weightage to conversation methods (interview, Brainstorming) as well. By applying interview along with brainstorming help the analysts to get deep understanding of user requirements. The prominent methods for elicitation barriers that are concluded from this interview are JAD, prototyping and interview. Observational methods work in situation when the target organization is not geographically distributed and project has sufficient time for its development.

### 6.2 Multiple Elicitation methods selection.

The implementation of single or multiple elicitation methods for requirement gathering is always debated. Three (E1, E3, E4) respondents supported the idea implementation of multiple elicitation methods in development of large web project. The accumulated results are plotted in figure 6.1.

![Selection of multiple elicitation methods](image-url)
They justified their arguments with some points; the large web projects have high resources, ambiguous requirement may lead to huge loss. Furthermore, the implications of multiple elicitation methods do not affect the time factor because several methods can be applied parallel e.g. while doing an interview with users, the ethnography can also be applied. Further motivations for multiple methods selection; a single method may skip any important requirement of system that could not be considered in later stages. By applying several methods this problem could be resolved. Those (E2, E5) who replied their answers in “depends” expressed that they apply multiple methods but not every time. Because some projects belong from the component of existing systems and they have mature requirements and users already have predefined set of requirements. The application of multiple methods in this situation will be a burden on project budget. (Example extracted from interview given by E5. A bank already has a web portal, adding a new facility for customers to pay utility bills online may not required implementation of multiple methods as compare to developing a brand new web portal for a bank. Because the organization already has a working system which fulfills the all customers’ requirements except the bill payments, In this case, requirements are mature)

6.3 Methods for different web systems

Selection of methods also depends on the nature of the system. Developing a component of existing domain has a higher level of certainty (vision, scope and requirements are well stated) with the problem area as compare to new domain (Working with new area, where user has insufficient knowledge of problem domain). The interviewees stated that working with new domain is different as compare to existing domain. Same methods may not be applied in both situations. So, different methods should be applied for naturally different systems. The interviewees proposed that the ethnography, social analysis and prototyping are suitable methods for new domain. In new domain, the requirements are not well defined and the users may not explain their needs properly. So, applying ethnography, prototyping and social analysis the analyst can observer the behavior and extract relevant requirements. But few respondents also showed interest in interview, JAD and brainstorming methods with context to new domain. Their motivations for selection of these methods are that the user participation (in conversational fashion, or group style) is important because they may have some typical ideas that an analyst may not observe with ethnography. And working in distributed style observational methods may not be feasible.

However, the methods selections for existing domain are different. The stakeholders have sufficient knowledge about the system and have defined vision and mission statement. They are known to the domain and can better express their needs. So, interviewees pointed out the interview, JAD and brainstorming methods useful for existing system redevelopment (or development of a component of existing system). In “others” they mentioned the consideration of requirement reuse, because already developed systems have well-defined requirements so documentation (Previous requirement
specification) can provide a starting point of development. The results from interview presented in figure 6.2.

6.4 Elicitation Methods for large web projects

Second major part of our study was to figure out an elicitation method or set of methods in development of large web projects. As discussed earlier (section 6.3), selection of methods depends on the nature of the project. When it was asked from the interviewees, how often they use an elicitation method (or methods) in their web projects development? The most responses supported the conversational (interview, brainstorming) and synthetic (JAD) methods. Large projects have vast number of diverse stakeholders, users’ observations may consume more time. The virtual meetings with discussions help the analysts to get concrete requirements from large number of users. Meanwhile, an interview method can also be applied on small sample of users to overcome the ambiguities that were left in group discussion.

The respondents’ responses are drawn in figure 6.3. They use interview, JAD and brainstorming while working with large web projects. The others methods those got some supports from these experts are reuse requirements and prototyping. Because developing a sub project of a complex project, already identified requirements can help the analysts.

![Elicitation methods for large web systems](image)

6.5 How elicitation methods help the analysts

Requirement elicitation is a second step of RE process but this is a process of several steps itself (Fact finding, requirement gathering & classification, evaluation, prioritization and integration) given in earlier chapter. In search of our third question, we asked the interviewees, how elicitation methods help them in requirement gathering, evaluation and integration? In response of these questions we received some logical connection among these processes. They said that the requirement evaluation is a quality control task which provides the requirements consistent, complete and unambiguous. The requirements can only be evaluated and integrated if sufficient amount of information has been collected in starting phase. This information could be knowledge about the organization and users for which the system will operate, the mission or roles statement, constraints on system must be identified in this process. They said that the interviews, ethnography and JAD can best explore the users’ needs; they are useful in requirement gathering where as brainstorming and prototyping deal with the requirement uncertainty and ambiguity.
These are useful when evaluating and integrating the collected requirements. When the requirements are gathered by using group methods with involvement of all relevant communities, it helps the analyst to understand the viewpoints of all parties that can help in conflict resolution in evaluating and integrating of the requirements. Authors concluded these responses in brief results shown in figure 6.4. The JAD, interview and ethnography methods got industrial popularity for requirement gathering, the brainstorming and prototyping methods were also prominent for requirement evaluation and integration.

### 6.6 Impact of Elicitation on RE Process

A question in the interview was asked about the impact of elicitation process on overall all RE process. Interviewees mentioned that the requirement elicitation as a base step toward requirement documentation, management and validation. It deals with fact finding, information gathering and integration in order to obtain a set of requirements which describe the possible solutions. This process has impact on requirement development process because success or failure of any system depends on the quality of the requirements. The quality in requirement can be achieved by application of appropriate elicitation methods. As the requirements elicitation is the starting point (after feasibility study) of overall RE process. The remainder of the requirement development process follows the results of elicitation process, because validating and verifying these requirements fulfill the goals of the system. Furthermore, if the requirements are well structured and refined then they carry out the easiness in further requirement development activities. Only clarified, refined and integrated requirements can provide a better track for system development. The applicability of multiple suitable methods make RE process more clear and distinct.

### 6.7 Other Useful Facts

In the result of informal interview, we collected sufficient amount of information from professionals. And it is very important to present those facts that interviewers (authors) could not point out in their interview questions but interviewees stated them in additional comments. So, user involvement, diagramming and social context were taken into account as useful facts.

#### 6.7.1 User Involvement

It is observed that from interview results, the users’ involvement is considered crucial especially in initial phase of requirement engineering process. Most of the interviewees supported the users’ involvement in requirement development process. Some (E1, E2 and E4) stated that users’
involvement must be in elicitation, negotiation, analysis and specification. They motivation behind the idea were; the user involvement and interaction in a project development decreases the gap between user and development team. This strategy helps in communicating needs, identifying and resolving conflicts, apart from sharing information that is necessary to efficiently complete the project. One respondent (E3) stated that user involvement should be throughout the project because a successful system can be built by deep involvement of user in all development processes. The results from industrial practitioners (professionals) show that the users’ involvement should be at least in earlier steps of requirement development. The users are not only involved in development but they get familiar with project, and their perception toward the development of system is enhanced. As a result of user involvement, they can assist the development by providing important suggestions and improvements. Geographical distributed users can also be involved virtually in large project development.

6.7.2 Diagramming

Diagramming is another useful fact that was captured in this interview. But it is a post elicitation activity that has worth in requirement specification phase. Their justification behind the idea of diagramming is that the several aspects of a project can be diagrammed for clear understanding by using UML diagrams. Furthermore, by visually mapping the requirements of project development provides better understanding of how things will come to gather. No further clarification was asked regarding diagramming as it was out of our study scope. Although it is an important aspect of requirement development as given in literature.

6.7.3 Social Context

Social context is another factor that was mentioned in the interview by few professionals. Their opinion was that elicitation is a decision making activity so all aspects of this process cannot be tackled in a purely technological manner, because humans are requirement sources and problem solvers. They referred their idea of social context to the ability of understanding, the capacity of remembrance and information processing activities. These social aspects are especially important across different cultures; they relate to the quality of requirement and indirectly affect the success of a system. They said that social issues can be handled with several elicitation methods (ethnography, social analysis and brainstorming).

6.8 Results from Literature Review

Authors have formulated their study findings that have been formed using the literature review of different books, papers, journals and articles. The sources were explored, read and analyzed, and then required results were extracted and presented in this report. In literature study, several authors (Frazier, 2004; Hickey and Davis, 2003; Lauesen, 2002; Nuseibeh and Easterbrook, 2000; Zhang, 2007) have contributed in this domain. Major problems to elicitation process (discussed in earlier chapters) were addressed, and some (Christel and Kang, 1992) of them suggested the few methodologies for these problems and others (Frazier, 2004; Zhang, 2007) provided some models. So, method selection suggestions depend on the different factors like size and nature of system, type of requirement sources, problem area, organizational context etc. The interviews, questionnaires and brainstorming provide direct interaction between requirement analysts and users and the requirements are mainly non-tacit. The ethnography and social analysis provide indirect medium by observing the environment where user works, and tacit requirements are gathered. The requirements can be collected indirectly and proactively by using of analytical methods (requirement reuse, laddering and card sorting). The JAD, prototyping and contextual inquiry methods emphasize on group approach on clarifying the feature of desired system. Both direct and indirect communication channels are used for synthetic methods.
Table 6.3 Comparison of elicitation methods

<table>
<thead>
<tr>
<th>AREAS / METHODS</th>
<th>Conversational</th>
<th>Observational</th>
<th>Analytical</th>
<th>Synthetic</th>
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<tr>
<td>Scope Problems</td>
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<td></td>
<td>x</td>
<td>xx</td>
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<tr>
<td>(Understandability)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Communication Problems</td>
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<td>xx</td>
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<td>Volatility Problems</td>
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<td></td>
<td></td>
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<tr>
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<td>x</td>
</tr>
<tr>
<td>Existing Domain</td>
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<td>x</td>
<td>xxx</td>
<td>x</td>
</tr>
<tr>
<td>Large Conventional systems</td>
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<td>xxx</td>
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<tr>
<td>General Application</td>
<td>xxx</td>
<td>xx</td>
<td>xx</td>
<td>x</td>
</tr>
</tbody>
</table>

The conclusion that is drawn from results of different studies (Frazier, 2004; Hickey and Davis, 2003; Lauesen, 2002; Nuseibeh and Easterbrook, 2000; Zhang, 2007) and is presented in tabular matrix Table 6.3. The elicitation methods are grouped according to their categories for result generalization. The results are summarized on the basis of problems in elicitation process, differences in conventional software, web systems and domain perspectives. The conversational methods are commonly used throughout the requirement development process. They can be applied in a situation when requirement sources are human (other requirement sources can be organization environment, market trend, current technologies etc). Observational methods are less applicable as compare to conversational but they are handy in brand new situation and understandability issues. Analytical methods are well applied in a situation when level of requirements certainty is high. These methods deal well when working with existing domain (requirement reusability). But these cannot apply on large scale because of requirement maturity problems. The synthetic methods (JAD, Prototyping and scenarios etc.) are more comprehensive in many situations. They deal well with elicitation problems, handy with large web and traditional systems. The synthetic methods require more resources so they cannot be applied on small systems. They can be useful in complex, large and scientific systems.

6.9 Research Questions

The purpose of this literature study and interview was to explore the answers that were raised in chapter 1. With the help of study results from literature review and interviews authors elaborated the solutions of these research questions.

RQ1: What are the communication obstacles in requirement elicitation and how do you tackle them in large web projects?

This research question has two parts, first the identification of communication problems with elicitation process and second find out solution for them. The possible obstacles that were identified in literature and interviews are scope, understandability and volatility (maturity). The communication problems lie under understandability problems so they are more crucial (section 6.1) as compare to others because other two elicitation barriers directly or indirectly relate to communication factors. An
efficient communication and better understanding of domain reduce the effect of scope and volatility problems. Stakeholders come from different regions, have diverse professional areas and speak different languages (English, French, and Danish etc). The users from management or medical may not understand technical aspects of system development and they will express needs their own way. The gap between diverse field areas, the analysts may not understand the terminologies used by the users to explaining their needs. The stakeholders (who belong to non-English speaking regions) may be good in speaking English in general communication, but may not accurate in expressing technical problems. Our literature findings and interview results state three areas where communication problems lie; “With-in” the user, “Between” users and “Among” users and analysts.

Firstly, the problems within the users are related to cognitive limitations of a user (memory, recalling facts), a user may express only those problems that happened rapidly, and may skip crucial problems that occur rarely. So, in explaining the needs, the crucial problems may be skipped due to this problem within the users. Secondly, the problems between the users; they are working in same organizational setting, and they may express their needs diversely because of different designation and experience. And thirdly, the problems “Among” stakeholders which arise when contradiction among stakeholders about the mutually identified requirements or jointly defined a large system that can be over budgeted. So as a result a choice of the subset of the requirements that will be implemented into a working system will involve tradeoffs among the various identified users needs. The possible solutions that are identified from our study results (section 6.1-6.8) are observational (ethnography) and synthetic (JAD, prototyping) methods because these methods deliver tangible concept, which is an efficient way to improve the individual (group) cognitive limitations and resolve the conflicts. The ethnography helps the analysts to observe the environment and extract requirements, when user habitually reserved in speaking. The JAD and prototyping are useful to resolve the conflicts among the stakeholders. Further motivations for these methods have been discussed in earlier sections.

RQ2: Which method or set of methods of the requirement elicitation process are appropriate for large web projects?

The large web systems have complex structure that needs multidisciplinary development team. They have diverse needs because some structuring, navigational, contents and access issues must be handled by the requirements analysts except the functional and non functional requirements. The multi-tier design architecture, backend database and integrity with third party applications are the critical aspects while gathering the requirements. Four categories of requirement elicitation methods are found in literature study. The applicability of method depends on the system type, nature, size of the system, budget and time constraints. Each method has advantage on other in term of simplicity, complexity and maturity. The answer of this research question is based on the finding from literature and interview results.

The elicitation methods that are commonly applicable in development of large web system are conversation and synthetic (Figure 6.1-6.3, Table 6.3). In conversational methods interviews and brainstorming are well suited and JAD and prototyping are prominent from synthetic category. Because interviews can collect large information from users while brainstorming help in gaining the depth knowledge of problem domain. Large projects have huge set of requirements and conflicts occur rapidly, JAD can helpful in resolving these conflicts in requirements and provide better interaction among stakeholders. The prototyping is an effective way to improve the understanding and communication in the stakeholders by presenting a real image of future system that is going to be developed. Further, motivations for implementation of these methods are given earlier in this chapter (section 6.4 - 6.6). These methods are dominant except in few situations in which conversational may be less effective than observational like communication problems. In situation, when a user is habitually reserved and reticent an interview method may not be effective in this case, with the help of ethnography analyst can observe the needs of the user. But ethnography can only be applied when stakeholders are not distributed geographically, and project has a sufficient time to apply this method. Although large web projects has sufficient time for this method but geographical distribution of stakeholders restrict the analysts to not apply ethnography method. The general conclusion about the methods for large web projects are; large projects have heavy budget, more time as compare to small
projects. So, combination of multiple methods can be applied because no single method guarantees the best exploration of requirements.

**RQ3: How do these methods help the analysts in requirements gathering, evaluation and integration in large web projects?**

Elicitation activity deals with the information gathering and integration in order to achieve the set of requirements for possible solutions of a system. The further steps in requirements engineering could only be feasible if initial requirements are properly identified and they are consistent. The analysts have responsibility to integrate the collected requirements for set of requirements that can serve the developers in desired system development. The integration and evaluation of the requirements can be done by mapping previous requirements (previous domain models and architectural models documents) onto new needs to organize them. But this is only feasible when working with existing domain, and system already has previous requirement documents.

The validating the requirements by involvement of all affected parties and agree them on single point is important for completion of successful elicitation process. The conflicts can only be resolved by stakeholders’ participation to address the deficiencies, inconsistencies and ambiguities in requirements. Because these integrated and validated requirements will communicate among analysts and developers in remainder stages of the project development.

The answer of third research question has been addressed in section 6.5 (Figure 6.4). Multiple methods can facilitate the analyst in several activities of requirement acquisition. Interviews, ethnography, brainstorming and JAD can help analysts in requirement identification, collection from requirement sources because potential requirements can effectively be gathered with these methods. Collected requirements must be integrated, prioritized and validated, so they could be used for further system developments. The results from interviews show that users’ participation along elicitation methods (brainstorming, JAD, prototyping) can help analysts in requirement evaluation, integration and validation.

### 6.10 Result Comparison

The purpose of this comparison was to check the results that are achieved from interview with those which are stated in literature. The authors have analyzed the applicability of elicitation methods from both prospective, first a deep study of literature and second a comprehensive interview execution. This analysis was made on the factors of elicitation problems especially communication obstacles, multiple methods implication and affect of these methods on further requirement processes. The results from both sources (academia and industrial) are similar as given in figure 6.1-6.4 and Table 6.3.

The study found that three types of the barriers that can affect the reliability of elicitation process. First, defining the boundaries of the system which relate to what should be in the system and what must be in the system? The ill-defined boundaries of the system lie under scope problems that occur on earlier stages of requirement elicitation. The scope of the system usually defined by the stakeholders and lack of domain knowledge will generate this issue. Second problem is understandability e.g. communication gap due to different languages, conflicts in requirements due to diversity among the stakeholders. Third problem is volatility in requirements e.g. maturation issues, change in requirements in later stages of system development. In literature, four different method categories are available to tackle these problems and elicit consistent and accurate requirements. The implementation of these methods is not only important to overcome these barriers but also facilitate the analysts by providing clear and consistent requirements in later stages of requirement development process. The observational and synthetic methods were suggested for solutions to these mentioned problems and overall selection of elicitation methods for large web projects. The implication of multiple methods in large projects was also suggested given in Table 6.3.

In interview, similar types of problems were identified by the professionals. Although they pointed out these aspects with different angles but their opinions were similar to categories as mentioned in literature. They also figured out barriers that lie under umbrella of scope, understandability and volatility. But they emerged the importance of understandability problems because communication
difficulties stem from the understandability issues. They also suggested methods for tackling these issues along with consistent requirement gathering for large web projects development. From interview results, the applicability of conversational and synthetic methods was suggested for handling the elicitation problems in requirement acquisition.

6.11 Discussions

After result comparison of industry and literature, we are convinced that there is certainly a gap between the theoretical perspectives of requirement engineering when observed from industrial viewpoint. The most apparent concern is that best practices suggested in the literature most often seem to overlook aspects such as resources within an organization where as from the industrial standpoint resources are matter eventually influencing the entire development process. Some factors are identified in industries that differ from theoretical perspectives although some general discussion is found in literature of below mentioned points. Our industrial interviews have customized these points in context to large web projects. Literature shows the problems but didn’t prioritize these barriers. We found in industry that understandability problems are root cause of all other problems, so we presented these problems according to their severity in development. In our study an inside operation of elicitation activity is presented (as elicitation process consists on several steps) and multiple elicitation methods applicability is also seen in industry. We found in interview results development teams do not depend on single method or technique, they apply methods as they can to reach at sufficient quality within resource constraints. An impact of elicitation methods on remainder development phases is drawn from industrial interviews. Final conclusion of the study presented in next chapter.

6.12 Study Limitations

The threats to research procedure were presented in previous chapter. In this section, the limitations of this study result are given.

- The study results are based on small sample of professionals’ opinions, generalizing these results on overall population may not be applicable.
- A difference may possible between what these professionals say they do, and what they practically do? (Although, these professionals assured, they participated in this interview sincerely)
- The applicability of requirement elicitation methods were addressed with context to development of large web systems. So, results may not be applicable to small scale development or general application development.

6.13 Summary

In this chapter, the result analysis of the study was presented, based on the interviews conducted with five professionals who were working in the relevant domain. The main focus of this chapter was to identify the possible communication problems in requirements elicitation, suggest some methods for these problems. The applicability of the elicitation methods were also addressed in this chapter with context to development of large web projects. Later on, the research questions were answered on the basis of conclusion drawn from this study and study comparison and limitations were also presented in last part. The next chapter has the conclusion of the study and some future directions in this domain.
7. EPILOGUE

7.1 Conclusion

The focus of this report was to find out the problems in requirement elicitation process of large web projects. Along with identification of methods that can help the analysts in requirement acquisition and solution to the problems. In the shed light of literature study and interview results, we have identified three categories of problems scope, understandability and volatility that faced by analysts in requirement elicitation process. The communication problems lie under understandability shadow. It is found that lack of understandability is the root cause of all other problems, and poor communication is first step toward project failure. These problems are curial because they related to stakeholders and stakeholders have cognitive limitations while expressing their needs. Communication barriers can be arisen due to problems “within” individual user, “between” two users or “among” group of stakeholders. These problems become more abstruse in large web projects because stakeholders are distributed geographically. It is hard to overcome these shortcomings because lack of direct interaction among stakeholders. These problems produce the resultant requirements in shape of vague, conflicted, ambiguous and inconsistent. That can lead to huge loss in the form of project failure because of poor requirements. So, analysts apply elicitation methods to reduce the affect of communication problems in their requirement elicitation process. Methods that are helpful in overcoming these barriers are ethnography, prototyping and JAD. The ethnography extracts users ‘need by observing them in their working conditions. Analyst observes the working environment and depicts the points from where conflicts are arisen. Prototyping gives a visual clue to the users to better understand the design of the system and JAD method is helpful for conflict resolution among the users under supervision of a moderator.

This study also explores that applicability of method or set of methods depends on several factors (domain nature, budget, time) of the project. The edge point of multiple methods implication is that it reduces the chance of important requirements omission. If one method skips any important requirement then other will cover it. However, multiple methods implication does not guarantee the project success. The methods that help the analyst for effective and quality requirement gathering are interview, brainstorming, prototyping and JAD methods. Because conversational methods gather large number of needs from users, so analysts have enough data for requirement extraction from these needs and prototyping proves helpful to collect a set of requirements from users by providing them visual sketch of the system. And JAD helps the analysts in getting ideas from all stakeholders and conflict resolution. The remainder requirement development process depends on requirement elicitation activity, if the quality requirements have been collected in this phase (elicitation) then analyst would able to analyze, integrate and validate them later on, otherwise the analysts may need to repeat the elicitation process and this affect the project’s resources.

It is importance delineation that the methods discussed in this report are based on the implicit supposition that the human stakeholders (end users, customers, analysts) are cooperative and sincere in method implementation. The users are willing to share knowledge with the analysts and the analysts are fully equipped before execution an elicitation session. The analysts should also have the interpersonal skills to help build consensus between heterogeneous groups of stakeholders. Such social skills are as important as the methods used in the elicitation process.

7.2 Future Work

There are several aspects of our study that can be addressed in future research. The interview was conducted on small scale and results were addressed the problems related to the large web projects. In future it could be possible to increase the sample size of population (subjects) for more generalization of results and issues in conventional software’s and small systems can be addressed with context to requirement elicitation. Since our study was a confirmatory, that compares the finding of literature study and interview results. In future it could also be possible to address this domain with case study
of a particular large web system or e-commerce system. In this thesis, only issues in elicitation process were focused, it could also be possible to deal with other adjacent activities like requirement analysis, specification, documentation and validation in future.
8. REFERENCES


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APPENDIX

Appendix A1: Interview Questionnaires

Interview on Requirement elicitation process for projects development.
Return at: usrizvipk@gmail.com

<table>
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<td>Purpose:</td>
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**General Information**

Name:  
Email:  
Organization:  
Experience:  
Date:  

**NOTE:**
As you already familiar with target domain, we have discussed in our last conversation (Skype chatting/cell phone). We hope you have understood the importance of this interview and your responses. Here are some questions relating to your experience and target study. You are requested to provide as much information (your experiences, observations, practical implementations) as you can. All (except 12, 13) questions are open ended.

**Questions**

1. Do you perform feasibility study before starting a new project? If yes, what are the parameters for this study?

2. Do you apply requirements elicitation process before developing a web project? If yes, how?

3. In enhancement of a web system, do you reuse requirements from other existing systems? If yes, which types of requirements do you reuse?

4. Before start gathering requirements which course of action do you follow to make your process clear and distinct?
5. What are the problems do you face in requirements elicitation process? Which are the more crucial in large web projects?

6. What kind of communication medium do you use for requirement gathering process and what are the communication problems do you face in this process?

7. What are the method(s) do you use to reduce communication problems while working with web projects?

8. How do you keep away from extra work load due to ambiguous requirements?

9. How do you know when you have done the requirements gathering process?

10. How much critical, the implication of elicitation methods on web projects as compare to other conventional projects?

11. How important is the requirement elicitation (gathering) process in system development, does it have impact on web projects.

12. What elicitation method or methods, do you apply in your requirements gathering phase, especially in context with large web projects. (Multiple selection. / Additional information can be given.)
   a. Interviews
   b. Questionnaires
   c. Observations (Ethnography)
   d. Social Analysis
   e. Prototype
   f. Scenarios
   g. Brainstorming
   h. Card sorting
   i. Joint Application Design (JAD)
   j. Others (write below)

Comments:

13. How often do you apply these methods in several projects? (Multiple selection)
   a. Interviews
b. Questionnaires

c. Observations (Ethnography)

d. Social Analysis

e. Prototype

f. Scenarios

g. Brainstorming

h. Card sorting

i. Joint Application Design (JAD)

j. Other:

14. Do you apply multiple elicitation methods for a project? If yes, then why?

15. How do you guarantee that selected elicitation method(s) will produce best results?

16. Did you ever notice any difference in the project's results, while applying same elicitation method(s) on similar projects.

17. What do you think the impact of requirement elicitation process on requirement analysis, evaluation and integration?

18. Additional comments.