Adoption of Usability Evaluation Methods in Web Development

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ABSTRACT

World Wide Web has attained a significant role in the communication, information sharing and services delivery within some years. The web based applications now contains the information for different organizations, academics, medical and many more. Online business in the form of E-commerce is widely using the concepts of web based business very efficiently.

Due to wide use of web applications, the usability and User Experience (UX) play important roles. The organizations often concentrate less on usability evaluation of web applications due to which the users encounter problems while using the product like page loading time, accessibility, font size etc. The bad usability influences the user experience.

Usability evaluation of web application helps the companies to develop more user friendly and accessible products which also improve the market positions of their products.

There are different Usability Evaluation Methods (UEMs) which can be used to evaluate the product. The appropriate UEM at appropriate time during product development ensures the high quality of product. Due to different definitions of usability and UX it is difficult to evaluate the usability and UX. Furthermore there are some organizational issues like time to market, evaluator's expertise, budget etc which restrict the deployment of UEMs in web development.

This thesis study is focused on the identification of different definitions of Usability and UX. The relationship between Usability and UX is also investigated. Interviews are conducted in order to identify the factors which restrict the adoption of UEMs. The results of interview are analyzed by using Grounded Theory. Some recommendations are given on the basis of empirical study that how appropriate usability inspection method(s) can be adopted during the product development.

**Keywords:** Web Design, Web Usability, User Experience, Usability Evaluation, Usability Issues
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My special thanks are for my mother whose prayers, love and care is the continuous source of encouragement for me. I am indebted to Huma for all her support and prayers which she has shown towards me. It is not possible to complete this task without her encouragement and support. I am also thankful to the companies and their representatives that participated in interview study. It was a wonderful experience with all of them.

Naeem
09th Sep.2009
Ronneby, Sweden
To my Mother...
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<table>
<thead>
<tr>
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<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>UEM</td>
<td>Usability Evaluation Method</td>
</tr>
<tr>
<td>UX</td>
<td>User Experience</td>
</tr>
<tr>
<td>MUSIC</td>
<td>Metrics for Usability Standards in Computing Model</td>
</tr>
<tr>
<td>CEO</td>
<td>Chief Executive Officer</td>
</tr>
<tr>
<td>GT</td>
<td>Grounded Theory</td>
</tr>
</tbody>
</table>
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SECTION I - OVERVIEW

Chapter 1: Introduction
1  INTRODUCTION

CHAPTER 1

When you take stuff from one writer it’s plagiarism; but when you take it from many writers, it's research. Wilson Mizner (1876 - 1933)

This chapter presents the brief overview of the thesis. The background and motivation of thesis is described in section 1.1. Section 1.2 discusses the aims and objectives of the thesis.

Research questions with their description are mentioned in section 1.3. The expected outcome along with the research methodology is explained in sections 1.4 and 1.5 respectively. The section 1.6 describes the complete outline of the thesis for the reader.
1.1 Background

World wide web (www) has achieved an important role in the communication, information sharing and services delivery within some years. World Wide Web consists of millions of web sites and web based applications which are deployed and are visited all over the world (Hu and Chang, 2006). The web based applications can be categorized into different categories on the basis of functionalities. The main categories are information oriented, services oriented and business oriented websites.

Each category has its own requirements and design rules (Rossi et al., 2001). These categories comprises the websites by using the information for different organizations, academics (Universities, Colleges, Research Centers etc.), medical (hospital websites), and many more. Moreover organizations with distributed business setups use web based applications for their operations like Payroll, Human Resources, online recruitment etc.

Users will be satisfied if the websites are conforming to the required functionality with desired quality level (Petrie and Kheir, 2007). Different standards such as ISO 9126, ISO9241, and ISO25000 etc and quality models like McCall, Boehm's, Dromy etc have been proposed which explain the quality of the product by identifying different quality attributes (ISO/IEC9126, 1991; ISO9241-11, 1998; McCall, 1997; Dromey, 1995; Bhatti, 2005).

ISO 9126 provides a list of quality attributes, their definitions and measures for Functionality, Usability, Reliability, portability, Maintainability, Portability and Efficiency (ISO/IEC9126, 1991). Usability is one of an important quality attributes that has gained a well recognized consideration for web development. The usability can be identified in different context like task performance, ease of use and ease of learning etc (Nielsen, 1993).

Due to wide use of web applications, the accessibility and usability play important roles (Petrie and Kheir, 2007). The inclusion of internet access in mobiles, teaching courses of web development, online shopping, and providing internet facilities to everyone contributes the expansion and awareness for accessing the websites. The web users vary with age, education, expertise, with different goals for accessing the websites and may have disabilities like blindness. All these factors motivate the organizations to develop such types of websites which are more accessible and usable for the users (Petrie and Kheir, 2007).

The extensive research has been conducted for the usability and perceived user experience (UX). The usability in ISO 9124-11 is defined as “The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (ISO9241-11, 1998). There are many other terminologies and concepts related to usability have been presented so far in literature which is discussed in later chapters.

According to Niamh, the discussion regarding the usability of the product has been re-directed towards the relationship between three elements i.e. the Functionality (product), Usability (interaction between product and user), and the
user satisfaction (user experience) (McNamara and Kirakowski, 2006). According to authors although the elements are independent but the influence in some way for example poor usability of the product leads to negative user experience (UX) which in results produce the frustration, annoyance, and bad impression towards the product.

Due to different definitions of usability and user experience, it is difficult to know the differences and make a choice of what evaluation method to use. Different studies have shown that different users have different requirements and satisfaction levels while using the web based applications.

According to Neilson, there are four ways for the evaluation of user interface i.e. automatically, empirically, formally and informally (Nielsen, 1993). There are many evaluation methods that have been proposed for the evaluation of usability. These methods are categorized into two categories i.e. usability inspections (based on experts analysis) and Evaluation Methods involving User Participation (Conte, 2007).

Several studies proposed different models and methods for the evaluation of usability, but from the literature review and interviews conducted during this thesis, it is found that web development organizations use different usability evaluation techniques. Sometimes traditional testing is used instead of any UEMs. In practice there is a lack of knowledge and gap between academia and web industry has shown.

Even many successful and multinational web development companies are not aware of such evaluation methods. This thesis will contribute to investigate these evaluation methods and give suggestions and recommendations that how these UEMs be adopt to increase the usability of product. In addition the factors which restrict the organizations to adopt these methods will also be explored in this thesis.

1.2 Aims and Objectives

The main aim of this thesis is to investigate and evaluate the different usability inspection methods, which can be applied during the development of web applications (See chapter 5). Moreover suggestions will be made which will help the web industry in improving the usability for their products.

It attempts to fulfill these aims through the following objectives:

- Identification of different terminologies and definitions of Usability and UX in the literature, models and ISO standards.
- Identifications of usability related issues faced by users while visiting the web applications.
- Investigation of the influence of usability of a product on the UX from web user’s point of view.
- Identification of usability inspection methods in the literature.
- Analysis and comparison of web usability evaluation (inspection) methods.
- Analysis of organizational factors which restrict the adoption of usability evaluation methods.
The objectives will be achieved one by one and briefly discussed throughout this thesis. The understanding of usability evaluation methods can be achieved by studying the Usability Evaluation Methods (UEMs) found in the literature.

1.3 Research Questions

The research questions (RQs) are as follows:

**RQ1: What are the different concepts and terminologies for usability and user experience in the literature?**

In this question different definitions of usability and UX are identified. The question will help in understanding the different concepts of usability and UX in different context by different authors (see chapters 2 and 3). This question is answered through literature review (Creswell, 2002).

**RQ2: What are the usability issues mentioned in literature that the users encounter when using web applications?**

Identification of different issues that the web users encounter while using the web applications like *page loading time, color scheme, font size etc* will be answered in this question. It will be answered through literature review (see section 4.3).

**RQ3: What is the relationship between usability and user experience for websites?**

By conducting a literature review, the nature of the relationship between usability and user experience is investigated from the point of view of users of web applications (see section 4.4).

**RQ4: What are the different usability evaluation methods?**

There are different usability evaluation methods. These evaluation methods are proposed for usability evaluation of traditional software as well as web based applications. They will be explored and compared based on their pros and cons on the basis of their efficiency and requirements. This question will mainly focus on usability inspection methods (see chapters 5 and 6).

**RQ5: How the identified usability inspection method(s) can be used to evaluate the usability of websites during development phases?**

There are three main categories of evaluations methods i.e. *inspection, inquiry and testing*. This thesis study mainly focuses on *usability inspection methods*. This question is answered by comparing the industry practices with the literature review results. Furthermore recommendations are given to web industry for their efficient use at particular time during the development process (See Chapter9).
RQ6: Which organizational factors influenced the adoption of these usability inspection methods?

There are some factors which restrict the organizations to adopt and understand these methods. This question will contribute to identify these factors and will suggest the organizations that if they overcome these factors then they can adopt the methods to get better usability evaluation results. This question will be answered through interviews conducted with web companies (See Chapter 9).

The relationship between research questions and expected outcomes is show in following figure:

Figure 1: Relationship between research questions (RQs) and expected outcomes

1.4 Expected Outcomes

A report answering the research questions along with following outcomes as well.

- Literature review of different ISO standards and already done research on usability and user experience.
- List of usability evaluation methods.
- Relationship between usability and UX.
- List of usability issues in web industry.
- The empirical study that:
  - Investigate that how usability inspection methods can deploy at different phases during the website development.
  - Identify the organizational factors which influence the adoption of evaluation methods.
1.5 Research Methodology

A mix research approach (Creswell, 2002) i.e. qualitative and empirical will be adopted for this thesis. The research was divided into two main parts Literature review and empirical part which comprising the interviews and observations.

Initially extensive literature review was conducted to study the different concepts of usability, UX and identification of different usability evaluation methods. This study also contributes to identify the usability related issues in web applications. This part contains the three steps. The understanding of definitions and concepts of usability and UX mentioned in different standards, models and literature was the outcome of first step.

In second step the usability related issues which web users can encounter during web browsing have been identified. The relationship between usability and UX which developed due to influence of usability on UX is also part of this step. In third step the investigation of different usability evaluation methods from the perspective of web industry have been sort-out. These steps are based on literature review.

After extensive literature review, the empirical analysis was carried out to identify that how web development organizations can adopt the usability inspection methods in the development of web applications through observations and interviews. The interviews were conducted with 4 web development organizations based in Pakistan.

The main reason of conducting interviews was to investigate in depth about implementation of usability Inspection methods at different phases during the web development in practice. To get in-depth and detail information regarding the UEMs, the interviews are selected instead of Survey. Furthermore there are some organizational issues which restricts the adoption of UEMs were also identified through interviews and observations. The results of these interviews were interpreted and analyzed through Grounded theory.

1.5.1 Exploratory Study

This thesis study is conducted as an exploratory study (Dematteo et al., 2005). Exploratory approach is used as very few research have been conducted which have this type of aims in a single report. It is best option to conduct research in this way as it is used when the knowledge about the research area is not available or not sufficient work have been done with same aims and objectives (Routio, 2007).

Exploratory research is basically based on literature review, data or qualitative approaches like informal discussions, in-depth interviews or observations etc. Exploratory research is helpful in determine the insight of situation (Routio, 2007).

This thesis study is mainly focused on exploring different terminologies and definitions used for usability and UX in the literature along with different usability issues which the user can encounter when he is using the web application. Furthermore the factors which restrict the adoption of UEMs and how UEMs can be deployed at different development stages in industry are identified. Therefore this thesis study is exploratory in nature.
1.5.2 Grounded Theory

Grounded Theory (GT) is very suitable for exploratory type of studies where the researcher don’t have any prior knowledge (Moghaddam, 2006). GT is a qualitative research methodology which systematically analyzes the data and contributes in generation of theory (Moghaddam, 2006). Barney Glaser and Anselm Strauss developed GT in 1967 during the research project (Moghaddam, 2006). GT helps to interpret and analyze the data by converting the raw data into code, concepts and then categories. Different methods are used to collect the qualitative raw data such as interviews, observation and extensive literature review.

The data gathered through interviews and observations is analyzed by using the Grounded Theory (GT) (Creswell, 2002). The factors which influence the adoption of UEMs and suggestions for adopting the UEMs were identified by systematic analysis of gathered qualitative data in this thesis study.

1.6 Thesis Outline

This section describes the outline of remaining thesis report for the readers. The thesis report is divided into 5 sections.

Section 1: Overview

This section describes the overview of thesis. The introduction of research area, Research Questions, Research Methodology, Aims and Objectives are the main part of this part. This part includes the Chapter 1 (Introduction) of thesis report.

Section 2: Literature Review

This section is based on literature review. The concepts about usability, UX, and web usability are found in this part. The included chapters in this part as:

Chapter 2 - Usability and User Experience
Chapter 3 - Web Usability
Chapter 4 - Usability Issues
Chapter 5 - Usability Evaluation Methods
Chapter 6 - Usability Inspection Methods

Section 3: Empirical Analysis

This section describes the empirical study conducted during this thesis. Empirical study includes the research design, how it is conducted and analysis of interview data. The main theme of thesis i.e. what are the factors which influence the adoption of UEMs and how UEMs can be deploy at different phases of product development is the part of this study. Furthermore the threats to validity are also mentioned later in this section. The chapters which contribute the empirical study are as follows:

Chapter 7 - Empirical Research Design
Chapter 8 – Empirical Research Conduct
Chapter 9 - Analysis and Interpretation
Chapter 10 – Validity
Section 4: Epilogues

Section 4 of this thesis comprises the conclusion and future work that is found during thesis research. RQs are re-visited in this section. References used in this report are present in the last chapter of this thesis. The chapters in this part are:

Chapter 11: Conclusion and Future Work
Chapter 12: References

Section 5: Appendices

Appendices are included at the last section of the thesis. These include the questionnaire which is used for the interview and Nielsen’s 10 Heuristic lists.
SECTION II – LITERATURE REVIEW

Chapter 2: Usability and User Experience
Chapter 3: Web Usability
Chapter 4: Usability Issues
Chapter 5: Usability Evaluation Methods
Chapter 6: Usability Inspection Methods
2 USABILITY AND USER EXPERIENCE

CHAPTER 2

Beauty and brains, pleasure and usability- They should go hand in hand. 
(Donald Norman, 2003)

This chapter provides an overview of usability and user experience (UX). This chapter is divided into two parts. First part is dedicated for the usability. The concepts and terminologies which are given by different authors in different context as well from different ISO models will be discussed in this part.

While the second part briefly discuss about the user experience (UX).
2.1 Usability

Usability is an important quality attributes that gets more and more well recognized and considered value in the software development. Many computer professionals and developers are not well knowledgeable in usability (Offutt, 2002). The concept of usability varies from person to person. In the following sections, the usability and UX concepts will be described.

2.1.1 Concepts and Definitions

The definition of usability varies within the software engineering community. Many different and some similar definitions have been produced as the outcome of research conducted on usability (Abran et al., 2003). In this section identified different concepts are discussed.

According to Nielsen, usability can be defined in terms of five factors i.e. Efficiency of use, Learn-ability, Memor-ability, Errors/safety, satisfaction (Nielsen, 1993). According to him the usability of the product will be good and the system is usable if it possesses these above five factors. Similar concept introduced by Preece and his colleagues in 1994 (Preece et al., 2002). According to them usability can be expressed in four components (Learn-ability, Throughput, Flexibility, Attitude).

In 1994, Nigel Bevan and Macleod (Nigel and Macleod, 1994) considered that usability is the quality requirement which can be measured as the outcome of interactions with a computer system. This requirement can be fulfilled and end user will be satisfied if the intended goals are achieved effectively with the use of proper resources. Molich in 2000 (Molich, 2000) stated that user friendly system should fulfill the following five goals i.e. Easy to Learn, Easy to Remember, Efficient to Use, Satisfactory to Use, Understandable.

In addition to different definitions of usability, there are some quality models and methods which define the usability in the form of attributes and sub attributes. According to MCcall, Usability is composed of three criteria i.e. Operability, Trainability, effectiveness by MCcall in his quality model (McCall, 1977).

*Diagnostic Recorder for Usability Measurement* (DRUM) by Macleod and Rengger (Macleod and Rengger, 1993) is a software tool for analyzing the user-based evaluations. According to this model usability can be measured by metrics mentioned in following table.

<table>
<thead>
<tr>
<th>Table 2: Usability in DRUM Quality Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Metrics</strong></td>
</tr>
<tr>
<td>Task time or total time</td>
</tr>
<tr>
<td>Snag, help and search time</td>
</tr>
<tr>
<td>Effectiveness</td>
</tr>
<tr>
<td>Relative Efficiency</td>
</tr>
</tbody>
</table>
Productive Period

The task time which is used in performing the actual tasks i.e. not spending time on help, snag or search.

A well known usability method which is used to measure the usability of product is Metrics for Usability Standards in Computing model (MUSIC) (Macleod, 1997). The usability measures mentioned in this model were later integrated in original ISO 9241 standard. MUSIC is considering as the more valid and reliable collection of measures which can be used for measuring the usability. The measures used in MUSIC model are mentioned in following table.

Table 3: Measures in MUSIC Method

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Sub Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td>Task Effectiveness</td>
</tr>
<tr>
<td>Efficiency</td>
<td>• User Efficiency</td>
</tr>
<tr>
<td></td>
<td>• Relative user efficiency</td>
</tr>
<tr>
<td></td>
<td>• Temporal Efficiency</td>
</tr>
<tr>
<td></td>
<td>• Human Efficiency</td>
</tr>
<tr>
<td></td>
<td>• Corporate Efficiency</td>
</tr>
<tr>
<td>Context of Use</td>
<td>User</td>
</tr>
<tr>
<td></td>
<td>Task</td>
</tr>
<tr>
<td></td>
<td>Equipment</td>
</tr>
<tr>
<td></td>
<td>Environment</td>
</tr>
<tr>
<td>Optional Measures</td>
<td>• Unproductive Actions</td>
</tr>
<tr>
<td></td>
<td>1. Help Actions</td>
</tr>
<tr>
<td></td>
<td>2. Search Actions</td>
</tr>
<tr>
<td></td>
<td>3. Snag Actions</td>
</tr>
<tr>
<td></td>
<td>• Productive Actions</td>
</tr>
<tr>
<td></td>
<td>1. Productive Time</td>
</tr>
<tr>
<td></td>
<td>2. Productive Period</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td></td>
</tr>
<tr>
<td>Helpfulness</td>
<td></td>
</tr>
<tr>
<td>Learn-ability</td>
<td></td>
</tr>
<tr>
<td>Affect</td>
<td></td>
</tr>
<tr>
<td>Task Performance</td>
<td>(Subjective and objective)</td>
</tr>
<tr>
<td>User Effort</td>
<td>(Subjective and objective)</td>
</tr>
<tr>
<td>Effort for error</td>
<td>recovery</td>
</tr>
</tbody>
</table>

Similarly Jurek and Mary in 1993, proposed a questionnaire named as Software Usability Measurement Inventory (SUMI) (Jurek and Mary, 1993). It is composed of about 50 questions related to user satisfaction. This questioner was the part of MUSIC project. The main aim to develop this questioner is to provide the measures for satisfaction along with some other measures i.e. global satisfaction, Effectiveness, Efficiency, Helpfulness, Control, Learn-ability.

According to Nunnally and Bernstein (Nunnally and Bernstein, 1994), software usability cannot measure directly, they can only inferred indirectly through observed measures. They proposed the measures of usability as Perceived effectiveness, User satisfaction, and Performance evaluation.

In addition to these mentioned definitions and measures, there are many others given by different authors. However the definitions presented in this thesis are widely used in usability context. The summary which shows different attributes of
Usability will be explained later in this chapter. Usability definitions mentioned in ISO and IEEE standards are described briefly in next section.

2.1.2 Usability and Standards

ISO and IEEE also proposed their definitions for usability. The standards of ISO (ISO 9126, ISO 9241-11, and ISO 13470) are widely used standards from usability point of view. In addition to ISO, IEEE also proposed its definition in IEEE Std.610.12.

2.1.2.1 ISO/IEC 9126-1 Quality Model

ISO/IEC 9126 quality model describes the quality of the software in a set of six attributes. These attributes are further divided into sub-attributes. The main attributes defined in this model are functionality, reliability, efficiency, usability, portability and maintainability.

According to ISO/IEC 9126-1, the usability is defined as “The capability of the software product to be understood learned, used and attractive to the user, when used under specified conditions” (ISO/IEC9126, 1991). These attributes along with their sub attributes are shown in the following figure:

![ISO/IEC 9126 Quality Model](image)

Figure 2: ISO/IEC 9126 Quality Model

The sub-attributes for usability which are mentioned in ISO 9126 are Understandability, Learn-ability, Operability, Attractiveness, and Compliance as shown in following figure (Fig 3).
A brief description of usability sub attributes is summarized in the following table (Abran et al., 2003).

Table 4: Usability Sub-Attributes in ISO/IEC 9126 Quality Model

<table>
<thead>
<tr>
<th>Sub Attributes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understandability</td>
<td>Can user understand how to use the system?</td>
</tr>
<tr>
<td>Learn-ability</td>
<td>Is it easy to learn the system?</td>
</tr>
<tr>
<td>Operability</td>
<td>Does the user operate the system with normal effort?</td>
</tr>
<tr>
<td>Attractiveness</td>
<td>Does the user interface is attractive?</td>
</tr>
<tr>
<td>Compliance</td>
<td>Is the system according to specifications?</td>
</tr>
</tbody>
</table>

### 2.1.2.2 ISO 9241-11 Guidance of Usability

ISO 9241-11 is considering as the guidance of usability. According to ISO 9241-11, the usability is defined as “The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (ISO9241-11, 1998).

In this standard, the usability is considered in terms of user performance and satisfaction. According to ISO 9241-11, usability depends on the context of use and the level of usability will change as the context changes. The usability attributes are effectiveness, efficiency and satisfaction. These attributes are further divided into sub-attributes as shown in the following figure (ISO9241-11, 1998).
The brief descriptions of usability attributes are summarized in following table (ISO9241-11, 1998).

Table 5: Usability Attributes in ISO 9241-11

<table>
<thead>
<tr>
<th>Sub Attributes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td>How effectively the users achieve their goals?</td>
</tr>
<tr>
<td>Efficiency</td>
<td>What resources (Human, Financial) are use to achieve their goals?</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>How much the user is satisfied from the system?</td>
</tr>
</tbody>
</table>

The usability measures effectiveness, efficiency, satisfaction and context of use are sub divided into sub components. This standard proposed a framework which describes the usability components and relationship between them. This usability framework is shown in following figure (ISO9241-11, 1998):
The brief description of usability components mentioned in the usability framework is given in following table.

### Table 6: Usability components in ISO 9241-11

<table>
<thead>
<tr>
<th>Usability Components</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context of use</td>
<td>It include the users, tasks performed, equipment used (hardware/software), the physical and social environment in which product will be use.</td>
</tr>
<tr>
<td>Goals</td>
<td>The intended outcome which the users can achieved through the product.</td>
</tr>
<tr>
<td>Equipments</td>
<td>The hardware, software and other material used while using the system.</td>
</tr>
<tr>
<td>Task</td>
<td>The activities performed by the user to achieve his goals.</td>
</tr>
<tr>
<td>Product</td>
<td>The actual hardware/software (entity) which is being used by the user to achieve the goals and for which the usability is to be specified.</td>
</tr>
<tr>
<td>Environment</td>
<td>The settings in which the system is being used.</td>
</tr>
</tbody>
</table>

#### 2.1.2.3 ISO 13407 Human-centered design processes for interactive systems

ISO 13407 provides the guidance on human centered design activities throughout the development life cycle (ISO13407, 1999) for the systems. The Human centered design is described in this standard with the objective of enhancing effectiveness, satisfaction and performance of the user towards the system. These activities are performed in an iterative fashion. The four human centered design activities which are mentioned in this standard are:

1. Understand and specify the context of use.
2. Specify the user and their requirements.
4. Assessment against Requirements.

Figure 6: ISO-13407 Design Activities

- Understand and specify the context of use.
- Specify the user and organizational requirements.
- Develop design solution.
- Perform assessment against the requirements.

The above mentioned activities are carried out to integrate the usability requirements in the development phases. The Human-centered process is use to address the cultural, organizational and issues within the organization.
2.1.2.4 IEEE Std.610.12

According to IEEE, the usability is “The ease with which a user can learn to operate, prepares inputs for, and interprets outputs of a system or component”.

2.2 User Experience (UX)

Similar to usability of the product, the user experience is also perceived differently in the software engineering community. This section provides some definitions of UX which are proposed by different authors under different context.

2.2.1 UX Definitions

According to Niamh and Jurek, the concept of usability is not only the interaction between product and user, it also includes other aspects such as user satisfaction and the functionality of the product (Niamh and Jurek, 2006). In 2008, Virpi and Eija presented the user’s feelings toward the product. They analyze that there are many factors which influence the feelings of users. These factors may include the user’s expectations form the product, environment where the product is used and the ability of system (Virpi and Eija, 2008).

Preece et al. proposed that UX includes the following elements i.e. satisfying, enjoyable, funny, entertaining, helpful, motivating, aesthetically pleasing, Supportive of creativity, rewarding and emotionally fulfilling (Preece et al., 2002). Jodi and Katja suggested that there are three approaches which help in understanding the UX. These approaches are (Jodi and Katja, 2004):

- Product-centered
- User-centered
- Interaction-centered

According to them the interaction-centered approach is used to understand the user-product interaction. Moreover they also suggested that UX usually arise from this interaction.

In 2006, Hans-Christian and Jens (Hans-Christian and Jens, 2006) suggested that User Experience is not only the integration of quality attributes which are mentioned in ISO 9126 i.e. reliability, functionality or usability etc, but also it includes the concepts of visual design, marketing research for product like attractiveness, stimulation, fun, coolness, sexiness or any other proposition which can success the product.

Hassenazhl and Tractinsky defined UX into three components (Hassenzahl and Tractinsky, 2006) i.e. User’s internal state, the characteristics of the designed system, the context within which the interaction occurs. These components can be visualized in following figure:
According to them (Hassenzahl and Tractinsky, 2006), the User internal state means the states or situations which any user can have while using the product. These states include his needs of use, expectations from the system, his motivation level and his mood during the usage period.

The second component of the UX is the characteristics of the system. The characteristics are the properties of the designed system like how much the system is complex, its purpose, and functionality etc. The third component which influences the UX is the context. The context includes the settings and the environment where the system will be used. All these components influence the user to perceive the good or bad experience. Using the same idea and three components of usability, Virpi (Virpi, 2008) suggested the set of attributes of UX for mobile industry. He proposed three main components like Hassenzahl and Tractinsky i.e. System, User, Context (Hassenzahl and Tractinsky, 2006). The set of related attributes of these three components are shown in figure below.

<table>
<thead>
<tr>
<th>System</th>
<th>Context</th>
<th>User</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Involved</td>
<td>Physical Context</td>
<td>Needs Resources</td>
</tr>
<tr>
<td>Objects Involved</td>
<td>Social Context</td>
<td>(Mental/Physical)</td>
</tr>
<tr>
<td>Service Involved</td>
<td>Temporal Context</td>
<td>Emotional State</td>
</tr>
<tr>
<td>Infrastructure Involved</td>
<td>Task Context</td>
<td>Experiences</td>
</tr>
<tr>
<td>People Involved</td>
<td></td>
<td>Expectations</td>
</tr>
</tbody>
</table>
The examples of these related attributes are mentioned in the following tables (Virpi, 2008).

Table 7: UX components (System) and Related Attributes by Virpi (Virpi, 2008)

<table>
<thead>
<tr>
<th>UX Component → System</th>
<th>Attributes</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products involved</td>
<td></td>
<td>Mobile devices, web browsers, the web applications, web users</td>
</tr>
<tr>
<td>Objects involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Services involved</td>
<td></td>
<td>The internet connection, Internet service providers etc.</td>
</tr>
<tr>
<td>Infrastructure involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>People involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Products involved</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8: UX components (Context) and Related Attributes by Virpi (Virpi, 2008)

<table>
<thead>
<tr>
<th>UX Component → Context</th>
<th>Attributes</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical context</td>
<td></td>
<td>Any tangible environment, its temperature, rain, humidity etc.</td>
</tr>
<tr>
<td>Social context</td>
<td></td>
<td>Feelings, expectations and influence of other people.</td>
</tr>
<tr>
<td>Temporal context</td>
<td></td>
<td>The time that the user dedicates for the system to perform some tasks under some restrictions.</td>
</tr>
<tr>
<td>Task context</td>
<td></td>
<td>The tasks which the user has to perform to achieve the goals.</td>
</tr>
</tbody>
</table>

Table 9: UX components (User) and Related Attributes by Virpi (Virpi, 2008)

<table>
<thead>
<tr>
<th>UX Component → User</th>
<th>Attributes</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needs</td>
<td></td>
<td>The requirement or the goal of the user to access the system.</td>
</tr>
<tr>
<td>Resources (Mental, Physical)</td>
<td>Mental Resources:</td>
<td>The availability of the user with all concentration. Some time the user is mentally absent while performing he tasks. So mental resources mean putting concentration on the ongoing situation. Physical Resources: The physical resources of the user to perform the task like hand for keeping the mobile, ear for hearing the voice etc.</td>
</tr>
<tr>
<td>Emotional state</td>
<td></td>
<td>The mood of the user. If the mood of user while performing the task is good then the user experience will be high while on the other hand if the mood is not good then the UX will be poor.</td>
</tr>
<tr>
<td>Experiences</td>
<td></td>
<td>The experience of the user towards the product. If the previous experience is not good then the user will expect for failure again, while if the he accomplish the tasks and satisfy with the product then UX will be high.</td>
</tr>
</tbody>
</table>

All these components and related attributes collectively influence the user due to which the UX is changed. If the user accomplished his task happily and without much difficulty then the user experience will be good, while on the other hand if he face problems and is not able to perform his task then his experience towards the
product will be poor. In graphical form the idea of User Experience by Virpi can drawn in this way (Virpi, 2008).

Unlike Usability there are many other identifications of User Experience is found from the literature. The researcher and the software industry are not yet agreed on the common identification of UX. The reason behind is that there is gap between the industry and the academia who proposed the definitions.

The relationship between usability and UX can be found from web product’s point of view. The relationship which developed between these two terms will be discussed in later chapters (see chapter 4).
This chapter provides an extensive literature review on web usability. In this chapter the different definitions and concepts on web usability are discussed.
3.1 Definitions

The definition of usability from ISO 9241-11 (ISO 9241-11, 1998) can be adopted to the context of web industry. The web usability might be defined as the achievement of goals from web applications effectively and efficiently which satisfy the web user.

Some other identifications of web usability are found from the literature. Although the main concept and theme of all these definitions is taken from ISO 9124-11, but the variations is present due to changing in context.

According to Shahizan and L.Feng (H. Shahizan and L. Feng, 2005), the usability consists of seven following factors: Screen appearance, Consistency, Accessibility, Navigation, Media use, Interactivity and Content. But it depends on the development organization that they will focus on all these factors or consider some of them during the development of web applications.

However Tom (Tom et al., 2002) suggested that web sites is usable if the user can achieve their goals effectively, easily and quickly. Moreover they also proposed that usable websites would have following characteristics:

- Functional correctness
- Efficient to use
- Easy to learn
- Easy to remember
- Tolerant of error
- Subjectively pleasing

Approximately the similar concept was given by Banati and his colleagues (Banati et al., 2006), According to them web usability is not composed of only efficiency, effectiveness and satisfaction, but there are some other factors as well which they point out in the form of pyramid. These factors are:

- Appearance of the site
- Work satisfaction
- Emotional satisfaction
- State of features
- Trustworthiness of the site

According to them state of feature is the bottom of the pyramid and the satisfaction level will be increase as long as all the below level factors would be satisfied.

According to Vince in their article (Vince et al., 2005), the interaction of user with the product can be measured by a set of usability attributes. These may includes the range of users i.e. the specific group of users, the training they have, the no. of tasks and the scenarios. Jakob Neilsen (Neilsen, 1990) defined usability by mentioning the five attributes of the interface:
- Easy to learn
- Efficient to use
- Easy to remember
- Causes few errors
- Pleasant to use

The ease of navigation and easy search is the main concept of web usability according to Nah and Davis (Nah and Davis, 2003). According to them web usability is the integration of tasks like locating the information and understanding where the user have to go after performing his task without using any extra effort.

The elements which enhance the usability of the web applications include the convenience of the site and loading speed of the web page etc. (Efthymios, 2004). According to authors the components of web usability are *Convenience, Site navigation, Information architecture and search facilities/search process, Site findability and accessibility, Site speed, Ordering/payment processes.* These brief descriptions of these components are given in following table (Efthymios, 2004).

<table>
<thead>
<tr>
<th>Components</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience</td>
<td>The web users relate the convenience of web application with easy and quick retrieval of information through fast browsing, online shopping and easy online transactions.</td>
</tr>
<tr>
<td>Site find-ability and accessibility</td>
<td>As every user search the sites through different key words and different search engines. It is important for web designer to use consistent and efficient search engines. Moreover by developing different types of web browsers which can be run on different platform can be useful in increasing the accessibility of the web applications.</td>
</tr>
<tr>
<td>Site speed</td>
<td>The downloading speed of the web page influences the experience of the user. The designers should understand this factor before designing the web page. Using so many images and flash animation may decrease the downloading speed of the web page which can affect the UX.</td>
</tr>
<tr>
<td>Site navigation, Information architecture and search facilities/search process</td>
<td>The easy, available and fast loading navigation is the demand of every web user. Similarly the information retrieve from the search engines should be reliable and fast, so that user can trust on this information.</td>
</tr>
<tr>
<td>Ordering/payment processes</td>
<td>In e-commerce web applications where online payment or ordering processes are involved should have consistent, easy, simple and secure transaction processes. The lengthy and complex processes increase the irritation and frustration of the user from the web application.</td>
</tr>
</tbody>
</table>
4 USABILITY ISSUES

A bad web site is like a grumpy salesperson
(Jakob Nielsen, 2001)

This chapter provides a detailed overview on the issues and challenges that the web users encounter when they are using the web applications. In this chapter initially the background will be stated, which briefly describe how web users can face the problems.

There are four factors which affect the usability of web sites; their brief description will be explained before discussing the major issues found from literature review.

The major issues which are found after literature review and some from observations will be mentioned with brief description. The bad usability is the foundation of these issues which leads to bad user experience. The influences of usability on user experience will also the part of this chapter.
4.1 Background

With the advent of internet and globalization (Whitehead, 2006), the use of applications is also experienced an extensive growth. Now most of the information can be accessed through internet, whether someone wants to buy a product, seeking the information regarding hospital or booking the tickets of trains. Students need to view latest updates on their assignments or university schedule and the graduates can browse the latest job postings through employer’s websites.

According to Ginige and Murugesan (Ginige and Murugesan, 2001), the web applications and websites with most complex and many diverse natures are available for diverse nature of users. This web-based era has set a trend which is also continuing. Due to changing the condition of world society from different point of view (politically or socially) the users need effective communication (Mosconi et al., 2008). The birth of e-newspapers (electronic newspaper) plays an important role in spreading the news throughout the world. Although every country have newspaper in their native language but the basic structure remains the same i.e. in the form of headings, news in columns, national or international pages for news etc (Mosconi et al., 2008).

Similarly internet plays a vital role in developing the communication between local citizens and the municipalities (Jong de, 206). Now it is possible for citizens to access the information any time. This information may include some announcements from the government or advertisements from different shop owners etc. All this happened due to extensive usage and awareness of World Wide Web.

Taking a glance on business, it is found that irrespective of physical or cultural boundaries, people are able to continue their business by taking the advantage of WWW. Now it is possible for a person to just log on internet and start the commerce. Although the factors like trust and security influence e-business but still it growing as long as the users become more aware about the technology (Poong et., 2006).

The university students use internet for seeking the information. According to Survey in 2005 on American teenagers and their parents, it was found that 42% of university students use internet when registering the university programs (Kane et al., 2007). The academics information, university news and events, examination date sheets and results, access of articles etc are all available mostly on university websites (Kane et al., 2007).

In addition to above the inclusion of web access on devices (e.g. Mobiles) contributes expansion in accessing websites. The users of websites vary with age, education, expertise, with different goals for accessing the websites and may have disabilities like blindness. All these factors motivate the organizations to develop such types of websites which are more accessible and usable for the users (Petrie and Kheir, 2007).

All the above mentioned services and most of others are the blessings of internet for the web users. The user can be satisfied if the web site s/he is looking fulfills his requirements with desire quality level (Bhatti, 2005). The diverse natures of users
have different quality level and requirements. They have different expectations from the product.

The development organizations try to satisfy the users by producing the desire functionality as much as they can, but in doing so sometimes the risk related to collision of different quality requirement may arise (Wohlin and Henningsson, 2002). For example the shop owners while developing the web application demands for listing the products as many as possible and using pictures which attract the customers, which may increase the attractiveness of the web site but on the other hand it may slow the downloading speed of web page (Shrestha, 2007).

Usability is an important aspect of web development. The web users face different type of challenges (see later in this chapter) related to usability. But a gap is present between users and the development organizations. Although extensive work has been done to identify the issues related to web applications, but it is difficult to search and useful for people, so this thesis will contribute in identifying the major usability challenges in a single report.

After extensive literature review during this thesis, it is found that four factors i.e. user, type of tasks, context and technology (Bruno et al., 2005) can be considered as the main categories of these web usability issues. The reason for this categorization is that only these factors involve in performing the task. The User has some needs or goals (Task) which he wants to achieve. This goal can be achieved through some tools or techniques (Technology). There should be environment (Context) in which the user perform this task.

4.2 Factors Affecting Web Usability

According to Bruno et al., (Bruno et al., 2005), there are four factors which influence the usability of web applications. These factors are:

- User of the web application.
- Type of Tasks performed by the user.
- Context in which the user performs his intended task.
- Technology used by the user to achieve the task.

All above mentioned factors are discussed from web industry point of view, as the main focus of this thesis is to identify the usability issues from the perspective of web industry. The following figure shows the four factors. This figure is drawn by inspiring from the idea of Bruno (Bruno et al., 2005). In this figure the red shape (Lightning Bolt) indicates the locations which affect the usability of web sites.
4.2.1 User

User is the main entity, who is affected from the web application (Hackos and Redish, 1998). According to Bruno (Bruno et al., 2005) the users can be primary users, secondary users, buyer or seller. All these types of user may be varying with age, expertise and skill by categorizing into novice, advance beginners, competent performers and experts. If the user is novice, then learn-ability is an important attribute for him, while for expert user the more focus should be on efficient use.

The psychological feature is present in every type of user. This characteristic has sub-factors like motivational, attractiveness, aesthetics. The psychological classification of users is listed in the following table (Bruno et al., 2005).

Table 11: Psychological Features of User by Bruno

<table>
<thead>
<tr>
<th>Psychological Features</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivational Feature</td>
<td>• Work itself (<em>Challenging, Fun, Meaningful etc.</em>)</td>
</tr>
<tr>
<td></td>
<td>• Achievement</td>
</tr>
<tr>
<td></td>
<td>• Responsibility</td>
</tr>
<tr>
<td></td>
<td>• Advancement and growth.</td>
</tr>
<tr>
<td></td>
<td>• Recognition</td>
</tr>
<tr>
<td>Attractiveness</td>
<td>Motivation, Arousal etc.</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>Balance, Density, Unity, Regularity etc.</td>
</tr>
</tbody>
</table>

In addition to psychological features, according to Marcus and Gould (Marcus and Gould, 2000) the *culture* is also an important characteristic of user. The culture in web applications can be a specific locality, organization or country. The accessibility plays an important role in the life of web users with disabilities. This

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Figure 10: Identification of Web Usability Issues
characteristic also affects the user in different ways like the tasks of a visually impaired user can be affected to his disability.

Although these characteristics are not much affected while measuring the usability of traditional software but they are considered in achieving the usability of web applications due to its diversity.

4.2.2 Type of Tasks

By the type of tasks, Bruno (Bruno et al., 2005) means which type of web sites the user is using to achieve his tasks. According to Deshpande et al. (Deshpande et al., 2002), the main categories of web applications are informational, interactive, transaction, workflow, collaborative work environments, online communities (market places), web portals, web services.

The interface design composed of structure, navigation and presentation describes the interaction style of each web application (Fraternali, 1999), while the interaction styles are controlled/constrained by the technology. The usability (especially learn-ability, efficiency and satisfaction) of web applications is affected by the task types, complexity and usage.

4.2.3 Technology

According to Fraternali (Fraternali, 1999), there are many tools which help in web development like visual editors and site managers, hypermedia web generators, web database gateways, web-based form editors and database web publishing wizards and model-driven application generators.

The characteristics like internet facilities and system variables (visual display capabilities, input devices limitations) have impact on usability of web applications (Lee, 1999). Visualization of an interface, system variables, and internet latency should be considered during the development of web applications as the diverse nature of devices are enable with internet.

4.2.4 Context

The industry (Glass and Vessey, 1995), contextual (Finkelstein et al., 2002) and customization (ANZSIC, 1998) are three characteristics of context which have been found from the literature. An industry classification describes the interaction environment for the user. This classification emphasizes the requirements of industry with respect to usability. The major industry classifications include agriculture, mining, manufacturing etc (ANZSIC, 1998).

Similarly according to Finkelstein (Finkelstein et al., 2002), as web applications can be accessed by any one (user), any time (time), anywhere (location) and by any media (network), customization of these web applications also affect the usability.

All these four factors i.e. user, type of tasks, technology and context play an important role in the usage of web applications. The next section will describe the usability issues categorized based upon these factors. The categorization of these issues is also the contribution of this thesis.
4.3 Web Usability Issues

Although web applications are very helpful and play an important role in every field, there are some issues which the web user encounters when he is using these web applications. These issues can be summarized in categories according to the factors i.e. User, Task, Technology, Context which are mentioned by Bruno (Bruno et al., 2005). These issues are categorized on the basis of judgment and the descriptions of these issues.

Although usability issues discussed below are particularly identified for web industry but they can also be found in traditional software such as reading complexity, literacy, navigation and scrolling. This thesis is mainly have focus on web usability and UX from web application point of view, so all the issues which user can face while using web application are explode in next sections.

4.3.1 User Category related Issues

The usability issues which can be categorized in user category are described in this section. The summarized issues are given below:

- Reading Complexity
- Understanding location/Path
- Old age user’s problems
- Literacy
- Accessibility
- Trust and Transactions
- Security

4.3.1.1 Reading Complexity

According to Chadwick-Dias (Chadwick-Dias et al., 2003), old people always take more time before clicking or submitting the button on web applications. They read all the text written near the button or links, think several time the reaction of clicking or pressing the button. It happens because most of the time a lot of text has been written especially when user input is required; it may cause confusion and spend extra time.

Similarly reading the text on web sites is also difficult due to addition of items like images, text, forms, banners etc (Arch, 2009). It becomes very difficult for old people to locate the desire information. According to Spool and et al. (Spool et al., 1998), the success rate of user task depends on locating the desire information. Spool’s idea (Spool et al., 1998) can be written in following equation form.

\[ \text{Reading Level} \propto \text{User Task Success} \]

The electronic newspapers are very common nowadays. According to Lee (Lee, 1999), large numbers of studies have proved that page background, height of displayed characters, use of colors and composition of contents affect the readability of online information. The splitting of text across the screens especially in small displays also affects the reading ability of the user. The information retrieval rates in web pages are very important from reading point of view (Dillon, 1992). In mobiles
due to narrow display, an extensive scrolling caused difficulty in locating and reading the contents (Shrestha, 2007).

4.3.1.2 Understanding location/Path

The understanding of information flow, location and path is very important to complete the task efficiently in traditional software as well as in web applications. The old people mostly confused and cannot understand the location (i.e. the web page), where they are (Chadwick-Dias et al., 2003). The generation of popup windows diverts the attention of user from their task, due to which most of time the user forget where and what he was doing.

Sometimes, the use of pagination to display the information on more than one page can confuse and lost the user from its location (Dillon, 1992). The links and navigation plays a vital role in web application. The misleading links often diverts the user to wrong locations which cause frustration and annoy the user (Spool et al., 1998).

4.3.1.3 Old age user’s problems

The old people encounter a lot of issues when they are using the web sites. According to Becker (Becker, 2004) the age factors which impact the usability of web sites are: vision, cognition, motor skill and literacy.

• Vision

The aging factor contributes in reducing to concentrate to close objects. The reduction of elasticity in lens affects the ability to see objects. All these factors related to visualization affect the use of web sites. The reading speed, navigation, search and other tasks are badly affected due to eye fatigue. Similarly, for many old people the font properties; background images also caused interruption in completing the tasks (Charness et al., 2001).

• Cognition

The ability to memorize, keeping concentration and attention affect the use of websites by old people (Charness et al., 2001). The poorly and complicated navigation and inefficient search facilities placed negative effects on the performance of old people.

• Motor Skills

The motor skills mean the speed at which the user can click a mouse or link and scroll the web page (Hawthorn, 2000). It is found that the motor skills are affected by the age factor. The reasons which cause the bad motor skills include the weakness, trembling, pain in joints, swelling or disability due to which the user is unable to grasp the things (Arch, 2009). The old adults take more time which leads to less smooth and irregular movements of mouse. The motor skills also affect due to consciousness about clicking the link and scrolling the page.

Moreover due to irregular motor skills and hard to focus, the old people face hard to interact with small elements on web page (Chaparro et al., 1999). The section of text on the web page and pointing the elements which required curser positioned affects due to bad motor skills. Sometimes old people and some other people are
unable to distinguish between green, dark blue and black color which also leads to sensitivity in movement of mouse.

4.3.1.4 Literacy

It is found that after age sixty five, the age influenced negatively on literacy skills (Becker, 2004). As it is difficult to remember and learn new processes to work with web applications for the older people. The educational level and ability to understanding of computer also caused hurdle to interact actively with web applications.

Excess use of abbreviations and symbols affect the understanding by old people as well as the people who are computer illiterate (Selvidge, 1999). Most of web applications use English as a default language, but sometimes the web user especially old aged people do not know English language. This caused the barrier between user and application and the user is unable to achieve his task efficiently.

Although the user don’t spend time to learn and understand the technology and new software especially the adult people, due to which they reject the application due to which they face problem when they use new things like web sites etc.

4.3.1.5 Trust, Security and Transactions

The web users rely and trust on the information they received from web sites. The user performs search by using different criterions for intended information, but most of time the information received is not updated which cause the breaking of user’s trust from web application and the owner of that application. For example searching for job or reading news online, the updated information are very important aspects for web users to develop trust on these news. Similarly entering password in mobile devices is a big challenge which the web user faced. As in mobiles the typing is difficult and anyone can view what the user is entering.

The user needs high trust level while using the e-commerce sites. The user leaves the site if no trust is developed with site. The trust worthy and secure completion of transactions like online shopping, filling out of forms which needs personal information, managing accounts using username and passwords are the aspects which high the trust level of the user.

The hackers usually steel the credit card numbers when users shop online. Due to this user avoids and left the site without purchasing anything. The development of user trust towards the websites is an important and challenging task for the designers.

4.3.1.6 Accessibility

It has been seen from many studies that accessibility is a very common problem which the user encounter while using the web application. The accessibility issues are common in old aged people or the users with any type of disabilities such as blindness, hearing problems etc.

The old aged users face difficulty while accessing the information, if it is displayed in large tables (Chadwick-Dias et al., 2003). According to Andrew Arch
(Arch, 2009), putting a lot of material on a single page makes problems for user to locate their desire information.

Moreover changing the navigation and interaction between different sites or within the same site makes confusion for the daily visitors. To resolve the accessibility issues of font properties, Andrew suggest that always use large fonts. Use of Arial/Sans Serif can be good option for web site text (Arch, 2009).

4.3.2 Type of Tasks Category related Issues

The issues which can be placed in the type of task category are given below. The type of task according to Bruno (Bruno et al., 2005) is the type of web site and the items placed in this web site.

4.3.2.1 Search and Search Engines

Search is an important functionality in any web application. The search facility can be used to locate the information within the web page or throughout the world. Although many search engines have been developed which help the user to complete the searching tasks. The well known search engines include Google, Msn, Wikipedia, Yahoo Search and many more.

But there are some problems that the web user complaint when they are using the search facility. According to Chariton and Choi (Chariton and Choi, 2002), initially the simple search with one text box, a search button and a link to advance search where different options can facilitate the search is used are display on the web page. But unfortunately, it is seen that most of time user neither pay attention on this link nor it works correctly.

The key words or phrases are used to search the desire information. Many users who have less expertise with computer don’t use the correct key words for their searching. For example the search with tired or tried affect the search results (Spool et al., 1998). The users are unable to understand the working of search engines, as some web sites use multiple search engines like onsite search or search through internet, to provide the search facility to the users.

The frustration and dissatisfaction from the user towards the search functionality proves that inefficient search engines are the main hurdles in effective use of web sites (Lee, 1999). The query which is formed after user input is not so efficient that it return the desire results. The plural, hyphens, special characters, wrong phrases influence the effectiveness of search query (Tom et al., 2002).

Another main problem due to which the search engines act unexpectedly is the use of frames in web page (Tom et al., 2002). The other frames on web page don’t refresh and interact fine with frame where search functionality is given. Sometimes the searched results are as large in number that they cannot display on one page. So in this case the pagination is used which takes more time as compared to normal time to display the results (Dillon, 2002).
4.3.2.2 Fonts and Links

Links are used to move from one web page to other page. The wrong link labels and in appropriate colors for visited and active links caused confusion when the user want to use the links. Moreover a lot of links redirect the user to same or wrong page which frustrates the user and major time is wasted to find the correct path and location of the desire web page (Selvidge, 1999). The web designer put a lot of links on the page in order to facilitate the user, but in practice the users confused when they see a lot of links at once and are unable to locate their desire link.

Usually the color of link changes when user visits the link once, just to distinguish between visited and unvisited links. Although the designers use cascading style sheets (CSS) to distinguish the colors but it don’t work so efficiently due to in accurately use of CSS files by the developers. According to Spool (Spool et al., 1998), the user misleads due to unchangeable color of links on images. This makes challenge for designers as well. It is commonly observed that links have different color with underline to differentiate with the text on the page, but if the link color is same, the users especially old aged takes more time to locate the links.

Due to increase in number of web pages and need for consistency throughout the application, the font size and color should be consistence and according to the conventions. But it is found that on one side CSS provides consistency in font color, types and size but on the other hand it restrict the change font size and provides the fixed size (Tom et al., 2002). Most web sites use font size of about 10, but it is found that the font less than 12 is not clearly visible to old age people.

Due to difficulty in concentration, it is hard for people with disabilities in general and old people in practical to locate the links (Chadwick-Dias et al., 2003) due to this they click on table headings, text, outside the border, icons etc. So the links should have different which differentiate them from plain text.

4.3.2.3 Navigation

According to Lee (Lee, 1999), the size of links in web sites affects the usability of the web page. For example the height and breadth of the navigation bar on page whether it is on the top of page or on left side, it affects the usability of whole web site. It is found that main links on menu type navigation bar are slow and take a lot of time to open the sub menu navigation. Moreover the browser also influences the navigation of the web sites. The Back Button is widely used instead of original navigation links.

It is researched that about 30-40% of all navigations actions are performed through back button. It may mislead the user to wrong page, because Back button always redirect to the previous page not on the first page of the application. For example when a user buy something online and add to his basket, then instead of using navigation or links the most of user press the Back Button of the browser, and as a result the previous page with empty basket will be display in front of user. It is very frustrated and annoying for the user to perform the same function twice (Lee, 1999).
In case of frames, it is not possible to change the appearance of the page. Because in frames the whole frame is refreshed at the time of click, which means that user may experience the low downloading speed. This may cause the user frustration and annoyance (Tom et al., 2002).

Many developers use the shell technique (Tom et al., 2002) to develop the web sites. In this technique first the navigation is developed and then adds the contents in it. But in practice it is found that web sites developed in this manner are hard to use as, the user unable to find the category links and the specific location of contents.

**4.3.2.4 Display Size, Page Size and Scrolling**

Usually web page is more in vertically or horizontally than the display size of the screen. It happened due to less concentration on usability of the web page. It is suggested that while reading the contents online, the readers establish a visual memory of locations of items (Tom et al., 2002). So scrolling is much more efficient as compared to pagination for long web pages. According to Dillon, scrolling the pages is better due to speed and the user will remain on the same page. But in pagination the whole page will be first downloaded and then display all the contents which take a lot of time.

Like Shrestha (Shrestha, 2007), Dillon (Dillon, 1992) also point out that usability is much better on bigger display as compared to small display. The page size and its weight should be normal and as less as possible. Some users may have high speed internet connection and they can view the page, but on the other hand most of people suffer with bandwidth delay. The larger page with a lot of images, flash animations and text may increase the page display time which leads to delay the user tasks. It can be view in following equation as:

\[ \text{Page Size} \propto \frac{1}{\text{User Efficiency}} \]

From the above equation, it can be seen that the increase in page size directly affects the user efficiency. Sometimes the text use on web pages will be stretched breadth wise which cause horizontal scroll bar on the bottom of page (Chadwick-Dias et al., 2003), usually the users don’t notice and lose some information.

According to Tom et al., (Tom et al., 2002) the use of frames with small window size is not good. The web page elements like logo, navigation, headers and advertisements use more than half window, while the actual contents have very less space for display. The web users use key board buttons or the wheel of mouse to scroll the page. If frames are used then it will be uncomfortable for users with motor disabilities. The scrolling is used whenever the display size is small as compared to page size. The display screen restricts the whole information to display at same time.

Although CSS are good but they are not always facilitate the user. It is easy to display the news in column like newspaper for large display but the same format/layout is not appropriate for screens with small display.
4.3.2.5 Images

Images are one of the items which contribute to enhance the look and feel the web sites. But lot of images on web page takes more download time which may irritate the user (Tom et al., 2002). If the number of images on web page is increased then the page size will also be increase, as a result more bandwidth is required to download the page and will be difficult for user to understand the page.

According to Spool (Spool et al., 1998), it is very frustrated for user to wait till the image downloading is complete. The user goes for next link or leaves that page if it takes extra time. Usually different types of flash animations and graphics are used in web page; they are very annoying and divert the concentration of user from his goal. It also increases the page size which requires more time to display. The animations which open in new windows (Popup windows) confuse the user and mislead from their intended goal.

4.3.2.6 Popup Windows

The web application owners insist the developers to use such methods which help their web sites to be more active in search results. To accommodate this requirement the developers use popup windows. They usually contain the advertisements and popup (immediately cover the browser window) whenever users click on link.

The popup windows divert the user from his actual goal and user sometimes forgets his actual location and mislead to some other page (Tom et al., 2002). The user becomes very frustrated and irritated whenever window popup at once during his work. It is seen that some of pop ups are build to transfer the virus and used to hack the computer of user through these pop ups.

4.3.2.7 Updated information

The web sites are used to advertise and spread the information throughout the world. So, it is important to update the information on the web sites. Sometimes organizations post jobs but after deadline they do not update the information, due to which the user got confuse and apply for old jobs again and again.

Similarly according to Chariton and Choi, user mostly obtained different information about fare or reservation of air tickets from the website and from the agent (Chariton and Choi, 2002). Sometimes the information is not given on the web sites or the link is broken which cause frustration for the user.

4.3.2.8 Transactions processes

The web sites which require processes for transactions are called the transactional web sites (Bruno et al., 2005). It includes the ecommerce sides, the applications which require online money transfer or some authentication is required. The users faced problems when they want to end their shopping on the web sites. Sometimes a very long checkout process makes the user frustrated. The security issues when entering the credit card number is another issues, but the form filling is very irritated process for the users.
Similarly when applying for job or taking admission, the lengthy online forms with mandatory fields like hobbies, aims etc (these fields can be optional) irritate the user. Some airlines demand to create the account on their website just to view the fares. It takes a lot of user time to compete his task and some time he may leave that site and search for alternative.

4.3.3 Technology Category related Issues

This section discusses the usability issues which the user faces due to technology. The technology refer to all the hardware, software and the services which collectively used by the user. It includes the computers, internet services, networks, mobiles, PDAs etc.

4.3.3.1 Networks

Internet is the combination of interconnected networks. The web applications can be accessed through internet, but before internet the interconnected networks also take part. Different type of networks affects the traffic between two sides. Similarly in case of mobile network, the Quality of Service (Qos) of mobile networks is different than traditional network (Springer and Spriestersbach, 2004). The network type and the bandwidth influenced the browsing of web sites.

The websites with lot of images, flash animations and the elements which increase the page size may decrease the downloading speed of the web page. The websites visited through mobile phones influenced due to internet connectivity, display size and mobile device.

4.3.3.2 Device Heterogeneity

Numerous devices are used to access the internet (Springer and Spriestersbach, 2004). These devices include desktop computers, laptops, palmtops, mobiles, PDAs etc. Each device has its own limitations towards the internet. Some devices are not good in displaying the large web pages. In case of mobiles, the display screen is small due to which complete web page is not display at once, so scrolling is required which cause frustration and disturb the user in his task.

According to Springer and Spriestersbach (Springer and Spriestersbach, 2004), the diversity of devices requires more effort for developing web applications for mobile and desktop computers. As each mobile series have different versions and models with different functionalities and design, so at one end maintaining all the series for mobile vendors and making them compatible with web standards while on other hand for web designers to design the site in such a way it fulfills the requirement of user is challenging now.

4.3.4 Context Category related Issues

The context plays an important role in every function of daily life. The change in context influence the usage and perceiving the things. In this section the usability issues which can arise due to different in context between user, designer, or any other reason will be describe briefly.
4.3.4.1 Context on Mobile

According to Springer and Spriestersbach (Springer and Spriestersbach, 2004), the applications are influenced by the change in context. The software engineering processes and the quality of product is change and influenced by the context of developer and the context of user (Springer and Spriestersbach, 2004). According to authors usability is more affected by the change in context in mobile or in traditional software.

Most of users do not use mobile for internet and services other than call and Short Message Services (SMS) functionalities, as they are not comfortable with speed, cost and browsing on mobile (Shrestha, 2007). The designers design the websites by considering the requirements from the customers and very less number of web applications is developed by considering the context of web users. The web page is design with a lot of graphics, animations and font size for desktop PC, but when user access the websites through PDAs and mobile, they face problems.

Some developers think that for user input, the selection widgets i.e. drop down box are more easy then writing the numeric input, but in mobiles and small display, it is not easy to select the items as they need more focus and concentration to small display (Springer and Spriestersbach, 2004).

The operability for the mobile is also affected due to surrounding environment. For example a user inputs the data while he is on the vehicle, so it may affect his task time and accuracy as well. The content and information planned by designer are very much different in context as compared to the information perceived by the user on mobiles (Shrestha, 2007).

4.3.4.2 Web Searching

The context plays an important role in web searching. As user input is required to search the information and sometimes user also choose different criterions for appropriate and fast search. But it is found that user most of the time use inappropriate terms and are not trained in search, due to which they suffer wastage of time and frustration (Dillon, 1992). The users are not aware of exact processing flow of search engines, so they often choose wrong criteria for their search.

It is commonly seen that while searching for flight information from the airline websites, the system usually require the input of codes or abbreviations of city or country but the user input city names or other terms, which may cause the empty result for the user. Similarly on the other hand, after searching the locations, city codes or abbreviations are display to the user which cause confusion and irritable for the user (Chariton and Choi, 2002).

4.3.4.3 Stakeholder's culture

Stakeholders are the main entities of any system and environment. The stakeholders are ones which may cause in the success or failure of web applications. As websites are accessible throughout the world and according to Web 2.0, web is everywhere for everyone. So before designing the website the intending users should be known.
Unfamiliar language and symbols make the website useless if they are not understandable to the users. In airlines websites they use terms legs or segment to describe the connecting flights, sometimes it is very confusing according to culture and person to person (Selvidge, 1999).

The web based ERP systems are widely used now a day. Most of systems especially where IDs or serial numbers like employee id =14 etc are used, the users reject the applications to use. The reason is that different countries have associated some different meanings with digits, like in Hong Kong ‘4’ means death and ‘8’ means wealth. If the system generates ‘4’ the employees cannot accept that and want to change it.

Similarly the cars with ‘8’, string of ‘8s’ or string of ‘Bs’ in number plates are sell with high price as compared to those which have ‘4’ in their number plates. The building floor numbers, telephone and account numbers are very carefully chosen by keeping the digit’s homonyms issue in mind. These cultural norms are not usually addressed in web based systems due to which employees are not happy with information gather from such systems. They try to avoid or use applications with bad hearty due to the cultural norms (Davison, 2002).

All the above discussed are the issues which the user encounters when he is using the web applications. There must be some more issues are present which are not yet identified. The next section will describe the effect of usability issues on user experience. As the issues which discussed above have influenced on user and as a result the user experience towards the application is good or bad. So, it means usability influence the user experience.

4.4 Usability and User Experience

According Niamh and Jurek, usability is not only the interaction between product and user, it also include other aspects like the user satisfaction and the functionality of the product (Niamh and Jurek, 2006). Similarly in 2008, Virpi and Eija analyzed that there are many factors which influence the feelings of users. These factors may include the user’s expectations form the product, environment where the product is used and the ability of system (Virpi and Eija, 2008). From above research and by different authors it is proved that usability of the product affects the user experience.

Good Usability of product results high UX. If usability is not according to level then the user must face difficulty in using the product and may suffer with different challenges which have been discussed above. It is shown from sections 4.1 and 4.2.1 that product users are differ from each other and every user has his own requirements and expectations from the system. Taking this idea in mind it can be conclude that usability of system can vary from user to user. For example if one user wants large font size with high resolution screens and intended web application fulfills his requirement, then usability is good in this case and he has high UX.

On the other hand if user requires normal font size with a lot of images on web page. Moreover the download speed is also up to the expectation level. If these requirements are not fulfill and he is not able to complete his task then bad usability is perceived with low UX. From this example it is clear that usability is good for one user but at the same time it is bad for other.
Recalling the definition of usability by ISO 9124-11 i.e. “The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (ISO9241-11, 1998).

Similarly using the idea of usability components, Virpi (Virpi, 2008) suggested System, User, Context are the main attributes which affect the UX on the basis of perception of Usability of the product (See Tables 7, 8 and 9). By mapping these two main definitions it is shown that good usability plays an important role for high UX by considering the specific context in which the product is being used.

This section will briefly describe that how usability can affect the user experience both in good and bad ways. This section is analyzed after extensive literature review and from the personal observations.

4.4.1 Frustration

It is found that usability is not only concern with visual and beauty of the product, but in fact Efficiency of use, Learn-ability, Memor-ability, Errors/safety, satisfaction (Nielsen, 1993) are the main attributes of usability. The user is frustrated when s/he cannot complete his task efficiently e.g. if user wants to read the newspapers online, then due to slow speed internet connection or if the web page is so heavy that it takes more time, then the user become frustrated and show his irritation towards the site. Most of time the user prefer to leave the sites which cause frustration for him.

According to Chadwick (Chadwick-Dias et al., 2003), the user feels frustration and annoyance from the popups. These types of windows and activities make the user depress and mislead from intended task due to which he is not able to complete his task efficiently. Although the look and feel of the product is good but if it is not according to user’s satisfaction, then we can’t say that user has good experience with the product.

By taking the example of searching on web applications, user feels irritation when entering the same search string again and again. The reason for this irritation includes may be he is not entering the correct search string or search engine is not enough capable to output the results with input string. The airline’s websites lose a lot of users only because the flight schedule or fare information is not updated on the websites, as a result the user lose his trust and frustrated when he do not receive the information which he is looking for.

4.4.2 Time

The unexpected behavior of the search engines and useless results restrict the user to complete his task on time. The user spends a lot of time in using the search facility of the web application (Hawthorn, 2000), due to which most of users are unable to complete their task. Most of them leave the site without any fruitful activities.

In addition, the web pages with a lot of graphics take more time to display (Hawthorn, 2000); the user cannot stop his activities and hold him until the whole web page is display. The slow internet connections, consuming high bandwidth and slow display of web page consume that time of user which he can planned for other
activities. Similarly the popup windows, broken, unfamiliar or wrong link labels mislead the user from his intended goals and spend his time in useless activities. Looking on web surfing of old aged people, it is found that the user needs more time to focus and concentrate on text and links due to inappropriate font size (Becker, 2004).

4.4.3 Cost
Despite of powerful development in World Wide Web, most of users do not have internet connections at their homes or work places. The users visit internet cafes to access the internet due to which they have to pay a lot. The users spend a lot of cost even then he cannot complete his task and is not satisfied due to bad usability of the web sites. The internet cafes have low speed internet connections which unable to download the web pages with rich graphics. This leads to bad UX and the user is unable to continue his task as it costs him more than his expectations.

4.4.4 Referral
The user with bad user experience will never refer the web sites to his/her friends. If the user was unable to complete his tasks and face problems when he used the web sites previously, then for sure firstly he reject to use the same website again and secondly he will not recommend his friends to use which results the decrease in number of users. The poor UX with e-commerce website cause decrease in online sale of products and affect the business.

4.4.5 Trust
Trust and security are the main features which every user wants when he is buying anything online. The hackers, phishing sites, viruses, unexpected generation of popup windows and fake information are the common elements due to which the user loses his trust from the websites. All these elements can be considered as elements of usability. The user will close the web site and visit another ones, if he is not satisfy with the trust level of that site, because some web sites demand for personal information i.e. credit card numbers, home address, bank account information etc, which the user avoid and leave the site immediately.

The aim of above brief discussion is to identify that how usability can affect the user experience. Bad usability caused the above mentioned factors which in turn lowering the UX of user. There are many other factors of usability which also have impact on UX. Most of web sites and online shopping carts lose its customers just because of poor usability with low trust level.

As according to Nielsen usability can be defined in terms of five factors i.e. Efficiency of use, Learn-ability, Memor-ability, Errors/safety, satisfaction (Nielsen, 1993). Web application is said to be successful and have high UX if it is according to user’s expectations and s/he is satisfy. Users only satisfy if they achieve their intended goals within available resources and expected quality in suitable time.

The literature shows that the user faces a lot of usability issues when s/he is visiting the web applications. The next chapter will describe the evaluation methods which can be helpful to identify the usability problems and evaluate the usability of the web applications.
5  USABILITY EVALUATION METHODS

44% of websites users do not succeed in finishing their purchase on e-business websites. (Nielsen, 2001)

Different types of evaluation methods have been proposed by different authors. This chapter provides a brief introduction about these methods. Starting with the discussion about needs of usability evaluation, it follows the related work for usability evaluation methods.

The brief description related to two main categories of evaluation methods i.e. Formative and Summative evaluation (Rex et al., 2003) will also present in this chapter. There are different criterions which help in the selection of appropriate usability evaluation method for the product.

They will be explained along with the different types of evaluation methods in details. This thesis study is mainly focused on usability inspection methods (see detail on next chapter) (Hom, 2005), so in this chapter and the proceeding chapters will focus on usability inspection methods.
5.1 Usability Evaluation

According to Holzinger (Holzinger, 2005), there are five usability characteristics which can be considered as integral parts of any software. These characteristics include learn-ability, efficiency, memor-ability, low error rate and satisfaction. It means that the software should be easy to learn, efficient to complete the task with low error rate, easily memorized for long period of time and satisfy the user in achieving the goals.

Although all these characteristics are essential, sometimes one characteristic is more important than the others, like learn-ability is the major requirement from any novice users, while the developers demands efficiency in the software (Holzinger, 2005). It is important to evaluate the software in such a way that it become usable for the user and can fulfill the requirements of its users.

Usability evaluation deals with making assessment and improvement in the usability of the software by identifying the problems and short comings in it (Ssemugabi and Villiers, 2007). An extensive research have been conducted which results with different type of evaluation methods, but still this is an important research area among the researchers and practitioners (Ssemugabi and Villiers, 2007).

It is not possible to regret the importance of evaluation for interface designs in web applications. The interface design cannot be considered as usable without extensive and appropriate evaluation. Usability evaluation can be categorized into two types of evaluations as mentioned in next section.

5.2 Categorizations of Usability Evaluation Methods

As software development life cycle has different phase and for developing good quality software it is important to evaluate the software at every phase. So by keeping this idea in consideration, Rex (Rex et al., 2003) proposed two categories of evaluation methods i.e.

- Formative Evaluation Methods
- Summative Evaluation Methods

5.2.1 Formative Evaluation Methods

Formative Evaluation Methods are used during the product development. These methods focus on usability problems which are essential to solve before the final design. So, these methods can be implemented during prototyping of the product in order to fix the usability issues to improve the interface design. The qualitative data which includes the identification of usability problems will be collected in these methods.

5.2.2 Summative Evaluation Methods

Unlike Formative Evaluation Methods, Summative Evaluation Methods are used before and after the product development. These are mainly used to evaluate the

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1 The users with no or have some knowledge about software.
efficiency of final design. These methods required complete and formal design to evaluate the design. In these methods the quantitative data like user performance, efficiency etc are mainly collected to assess the design.

The above discussed are the categories of usability evaluation methods. Three types of evaluation are performed within these categories to evaluate the usability of the product. These evaluation types are described in next section.

5.3 Type of Usability Evaluation

On the basis of evaluation categories, three main types of usability evaluation can be performed to evaluate the quality of interface design. These types are (Ivory and Hearst, 2001; Whitehead, 2006; Hom, 2005).

5.3.1 Inquiry

5.3.2 Testing

5.3.3 Inspection

The UEMs which fall in inquiry type are generally implemented before and after the software development, while the inspection and testing methods are used during development. A person who evaluates the usability of the software is called evaluator. The other roles which include in the usability evaluation are software developers, usability researchers, usability specialists and users etc. Usability Evaluation Methods (UEMs) can be shown in following figure:

![Usability Evaluation Methods (UEMs)](image)

Figure 11: Usability Evaluation Methods (UEMs)

In each evaluation type, there are some methods which can be used to evaluate the usability. The following table briefly describes the evaluation types along with methods used in the specific type (Hom, 2005).
Table 12: Usability Evaluation Methods (UMEs)

<table>
<thead>
<tr>
<th>UEMs Type</th>
<th>Description</th>
<th>Users</th>
<th>Phase</th>
<th>Methods</th>
</tr>
</thead>
</table>
| Inquiry   | The information about likes, dislikes, requirements from the users are collecting by interviewing or observations. The interviews can be in the written form or verbally. | Usability Evaluators   | Before, Development, After Development | • Field Observation  
• Focus Groups  
• Interviews  
• Logging Actual Use  
• Proactive Field Study  
• Questionnaires |
| Testing   | The user tests the system by performing different tasks on actual software or by using the prototype, while the evaluators observe that how interface helps the user to complete his task. | User, Usability Evaluators | During Development          | • Coaching Method  
• Performance Measurement  
• Question-asking Protocol  
• Remote Testing  
• Retrospective Testing  
• Teaching Method  
• Thinking Aloud Protocol |
| Inspection| The Usability specialists or any responsible do inspection on the usability of the product. | Usability Specialists, Developers | During Development          | • Cognitive Walkthroughs  
• Feature Inspection  
• Heuristic Evaluation  
• Pluralistic Walkthrough  
• Perspective-based Inspection |

The usability inspection methods have been highlighted in the above table, because this thesis is mainly focus on usability inspection methods (See details in the next chapter).

Despite of many usability evaluation methods found in the literature, it is important to select an appropriate UEM for the identification of usability problems (Ssemugabi and Villiers, 2007). Sometimes combination of two UEMs gives better result as compared to single method. The UEMs can be select by comparing the efficiency of UEMs, time required to evaluate and the nature of application, expertise of evaluators.

According to Ssemugabi and Villiers (Ssemugabi and Villiers, 2007), the time, efficiency, cost, effectiveness and ease of application may influence the selection of UEM. The next section describes criterions for the selection of appropriate UEMs which is best fit from different aspects.

5.4 UEM Selection Criterion

Many UEMs have been proposed so far. Each method has some advantages short comings. To evaluate the usability it is important to select the most appropriate evaluation method. The selection of UEMs may influenced by cost, time, efficiency, expertise and ease of application (Ssemugabi and Villiers, 2007). The selection of UEMs is difficult due to need of following reasons (Ssemugabi and Villiers, 2007):

- Standard criteria for UEMs comparison.
- Standard definitions, measures, and metrics for criteria.
Standard processes for UEM evaluation and comparison.

Rex (Rex et al., 2003) proposed criterions for the selection of usability evaluation method. The most important and widely used criterions extracted from extensive literature review are presented below:

- Determining Realness by Comparing With a Standard Usability Problem List
- UEM performance Measures

### 5.4.1 Determining Realness by Comparing With a Standard Usability Problem List

By using the UEM, evaluators prepare a list of usability problems which they have found during evaluation of interface design. But only developing the list is not enough, it is important to determine whether the UEM identified the real usability problem list or not.

Before the design evaluation, an evaluator must have complete list of real usability problems that can be found in the targeted design (Rex et al., 2003). This list may contain heuristics, list of problems found in same type of application previously, or list developed through research etc.

The evaluator compares the identified list of usability problems with the standard list to determine the realness of identified problems. The comparison is not complete by only counting and determining the overlap/duplicate usability problems, but comparing the complete description is required. The complete, clear and unambiguous description is required to compare the descriptions of the usability problems.

Similarly sometimes evaluator seeds\(^2\) the known usability problems in the application to discover all unknown and undiscovered issues. Although this is a good way to identify the problems but some researchers claim that seeding the problems is not good to evaluate the efficiency of UEM because the result is mainly depend on UEM as well on the evaluator’s skills. Experienced usability evaluators understand that seeding problems rarely match with real usability problems. So efficiency of evaluation methods can also be compare by seeding the problems.

### 5.4.2 UEM performance Measures

There are some measures which can be used to measure the performance and efficiency of the UEMs. These measures are
- Thoroughness
- Validity
- Effectiveness
- Reliability
- Cost Effectiveness

The authors (Rex et al., 2003) prove these measures by using the concepts of sets, however only brief introduction is included in this thesis report.

---

\(^2\) Adding the known usability problems to find all the unknown problems
5.4.2.1 Thoroughness

Thoroughness is one of the most important and widely used measures to evaluate the UEMs (Rex et al., 2003). Evaluators expect from their UEM to identify as many as possible usability problems in interface design. The UEM which found more problems are consider as more efficient and have high thoroughness in the design. This measure identify the proportion of real problems found by UEM to the real problems exist in the system, i.e. if an UEM identify 10 problems out of 20, then its thoroughness will be 0.5. It can be written in following equation form (Rex et al., 2003).

\[
\text{Thoroughness} = \frac{\text{No. of real problems found}}{\text{No. of real problems that exist}}
\]

The UEMs which have low thoroughness may leave un-identified important usability issues in the evaluation process.

5.4.2.2 Validity

Validity is an important measure from information storage and the result’s precision point of view (Rex et al., 2003). The validity measure identifies the proportion of real problems found to the number of issues which are identified as problems i.e. if an UEM identify 5 real problems out of 20, and then its validity will be 0.25 by using following equation (Rex et al., 2003).

\[
\text{Validity} = \frac{\text{No. of real problems found}}{\text{No. of issues identified as problems}}
\]

The UEMs which have low validity, but identify large numbers of usability problems which are not real, than it is the wastage of evaluator’s effort, analysis time and evaluation.

5.4.2.3 Effectiveness

Only thoroughness or validity alone is not sufficient to determine the effectiveness of an UEM (Rex et al., 2003) i.e. thoroughness alone identify large numbers of usability problems which are not real, while alone high validity may missed some real problems, so the effectiveness of UEM cannot be determine in this way.

The UEM is said to be effectiveness which identify the usability problems as a product of thoroughness and validity. The equation is used to measure the effectiveness by simple product is given below (Rex et al., 2003):

\[
\text{Effectiveness} = \text{Thoroughness} \times \text{Validity}
\]

The thoroughness, validity and effectiveness have same range i.e. from 0 to 1. If high thoroughness is achieved with low validity by using the UEM, then effectiveness will also be low (Rex et al., 2003).

According to Lai-Chong Law and Hvannberg (Law and Hvannberg, 2004), the efficiency of the UEM can be determined by using the following relation.
5.4.2.4 Reliability

The consistency and reliable usability evaluation results are important consideration while selecting the UEM (Rex et al., 2003). Reliability of UEMs can be determined if exactly the same or approximately same results, with reasonable variation can be obtained. The UEMs which are independent from evaluator’s skills, type of application are more appreciated.

As the evaluation results from UEMs are being merged after collecting from all the participated evaluators, so the thoroughness is said to be high with low individual reliability and high variability among the evaluators. It can be seen from following equation (Rex et al., 2003):

\[
\text{Reliability of UEM} = \left[ \frac{\text{Low Individual Reliability} \& \text{Higher Variability among Evaluators} \& \text{Higher Overall Thoroughness}}{\text{No. of Hours invested}} \right]
\]

5.4.2.5 Cost Effectiveness

The UEM is cost effective, if UEM identify maximum usability with lowest cost (Rex et al., 2003). It includes the cost to learn and use the UEM. The efficiency can measure by combining all the costs of each evaluator. Usually cost of an UEM is measure in the functions of method or tool use. These functions includes the fixing overhead of learning a method along with time and effort required to fix it.

The main problem in measuring the cost is accuracy, consistency and quantitative estimation of cost. There are some other criterions which organizations used to evaluate the efficiency of UEMs. The above discussed are the most common criterions used to select the appropriate method to evaluate the usability of application.

This chapter mentioned different types of usability evaluation i.e. inquiry, testing and inspection (Hom, 2005). As this thesis study is mainly focus on usability inspection methods, so the various methods, their pros and cons will be discussed in details in next chapter.
Most websites today fail basic tests of usability
(Forrester, 2003)

There are three main types of evaluation methods (inquiry, testing and inspection) which can be use to evaluate the usability of software for both traditional software and web applications.

As this thesis study is mainly focus on usability inspection methods, so this chapter provides detail overview of usability inspection methods. There are different methods which will be discussed in this chapter along with their pros and cons.
6.1 Usability Inspection Methods

Many inspection methods have been proposed in literature by different authors. This section will briefly explain these usability inspection methods. But before discussing these methods the overview of usability inspection methods will be presented.

6.1.1 Overview

According to Nielsen (Nielsen, 1994), user interface can be evaluated automatically, empirically, formally or informally. The automatically evaluation can be performed through automated computer programs. These programs evaluate the user interface according to specifications which are set for specific interface. Empirical evaluation is the traditional testing of user interface (UI) i.e. evaluating UI by using the real users. Formally evaluation uses the models and formulae to measure the usability while the informally evaluation majorly concern with the skills, education, experience of evaluators and the type of application.

The automatic and formal methods are difficult to implement due to lack of evaluators skill, experience, shortage of budget and time, project schedules and different types of applications. While the empirical methods need the participation of real users, which is difficult or make it extra cost to invite them for evaluation. The application may have more than one versions and evaluating them with actual users is not an easy task (Nielsen, 1994).

Keeping all these restrictions in mind, the evaluators usually prefer informal evaluation of UI. The informal methods like inspection methods are consider popular and widely used due to cost effective, meeting the project schedule, according to evaluator’s skill and can be conducted with limited resources (Nielsen, 1994).

According to Nielson (Nielsen, 1994), usability inspection is the set of cost effective, informal and easy methods to evaluate the UI. There are some standards and design conventions which are used to identify the usability problems (Holzinger, 2005). Although usability testing and other methods are effective but they are expensive to use (Hollingsed and Novick, 2007).

In this case, the inspection methods contribute in identifying the usability problems by lowering the evaluation cost and depend on evaluators’ review skill. Usability inspection methods are used at the early stages of development life cycle (Holzinger, 2005). They are easy and cheap methods to implement on the requirements, prototyping designs and code as well for evaluation.

6.1.2 Inspection Methods

This section describes different types of usability inspection methods. According to Nielsen (Nielsen, 1994), the widely used and proposed usability inspection methods are as follows:

- Heuristic Evaluation
- Cognitive Walkthroughs
- Pluralistic Walkthrough
- Perspective-based Inspection
- Feature Inspection

These inspection methods can be shown in following figure.

![Usability Inspection Methods](image)

**Figure 12: Usability Inspection Methods**

Different authors conducted research on the usability evaluation methods by focusing on usability inspection methods. Zhang and Bisili (Zhang et al., 1999) compared perspective based inspection methods with Heuristics evaluation method. According to them the widely used methods are ineffective as compared to perspective based.

Similarly Ssemugabi and Villiers (Ssemugabi and Villiers, 2007) proposed different criterions which can be used to select the appropriate evaluation method. It is shown that inspection methods have ability to identify more usability problems as compared to testing methods (Nielsen, 1994).

On the other side usability testing methods find those problems which inspection methods may ignored while evaluation, which means the combination of both inspection and testing methods are useful for evaluating the interface. Each inspection method has some variation in the form of number of evaluators, development phases where to implement, cost and time required applying. The next sections explain these inspection methods to give an overview of all these methods.

### 6.2 Heuristic Evaluation

Heuristic evaluation is one of the widely used usability inspection method which used some predefine usability guidelines (known as heuristics) to identify the usability problems and evaluate the application whether it is according to these guidelines or not (Ssemugabi and Villiers, 2007). Nielsen (Nielsen, 1994) proposed this method in early 90’s.
It is easy to implement with low cost and effort which results the identification of major and minor usability problems (Nielsen, 1992). It is found that major problems have high probability to identify than minor problems, but large number of minor problems can be identify through this method (Nielsen, 1992). According to him the interface can be evaluate with 10 heuristics which he have proposed (Nielsen, 2005).

As the software development process is usually iterative, heuristic evaluation is proposed mainly to use at the earliest stages for the improvement of design (Nielsen, 1992). Initially this method is developed for single evaluator which goes through the design various times and identifies the problems. It is observed that 55-90% usability problems can be identify by increasing evaluators up to 4-6 (Nielsen, 1992). Each evaluator examines the interface according to predefined principles and generates a report containing the list of usability problems.

To ensure unbiased and high thoroughness results, evaluators can communicate when their lists are merged. Different lists are merged to prepare a single list of usability problems. After merging the lists, duplicate problems are excluded and real problems are included in final list (Law and Hvannberg, 2004). The heuristics must be selected very carefully as rest of development process is based on this evaluation.

According to Nielsen (Nielsen, 1992), evaluators for HE can be novice (without or little expertise), usability expert and double expert (have expertise both in usability and in the particular interface). The novice evaluators are not appropriate to perform HE, according to research it is shown that double experts can found more usability problems as compared to any other.

A list of 10 heuristics proposed by Neilson (Nielsen, 1992) is widely used when conducting the Heuristics Evaluation. Sometimes evaluators add more heuristics along with Neilson’s heuristics to obtained maximum thoroughness. The Neilson’s heuristics borrowed from his alert box (Nielsen, 1992) are populated in following table. The descriptions of these Heuristics have been paraphrase for this thesis study.

<table>
<thead>
<tr>
<th>Neilson’s Heuristics</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visibility of system status</strong></td>
<td>The system should always keep users informed through appropriate feedback within reasonable time.</td>
</tr>
<tr>
<td><strong>Match between system and the real world</strong></td>
<td>The system should use familiar and conventional terms in logical order instead of using the system oriented terminology.</td>
</tr>
<tr>
<td><strong>User control and freedom</strong></td>
<td>The system should support undo and redo functions, as users often choose mistakenly wrong path and needs emergency exit to leave the undesired state.</td>
</tr>
<tr>
<td><strong>Consistency and standards</strong></td>
<td>The system should have different words, situations and actions for different things. It is not suitable that user confused with same words but different meaning. Always follow the platform conventions on which the system will be used.</td>
</tr>
<tr>
<td><strong>Error prevention</strong></td>
<td>Always use confirmation option to users before they commit the action in order to prevent errors. The error</td>
</tr>
</tbody>
</table>
message should be used carefully, as they prevent the problems.

| Recognition rather than recall | User’s memory load should be minimizing by making the actions and options clear. It is not appropriate for users to remember information at different phases of use. The help/instructions for use should be clear and easily accessible. |
| Flexibility and efficiency of use | The system is capable to accommodate both experience and inexperienced users by using accelerators. The users should be allowed to tailor their frequent or last actions. |
| Aesthetic and minimalist design | Irrelevant and the information which are seldom used reduce the visibility and relevance of required information, so they should be avoided in the system. |
| Help users recognize, diagnose, and recover from errors | Error messages should be constructive and in plain language. They indicate the problems and suggest the reasonable solution. |
| Help and documentation | The system should provide with documentation and helping manuals which concentrate on the user’s tasks and list of productive steps precisely. |

According to Nielson (Nielsen, 1992), there are some factors which affect the Heuristics Evaluations. He defined these factors in following manner.

### 6.2.1 Factors Affecting Heuristics Evaluation

The factors which affect the heuristics evaluation can be:
- Expertise of the evaluators
- Severity of the usability problems
- Individual Heuristics
- Activities needed to identify the problems

The factors which affect the HE can be view graphically in following figure:

![Figure 13: Factors Affecting Heuristics Evaluation](image)

### 6.2.2 Advantages of Heuristics Evaluation

The Heuristics Evaluation has some advantages over other usability inspection methods (Nielsen, 1992; Law and Hvannberg, 2004; Holzinger, 2005).
• It is cost effective.
• It is use at the early stages of development process.
• It identifies the minor and major usability problems.

6.2.3 Disadvantages of Heuristics Evaluation

Heuristics Evaluation reduces its effectiveness due to following weak points (Nielsen, 1992; Law and Hvannberg, 2004; Holzinger, 2005).

• The evaluators must have expertise.
• Several evaluators are required.
• Most of usability problems identified by Heuristics Evaluation are minor.
• It is separated form end users.
• Selection of heuristics depends on evaluator’s skill and expertise.
• HE does not evaluate the entire design, as the evaluators may focus on one part of the system.

6.3 Cognitive Walkthrough

Cognitive walkthrough (CW) is a task-oriented usability evaluation method in which evaluators examine step-by-step completion of user task (Holzinger, 2005). This method is focus on cognitive matters like learn-ability i.e. how long the user can take to learn new system.

This method is based on exploratory learning i.e. learn the system without documentation and supporting manuals. This method is used at early stages of product development life cycle. The number of usability experts can be 1-4 and sometimes software developers can also participate in evaluating the interface (Hom, 2005).

This method is famous from engineering perspective because it can be use by evaluators who are not usability experts (Allendoerfer et al., 2005). While from research perspective, it is famous because it is theory based inspection method by focusing that how people learn. Cognitive Walkthrough (CW) focuses on how the users choose actions based on information provided by the system.

In CW session, the evaluators create success and failure stories at each step by using the action sequences (AS). These action sequences must be prepare and given to each evaluators during the CW session. The divergence between action sequences and user’s tasks results the creation of failure story (Allendoerfer et al., 2005).

These stories help in two dimensions i.e. the source of improvements in design, while on the other hand many possible sequences discover which lead the user to his destination. Sometimes user thinks he is on wrong path as it is different from designer’s intention, but in fact this path also leads to success but from different designer’s intension (Allendoerfer et al., 2005).

It is found that details provided about action sequences can affect the identification of problems in CW. If more information is provided then more

---

3 Action sequences describe how to complete each task (Allendoerfer et al., 2005).
problems can be identify. It is suggested that let allow the evaluators to create their own action sequences (Wharton et al., 1994). To perform CW, evaluator must know the following information (Wharton et al., 1994).

<table>
<thead>
<tr>
<th>Information</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prototype of system</td>
<td>May be not complete design, but clear details like location and contents of menu.</td>
</tr>
<tr>
<td>Tasks the user is to perform</td>
<td>The details about tasks which the users will perform.</td>
</tr>
<tr>
<td>List of Action Sequences</td>
<td>Complete list of actions which are necessary to complete the task.</td>
</tr>
<tr>
<td>Indication of User</td>
<td>Details about the intended users, experience and knowledge required by the evaluators.</td>
</tr>
</tbody>
</table>

As long as the evaluators complete CW, the evaluator will ask following questions from the system (Wharton et al., 1994)

- Will the users try to achieve right effect?
- Will the user notice that the correct action is available?
- Will the user associate the correct action with the effect to be achieved?
- If the correct action is performed, will the user see that progress is being made toward solution of the task?

6.3.1 Advantages of Cognitive Walkthroughs

There are some advantages of CW over other usability evaluation methods. They presenting below (Nielsen, 1994):

- Paper prototypes or functioning prototypes can be used to perform CW.
- Designers and evaluators keep in mind the user’s knowledge, goals and cognitive complexity required to use the system.
- It is effective methods to identify the expected usability problems which affect the user’s performance.
- Both novice and expert evaluators can be used to perform CW.

6.3.2 Disadvantages of Cognitive walkthroughs

CW reduces its effectiveness due to following weak points (Nielsen, 1994):

- It is time consuming and difficult to perform on large and complex tasks.
- The development of action sequences depends on evaluator’s skills.
- Having narrow focus on usability attributes i.e. learn-ability.

6.4 Perspective-based Usability Inspection

It is not possible to indentify all the usability problems by each evaluator at the same time (Zhang et al., 1999). So, Bissili and Zhong proposed another evaluation method (perspective-based usability inspection) (Zhang et al., 1999). In this method each evaluator focuses on single usability perspective and identify the usability
issues w.r.t that perspective. Empirical studies have shown that other inspections methods (HE, CW etc) are less efficient in indentifying the usability problems.

The percentage of detection of usability problems by each evaluator is high in perspective based usability inspection method because in this method every evaluator identifies the problems from one perspective, and by aggregating the results of different evaluators a large number of problems could be determined (Zhang et al., 1999). It should be noted that each perspective must provide the information (Zhang et al., 1999):

- The point of view of evaluator.
- A list of questions related to specific perspective.
- The complete procedure to perform the perspective based inspection.

It is found from the research that (Zhang et al., 1999) like inspecting the requirement documents; evaluator is allowed to select a single perspective and focus on one class of defects, in this way s/he can identifies large number of problems during the inspection session as s/he is concentrating on single perspective.

### 6.4.1 Model of Human Computer Interaction

The perspective based inspection method follows an iterative nature model which has some user’s actions. This model was proposed by Zhang and Bisili (Zhang et al., 1999). This model defines the iterative process of HCI. It is the extension of Norman’s famous model (*Seven Stages of Action*) (Norman, 2002). The steps in Zhang and Bisili’s model are (Zhang et al., 1999):

- Forming of goal
- Forming the intention
- Identify the action
- Execute the action
- Perceive the system response
- Interpret the results
- Understand the outcome
- Deal with errors that may have occurred

The user performs this complete iteration in order to perform the Human-Computer Interaction. These iterative steps can be shown from the following figure:
From the above figure it can be seen that goal leads the user to the completion of task. For example: if the task of user is to filling out an online form, then goal can be filling out the name filed or filling out any other fields placed on that form.

According to this model the user translates his goal to intention, and so on (Zhang et al., 1999). This model can be summarized as the iterations of execution and evaluation with error handling. This model contributes in identification of two types of usability problems (Zhang et al., 1999) i.e.

- **Gulf of Execution**: Difference between user’s goal and defined actions.
- **Gulf of Evaluation**: Difference between system and user’s expectation.

According to Zhang (Zhang et al., 1999), these perspectives act as scenarios of HCI and should be mutually exclusive. The user will come across with following situations.

<table>
<thead>
<tr>
<th>Situations</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Novice Use</strong></td>
<td>The knowledge of user is not sufficient to guide the user how to use the system.</td>
</tr>
<tr>
<td><strong>Expert Use</strong></td>
<td>The knowledge and experience of user is sufficiently tells the user how to achieve goals efficiently.</td>
</tr>
<tr>
<td><strong>Error Handling</strong></td>
<td>The user encounters a problem which he wants to resolve.</td>
</tr>
</tbody>
</table>

When conducting perspective based inspection, the procedure of perspective is given to the evaluator, evaluator then perform this evaluation by considering the above mentioned situations i.e. novice use, expert use and error handling (Zhang et al., 1999).

This helps the evaluator to detect the usability issues during the session and by combining all the results, the complete list of usability issues could be prepare.
6.5 **Pluralistic Walkthrough**

The developers, user representatives and usability experts evaluate the system design when prototype is ready at design stage (Hom, 2005). The group walkthroughs provide various natures of skills and perspectives which can be used to identify the usability problems. It is found from research that high number of usability problems can be identified by involving more people in evaluation.

The pluralistic usability walkthrough (Hollingsed and Novick, 2007) follows the same principle i.e. adding more people in the traditional usability walkthrough. This method was proposed by Bias in 1990, who was the advisor of human factor in Personal Systems Programming Center at IBM Austin (Bias, 1991).

6.5.1 **Characteristics of Pluralistic Walkthrough**

Bias proposed four characteristics of Pluralistic Walkthrough (Bias, 1991), which are written below:

- Users, System designers and usability experts should be the part of same walkthrough session.
- The system prototype is presented in hardcopy panels and in the same order as they would appear in functional system.
- All participants note down the detailed actions which they have performed.
- The users will speak first and usability experts speak when the users stop in panel discussing sessions.

During evaluation session, paper prototypes along with hard copy panels or screens, dialogues etc are provided to evaluators (Hom, 2005; Bias, 1994; Bias, 1995). It is asked to every evaluator to write down each action which he wants to perform in as much detail as possible. For example if filling the user name and password fields, then he writes as follows: enter username, press tab button, enter password and again press tab, then press Enter.

After writing all the actions, a discussion about prototype begins. The users speak first and when they stops the usability experts will tell the correct actions which should be according to the designer’s intension. After discussion, the new screen panel will present and walkthrough proceeds further (Bias, 1994).

It is found that pluralistic walkthrough is widely used in industry. Its application during the upgrading of graphics programs in Windows NT is the real life example of this walkthrough (Hollingsed and Novick, 2007).

6.5.2 **Advantages of Pluralistic Walkthrough**

The Pluralistic walkthrough has some advantages over other usability evaluation methods. Below are the some advantages of this method (Hollingsed and Novick, 2007).

- It identifies usability issues in early stages of development life cycle.
- Different nature of evaluators jointly provides useful and productive response.
- This method can be used even if the interface is not code.
• This method provides early feedback and contributes in fast iterations of design as users involved in this method.
• Easy to perform and can be informal.
• Both qualitative and quantitative data can be collected from this walkthrough.

6.5.3 Disadvantages of Pluralistic Walkthrough
The shortcomings in Pluralistic walkthrough are (Hollingsed and Novick, 2007).
• Difficult to identify every path in prototype which user can use.
• The usability experts or leading evaluator can influence group discussion.
• The standard techniques must be required to analyze the qualitative data.
• The detailed description of paths is not too much useful, as actual user may not follow the same path when s/he using the application.

6.6 Feature Inspection
The name reflects the main theme of this method. The evaluator in this method focuses on the features (functionality) of the product (Patrick, 2008). The use cases and expected outcomes of the each use case are provided to the evaluator. This method is usually focus on the usability attributes like understanding the product (understandability), accessible feature (accessibility) and availability (Patrick, 2008). For example if a use case is to write a letter by using any word processor then the features used in this use case will be typing text, spell checking and so on (Patrick, 2008).

In this method, all features are listed down in the same order in which they can be performed by the user. After listing all the features the evaluator examines the features from the perspective of its accessibility, availability and other usability attributes.

The staff related to documentation like technical writers etc; they document each scenario in the form of procedures and process. The scenarios which are hard to explain in documentation will also be difficult for user to perform (Patrick, 2008).

This method is best to use in the middle of development life cycle and after design stage. The actual working of features is well known and can be test/inspect at this stage. Like all other evaluation methods, there are some advantages and disadvantages of Feature’s inspection method.

6.6.1 Advantages of Feature Inspection
The Feature Inspection has some advantages over other usability evaluation methods. Below are the some advantages of this method (Patrick, 2008; Foraker, 2005).
• It is useful even if evaluators are not usability experts.
• The evaluator examines every task, which increase the identification of usability problems probability.
• It contributes in Product and usability inspection simultaneously.
6.6.2 Disadvantages of Feature Inspection

The shortcomings in Feature Inspection are (Patrick, 2008; Foraker, 2005).

- Difficult to interpret the easiness of feature.
- Usability cannot be measure directly in this method.
- The usability experts or leading evaluator can influence group discussion.
- It provides over view of product’s features.

The above sections describe the usability inspection methods in detail. These methods can be used at different stages during the software development. The next chapter will give brief description that how usability inspection method can be used during development life cycle.
SECTION III – EMPIRICAL ANALYSIS

Chapter 7 : Empirical Research Design
Chapter 8 : Empirical Research Conduct
Chapter 9 : Analysis and Interpretations
Chapter 10 : Validity
In empirical study part of this thesis, the factors which restrict the adoption of Usability Evaluation Methods (UEMs) are explored. Furthermore how UEMs can be deployed at different phases of the development life cycle is also investigated.

As a research methodology, observations and interviews were used along with a questionnaire as the data collection instruments while Grounded Theory (GT) is used to analyze the data for this empirical study part.

The chapter starts by motivating the use of interviews and observations for data collection. The methodology and complete procedure for interviews research design is explained. Then, the design of the questionnaire is provided.

After discussing the data collection methods i.e. observation and interview, the method for data analysis (Grounded Theory) is described. This chapter explains the empirical research design in detail.
7.1 OBSERVATIONAL STUDY DESIGN

The observational method is one of the methods used while conducting the empirical part of this thesis. The observation is used to get in depth information about the Usability Evaluation Methods (UEMs) and to identify the organizational factors which influence their adoption.

According to Creswell (Creswell, 2002) observations can be used to collect the observational data on the behavior and activities of the participants. Although interview was the main data collection method, observation helps in validating the interview answers with deeper information. The observation can be considered as parallel or secondary source of gathering information for this thesis.

The observational study is conducted in such a way that the presence of Chief Executive Officer (CEO) among the employees and questions pose to participants do not influence the findings (Creswell, 2002). The guide which contains steps and questions (mainly from the original questionnaire) is used during the observation. The data which was collected during the observation are:

- How do people actually conduct evaluation of web application?
- What are their views towards the evaluation of applications?
- How many and what are the resources do they use during the evaluation?
- What are their real working conditions?
- What is the attitude of other team members towards the usability evaluators or testers?

The observation is conducted after taking the permission of CEO of the companies. Since no sensitive and confidential data was gathered, it was rather easy to convince them for participation.

7.2 INTERVIEW STUDY DESIGN

Interviews are conducted to investigate how different usability inspection methods can be deployed at different phases during the web development. To get deeper and detailed information regarding UEMs, Interview approach was selected instead of a Survey. According to (Creswell, 2002) interview helps in data collection through face to face, one to one, person interview or telephonic interviews.

Interviews reduce the ambiguities and confusions and a detailed data can be collected. The historical information can also be obtained by interviewing the participants. Interviews are supported with set of open ended questions.

The interview study design for this thesis consists of following steps:

i. Interview Structure
ii. Selection of Interviewees
iii. Interview Questions
iv. Procedure
   a. Interview Preparation
   b. Execution
   c. Data Validation
7.3 GROUNDED THEORY

As this thesis study is conducted as an exploratory study (Dematteo et al., 2005), the data was analyzed by using the Grounded Theory (GT) (Creswell, 2002). GT is very suitable for exploratory type of studies where the researcher don’t have any prior knowledge (Moghaddam, 2006).

GT is a qualitative research methodology which systematically analyzes the data and contributes in generation of theory (Moghaddam, 2006). Barney Glaser and Anselm Strauss developed GT in 1967 during the research project (Moghaddam, 2006). It was developed by aiming to investigate the occurrence of any complicated phenomena with following objectives (Moghaddam, 2006).

- It can be used to manage raw data.
- It provides alternatives meanings of any event.
- Provides systematic analysis.
- Helps in developing and relating the concepts to develop the theory.

The factors which influence the adoption of UEMs and suggestions for adopting the UEMs during development life cycle were identified by systematic analysis of gathered qualitative data. The analysis was performed by using three types of coding techniques for GT i.e.

- Open Coding
- Axial Coding
- Selective Coding

7.3.1 Open Coding

The analysis of gathered data started with open coding (Strauss and Corbin, 1998). In Open Coding the notes/data are reviewed again and again to find the codes which have some meanings and used in the data. The similar codes are grouped to develop the concept. In last step of open coding, the similar concepts are grouped to more general categories. Coding and categorization of data is the analysis of data as the data is not quantified in GT.

According to Creswell (Creswell, 2002), the theoretical saturation is considered into this stage. Theoretical Saturation means that data is reviewed repeatedly to ensure that no new code can be emerged afterward. Gaining the theoretical saturation sows the validity of theory.

7.3.2 Axial Coding

Axial coding is another type of coding in GT, in which the codes are reduced in such a way that some relationship is shown between the identified categories (Moghaddam, 2006). This coding comprises two steps i.e. reducing he codes (determining relationship) and finding the core category.

Core category is such category which is the central phenomenon around which all other categories can be related (Moghaddam, 2006). The criteria for choosing core category are (Strauss and Corbin, 1998):

- It appears frequently in the data.
- It is central in nature and all other categories can be related with that.
• The name of core category behaves as sufficiently abstract.

### 7.3.3 Selective Coding

The last step in coding is selective coding (Strauss and Corbin, 1998). In this coding the relationship between categories are validating and filling the categories if any modification is required. The categories are validated and integrated in order to develop the theory.

Next chapter will describe the conduct of empirical study. The complete procedure which was followed to conduct the empirical study will be explained in next chapter.
CHAPTER 8

“The grand aim of all science is to cover the greatest number of empirical facts by logical deduction from the smallest number of hypotheses or axioms.”

Albert Einstein (1879-1955)

This chapter provides the detail description about the empirical research conduct.

All the steps which were used during the interviews will be discussed in this chapter. In addition information related to the participated companies is also given at the end of this chapter.
8.1 INTERVIEW CONDUCT

This section explains that how the empirical study was conducted during this thesis. The interview steps mentioned in last chapter (See chapter 7), are explain in this chapter.

8.1.1 Interview Structure

Interview is considered as an easy way to gather the desire information (Cohene and Easterbrook, 2005). However there are some limitations which influence the results of an interview. The information gathered through interviews is usually specific place oriented\(^4\) rather than natural field settings (Creswell, 2002). Moreover the interviewee may influence and biased due to presence of researcher or higher authority. The shyness and communication gap is also the factor which affects the findings of interviews (Cohene and Easterbrook, 2005; Creswell, 2002).

It is important that interview can be conducted in such a way that it fulfills the objectives of interviews. The right question can be asked at the right place to keep the essence of interview and the interest of interviewee in interview. *Semi-Structured interview* is used for this thesis study.

A semi-structured interview is an informal discussion which can be used when researcher won’t get more than one chance to interview and several interviews are required to gather the information (Cohen and Crabtree, 2008; Wageningen, 2006). This type of interview is preceded by observation and informal discussion to keep the interviewee active and develop interest in producing the desire information. The interview guide is used which contain the set of questions, topics which need to covered during the discussion.

As the semi-structured interview is informal, there is a possibility to generate new questions and de-track the conversation from the actual agenda. Sometimes new questions arise during conversation. These questions are related to thesis study or informal talks. It is tried to keep the interview on track without staring any new discussion which is not related to interview agenda. The method is used for this thesis study because it is easy to conduct and provides in-depth information regarding the topics. The open ended questions are used during the interviews and of course some more questions other than stated questions arise during the interview sessions. The questionnaire along with interview guide is prepared before the interview.

8.1.2 Selection of Interviewees

As this thesis is all about the usability evaluation of web applications, all interviewees are related with web development especially in usability evaluations. The main roles which are selected for interviewees are web application graphic designers, testers or evaluators, developers, project managers and CEO of the organizations. The interviewees are selected on the basis of following criteria:

- The interviewee company should involve in web based projects.
- The interviewee should involve in the development of web application.

\(^4\) Interviewees answer the question in context to place where interview is being conducted.
• The interviewee must have working experience in web industry.
• The interviewee should know all the requirements of the project.
• The interviewee should have knowledge of development and evaluation of web project.

8.1.3 Interview Questionnaire
Interview questions are designed after extensive literature review and according to required qualitative data. After listing the questions, duplicate and irrelevant questions are removed in the questionnaire review. According to feedback from supervisors, the questionnaire was updated by the addition and modification of some questions (See Appendix A).

The open ended questions are used. As time is an important factor in interview, those questions are added in the questionnaire which can be answered easily in promised time. Approximately 45-60 minutes interviews were conducted. The brief introduction about this thesis study and evaluation methods is also included in this duration.

The answers obtained from interviews are analyzed through Grounded Theory (GT). The detail about GT is present at section 7.3.

8.1.4 Procedure
The procedure of conducting the interviews contain the steps related to interview preparation, execution and data validation of gathered information. The web development organizations from Pakistan are selected for interviews. To save the time and effort the companies are contacted when the questionnaire is being developed. The complete interview process is described as follows.

8.1.4.1 Interview Preparation
There were three phases before the interview conduct. The preparation of interview starts by developing the questionnaire along with a questionnaire guide and its approval from supervisors. In the second phase, the companies were contacted and their willingness was determined by introducing the main purpose along with possible outcome of this interview to develop the interest in this interview. Setting the time, date, duration and venue is the last phase before conducting the interview.

8.1.4.2 Execution
The actual interview procedure composed of two phases:
• In first phase a short briefing about thesis research and especially the Usability Evaluation Methods (UEM) is given to develop the interest and concentration towards the interview.

• Asking questions and transcribing the answers is the second phase. In this phase, mostly open ended questions were asked. To get in depth information questions pose during the interview session, as it is more informal and semi-structured (Cohen and Crabtree, 2008; Wageninegen, 2006). The answers were recorded in the form of paper notes to make sure that no information is
lost at any stage. Interviewee was not interfered until or unless anything is not clear. All interviews are conducted in well relaxing mood with informal conversation \((mostly \ related \ to \ UEMs, \ Thesis \ and \ Trend)\) as well. As some questions are expected during the interview session, so interview guide is used. Every asked question was marked on gathering the complete information. Interviews were not recorded with tape recorder as it influences the answers and interviewee may hesitate to answer freely.

**8.1.4.3 Data Validation**

The answers were summarized to reduce the ambiguities and confusions. Sometimes interviewee do not know the exact answer of the question, so all these questions are also validated and asked again at the end of interview session. It was tried to collect the actual and realistic data, so the answers which seem ambiguous with exaggeration are also re-asked in the last session of the interview.

This chapter is primarily focused on the empirical research part i.e. the procedure which have been followed to conduct the empirical portion is conducted. The next chapter discusses how the data collected were analyses.

**8.2 INTRODUCTION TO THE COMPANIES**

The companies participated in interviews were all Pakistan based. All are involved in web based development. This section is briefly described about the companies. The information is gathered during the interview session and from their websites. The actual names of the companies are not mentioned in this report due to confidentiality, so the companies are named with A, B, C and D.

**8.2.1 Company A**

Company ‘A’ is small sized Web Development Company with 22-23 employees. The main services which company ‘A’ provides are Web design and Development, E-Commerce Solutions, Logo Design, Software development and office automation. The company has international as well national clients. This is project based company i.e. mostly work on bespoke projects. Company ‘A’ has developers, designers and SEO with different skill levels.

The interviewee at company ‘A’ is Chief Executive Officer (CEO) of the company. He has 9 years working experience. He was also involved in usability evaluation of web applications developed in his company.

**8.2.2 Company B**

Company ‘B’ is web based company with 25-30 employees with designations Project Manager, Team Lead, Software Developers, Designers, Tester, Search Engine Optimization (SEO) and technical writers. This company has more focus on market driven products as compared to fixed scheduled projects. Their services involved development of web applications, E-commerce solutions, graphics and animations.

The interviewee ‘B’ is working as Senior Quality Assurance having more than 8 years professional experience with expertise in Quality Assurance. He is actively
involved in assuring the product quality and giving trainings to juniors in this department.

8.2.3 **Company C**

Company ‘C’ is the e-learning solution provider having offices in different countries. The employees at Pakistan office are 40-45. Their main services include the development of web-based learning solutions, training management systems, course development, graphics & multimedia and web-based learning technologies.

The representative at this company is working as Quality Assurance Lead (QA Lead) with 7 years experience in web development and Quality Assurance work. He is also involved in the requirement engineering and on-site testing of products.

8.2.4 **Company D**

Company ‘D’ is the web based solution Providers Company with 30-40. Their main services include the development of software applications with emphasize of web based E-commerce business solutions, Web based ERP and other management applications.

The interviewee at company ‘D’ is working as Quality Assurance Engineer having approx. 5 years experience in web development, designing and quality assurance of web products.
All great truths are simple in final analysis, and easily understood; if they are not, they are not great truths
Napoleon Hill (1883-1970)

This chapter provides the detailed analysis and discussion about the research findings through interviews and observations. The qualitative data is gathered during interview sessions to identify the factors which restrict the adoption of Usability Evaluation Methods (UEMs).

Furthermore the data about how UEMs can be deployed at different phases of development are also gathered through interviews. The analysis is performed with Grounded Theory (GT).

In short this chapter is all about the analysis of gathered data and discussion upon it in the form of description of factors and suggestions or recommendations is presented.
9.1 DATA ANALYSIS

This section describes the detailed analysis of data gathered during the interviews and observations. The interviews were conducted to complete the empirical part of this research.

The analysis part starts by explaining the complete procedure that how Grounded Theory is applied to get the results.

9.1.1 Open Coding

Open Coding is the first step in GT to analyze the data. In this step the interview text (field notes) were reviewed twice to identify the factors which influence the adoption of Usability Evaluation Methods (UEMs) and how UEMs can be deployed at different phases of development life cycle.

The raw data of each company were noted separately to reduce the threat to mixing of any data. Every sentence which contributes in identifying the influencing factors is noted on the place where company’s raw data was noted. 97 codes were identified by labeling each sentence with unique and proper keywords.

Interviewees sometimes say the same sentences with different words. Different codes were given to similar concepts, so codes were grouped to form a general concept. By grouping similar codes, 18 concepts were collected. At last these concepts were again grouped into more generalized groups i.e. categories.

There were 9 unique categories identified by grouping the similar concepts. This process was iterative in nature. The data was reviewed to ensure that no sentence would be skipped. The following example shows that how GT is applied to form codes, concepts and then categories from the raw data.

Each interviewee talked about the Time and Giving importance to Usability as the two major factors which influence the adoption of UEMs. So, in the following example how GT was applied to form categories about Time and giving importance to Usability is shown. The raw data from company A contains following text about Giving importance to Usability.

Example 1: Development of Category – Usability Importance

Interview Text Company A: More importance is given to functionality as compare to usability to fulfill the basic functionality.

Interview Text Company B: The level of Usability is lower than the functionality and error detection.

Interview Text Company D: We put more focus to provide exactly the required functionality to the customer.

The sentence/text given by company A is coded with key word Less Importance (Code). Similarly codes Low Level and Less Focus for interview text from company B and D respectively have been given. Now these codes are grouped to concept with
title *Usability Understanding*. In the last step of open coding, the *Usability Understanding* is grouped with similar concepts like *Usability Knowledge* etc into more general category *Usability Importance*.

**Example 2: Development of Category – Time Constraint**

Another category was developed by repeating the same procedure as mentioned above. This example shows how category related to Time, as one of the major factor which influences the adoption of UEMs.

Interview Text Company A: *The Usability evaluation is specifically ignored due to strict delivery time.*

Interview Text Company B: *The Usability evaluation suffers due to short Time to Market.*

Interview Text Company C: *The Usability evaluation is performed with traditional product testing due to less time for evaluation.*

Interview Text Company D: *Task dependencies cause informal evaluation of usability due to less time remaining for Usability evaluation.*

The text given by company A is coded with key words *Strict Delivery time* (Code). Similarly the codes *Short Time to Market, Less Evaluation Time* and *Task dependencies* for interview texts from company B, C and D respectively have been given. After assigning the codes, similar codes were grouped into concept i.e. *Time limit*. The grouping of *Time limit* concept with other similar concepts such as *User Approval Time* results the category named *Time Constraint*.

Similarly 9 categories were developed by following the same procedure in open coding step. The final categories identified are:

1. Budget Constraints
2. Time Constraints
3. Usability Importance
4. Resource Availability
5. Education and Expertise
6. Evaluator’s Role
7. Customer Involvement
8. Insufficient Requirements
9. Communication Gap

### 9.1.2 Axial Coding

The next step in data analysis through GT is Axial coding. This step is composed of reducing the codes (determining relationship) and finding the core category. After reviewing the field notes and texts of interviewees, it was found that there can be relationship between these above mentioned categories. Therefore all these categories are related with each other on the basis of relationship exists between them. The following figure (Figure 15) shows the interpreted relationship between identified categories.
It was found that in each category there are some factors which influence the adoption of UEMs. The relationship between categories can be observed in such a way that if evaluator have no UEMs knowledge (Category: Education & Expertise), then he should take some time (Category: Time Constraints) to understand and make expert of UEMs. Similarly evaluator is unable to get knowledge and expertise (Category: Education & Expertise) if there is communication gap (Category: Communication Gap) between evaluator and other development team. After determining the relationship between categories, now Time Constraint was selected as core category. The main reason for selecting this category as core is that it appears frequently in the data and all other categories can be related to it. For example, sometimes customer involvement (Category: Customer Involvement) takes too much time that Usability Evaluation is affected. Similarly the evaluators and other team members spend a lot of time on determining the requirements if they are not sufficient. So insufficient requirements (Category: Insufficient Requirements) cause time delay (Category: Time Constraint) in adoption of UEMs, then in this case they prefer to use traditional evaluation instead of adopting any new formal method.

Figure 16 shows the identification of core category and other sub-categories. All other categories are related with this core or central category.
9.1.3 **Selective Coding**

The last step in coding is selective coding (Strauss and Corbin, 1998). In this coding the relationship between categories are validating and filling the categories if any modification is required. The categories are validated and integrating in order to develop the theory.

Data gathered through interviews and observation is analyzed twice to validate the developed categories. The data is reviewed again and again to validate already developed categories and make possibility to identify any new category. In this step the data analysis assure that no new category can be generate afterward. Irrelevant, duplicate and fake data is discarded to develop theory with logical and reasonable categories. The field notes which already coded are again analyzed in this coding phase.

After careful reviewing and validation 1 core category and 10 categories named as **influencing categories** contributes in grounded theorizing. All the categories were identified from the data collected through interview and observation.

9.2 **IDENTIFIED CATEGORIES**

The brief description of each identified category is presented below. The factors which are present within the specific category are also discussed under each category.

9.2.1 **Time Constraint**

Time is one of the main factors which contribute a major role in the success of product. The late delivery of product or wrong launched time of product cause dissatisfaction of the user and some time leads to product failure. Before the project start the wrong selection of process life cycle, team and resources used for the project caused delay in the delivery of the project.
Sometimes water fall model or modification of Water fall model (such as V model etc) which take more time in analysis, design and development of the product, while very short time is given to testing or evaluating the product. Although some UEMs are easy to conduct, they require sufficient preparation before the evaluation time. For example the list of Heuristics along with developed prototype is required if Heuristics Evaluation would be desired, but in doing so time is needed. The adoption of very lengthy processes or very short time during the development process, the testing/evaluation portion is always ignored.

9.2.2 Budget Constraint

Proper allocation of budget in the development phases plays an important role in the smooth completion of a project. It is observed that budget is not allocated properly due to wrong cost estimation.

The budget is important factor which influence the adoption of UEMs in such a way that most of UEMs required user involvement, conducting surveys and interviews for feedback, traveling to the customer etc, all these activities can be accomplished if the project have reasonable budget. It can be done if at the start the budget is allocated properly.

As evaluator is unable to complete all the steps of UEMs, either he uses the traditional testing or ignores the extensive usability evaluation and in both cases the product will be hand over to user with poor usability which also leads to poor User Experience.

9.2.3 Education and Expertise

Evaluator’s expertise and knowledge of UEMs is one of the main factors which influence the adoption of UEMs for usability evaluation. It is common practice that testers or product evaluators in software industry have basic university level education, i.e. Bachelor degree (B.Sc, BIT etc). Furthermore most of evaluation for web applications is done with internees or the newly hired employees. In this case the evaluators do not know anything about UEMs, and they perform traditional testing instead of using any UEM in order to complete their job responsibilities.

However, regular evaluators or testers, although having expertise in usability evaluation, sometimes can’t use UEMs due to lack of their knowledge. Most of the time, very small span of time is given to evaluators for test and evaluate the product. In this time span they are supposed to understand the working of application along with evaluation.

During this time, they are unable to learn or adopt any new process, as adopting new process at this time may be crucial for the project. In addition sometimes the developed application is so complex that evaluator unable to understand it fully, due to this he adopts wrong evaluation procedure.

9.2.4 Resource Availability

All team members, any type of hardware, technology or service that can be used during the project are considered as the resources for the project. The appropriate
resource at desirable time is very important for the success of any project. It is observed during the interviews that resources especially team members may be unavailable near the completion of a project. When developers code the project and handover to testers for evaluation, then developers may be involved with another project at office site or on customer site.

In this case they cannot give sufficient attention to the projects and prefer to ignore or find alternatives instead of correcting the problems. Similarly situation is experienced by the evaluators.

There are only 1 or 2 evaluators who are involved in the project team especially if the project is web based. The main reason of involving less numbers of evaluators is the unavailability of human resources. Although the QA lead is also included in the team, most of time he only supervises his juniors rather than working together with them.

These conditions cause difficulties in adoption of UEMs and proper usability evaluation. Sometimes, evaluator who knows how to use UEMs is unavailable, in this case the other evaluators may try to evaluate the product, but they cannot evaluate as much as a usability expert could evaluate.

9.2.5 Usability Importance

It is observed that requirement engineers and customers pay less importance to quality requirements during requirement elicitation meetings. Similarly developers also ignore most of important quality requirements. The major emphasize is given to the functionality and low error rate with security of the products.

The gap between academia and industry can be observed. Most of companies do not have any research activities or collaboration with any university or research centers. It results that general people have limited knowledge about the usability, which mostly ends with the concept of visual interface, color scheme and graphics etc of the product only. The evaluators and especially customer put more focus on interface design instead of actual concept of usability.

As it is seen from the literature review during this thesis study that (See Chapters 3&4) usability is not limit to visual interface of the product, rather it contains page load time, effectiveness of web page and contents, error and safety, learn-ability, understandability and many more. These concepts are mostly ignored during the usability evaluation.

Most of companies do not follow any specific evaluation methods just to evaluate one quality requirement instead they prefer to evaluate whole product in testing phase at once. It is very difficult to motivate the customer and evaluators to change their mindset to focus on usability issues along with functionality of the product as well to use the UEMs for usability evaluation. When ever asked to an evaluator about UEMs most of them answer with lack of knowledge, time constraint and unavailability of resources.
9.2.6 Customer Involvement

The involvement of customer in evaluation process sometimes causes difficulties for the evaluators. Evaluators seem very difficult to motivate the user to put more focus on usability of the product. Lack of knowledge about usability, giving limited time (Meeting Time) for formal product inspection with development organization and putting more pressure to complete the product as soon as possible are the main activities due to which the evaluators use traditional and less formal testing for product instead of adopting any UEMs.

The main obstacle due to which the customer influences more while adopting the Usability evaluation method is time constraints and budget. The customer refuses any further financial assistance and insists to complete the project within limited resource with good quality. The lack of budget (See more about budget in section 9.2.2) from the customer caused to ignore the adoption of UEMs and prefer traditional with nominal evaluation of product.

9.2.7 Communication Gap

Healthy and effective communication between team members’ plays an important role to create the friendly atmosphere between project team. The communication gap between developer’s group and evaluator’s group is observed some time. The main reasons which results the communication gap are the status of employees in the project, age factors, experience and domination due to large numbers.

As developers gain more attention and high status during the project by involving them in requirement elicitation, analysis, development, maintenance and deployment, the evaluators also involved in all phases of development life cycle treated with less importance and have passive role in phases except testing.

Evaluators get less time and chance to understand the whole product due to this communication gap. They are unable to select appropriate method and procedure for evaluation. However this is not true for all companies. Some companies now give vital attention and involve evaluators actively in all phases of development.

When evaluators do not know exact requirements and procedure which the developers follow to code the product, they are unable to evaluate efficiently and cannot select the appropriate UEMs. In this case, the evaluators prefer traditional testing which can be sufficient for product’s reliability, but not from usability point of view. Similarly some developers do not share and give satisfactory feedback when evaluators ask anything from them which may also cause confusion in selecting the appropriate process and methods for evaluation.

9.2.8 Evaluator’s Role

The adoption of UEMs and usability evaluation also suffers due to personal issues or concerns of evaluators with team, salary, job satisfaction etc. As it is discussed above that less attention is given to evaluators in the team. Therefore, sometimes they lose their interest in the project and perform such activities which only fulfill their job responsibilities.
Furthermore, some evaluators are not capable enough to work on more than one project at the same time. For example if evaluator is working on two projects at the same time, he is not capable to adopt appropriate process for the evaluation. Lack of time, expertise and understanding of application as well a UEMs influence the adoption of Usability Evaluation Methods.

9.2.9 Insufficient Requirements

Changing or adding new requirements during the product development at later stages cause frustration for the evaluators. Evaluators develop test cases and make arrangements for evaluation according to requirements handover him at the start of project. But the modification and addition of new requirements make impossible to use the planned process for the evaluation. In this case they prefer to use traditional evaluation instead of making arrangements according to new requirements.

Changes in requirements affect the speed and working of the project. The projects de-track and schedule cannot follow as long as the project is approaching to project deadline. In this case the time for evaluation is neglected and nominal evaluation would be performed just to ensure the correct functional product without emphasizing the usability evaluation.

9.2.10 Cultural Difference

The cultural background of evaluator and the product is also one of the major factors which influence the adoption of UEMs. Most of time the application is developed according to the culture where development is done, and application is also evaluated according to existing culture. In this case the adoption of any formal process for evaluation reduces its effectiveness as the product is already developed according to standards.

The knowledge about the context in which the product will be used is an important factor which evaluators mostly ignore during the evaluation. The terminologies, interface standards, color scheme, accessibility issues etc are the main factors which vary with culture and the evaluator is unable to select the most appropriate and best suitable method for usability evaluation.

There are also some more factors which also were gathered through interview and observation. These factors can be called as the obstacles in adoption of Usability Evaluation Methods. These factors may include the dependency of customer’s approval, training, understanding of developed application, management attitude towards evaluators, pressures by project manager, customer and influence of change management etc. These factors are not discussed here because they are the part of above discussed factors/categories. For example training can be including in education and expertise category, pressures by project manager have relation with time constraint etc.

9.3 ADOPTION OF UEMs

The adoption of correct UEMs at correct time during the development of product is very important form the point of view of product’s quality and user satisfaction.
Extensive research have been conducted which describe the pros and cons of every UEMs and the procedure that how it can be deploy during the development.

During interviews and observation, the gap between academia and industry was found. This gap creates difficulty for evaluator to select and implement the appropriate UEMs. The main aim of conducting interviews is to find that how actually the UEMs is deployed because it is found from the interviews that the description of methods in literature and its implementation in real settings are different from each other.

By continuing the analysis and interpretation of data gathered by using the Grounded theory (GT) as mentioned in previous section, it was noticed that the main phases in web industry are the same as of traditional software development. The web development life cycle starts with Requirement Engineering and ends with deployment. The in-between phases are Analysis, Design, Coding and Testing. But these phases are more informal in nature in case of web industry. Most of organizations in web industry with only web development business have small setup with less than 50 employees having different expertise.

The importance of Usability from the developers and customer’s point of view is discussed above. It is found that very less importance is given to the usability. Due to this reason most of companies do not conduct usability evaluation in particular. They prefer to test the usability of the web application along with traditional testing in testing phase due to time, unavailability of resources and budget.

Many Usability Evaluation Methods (UEMs) have been proposed (See chapter 7). Some of them can be implemented at the early stages when paper design or prototype is developed like Heuristic Evaluation, Cognitive Walkthroughs etc. But it is the common practice that only approval from the customer is assumes to be sufficient after developing the design or prototype.

While on the other hand the customer only wants the functional and attractive product. Most of customer doesn’t know exactly about the concept of Usability, so due to lack of knowledge they cannot prefer to use UEMs. The customer put more stress on testing of product at the testing phase.

During interviews and observations, an interesting fact which was found is that the evaluators use combination of UEMs, but in fact they do not know the exact procedure and description of that method. For example the combination of Heuristic Evaluation (HE) and Feature Inspection was commonly used. Although they do not follow exactly the same procedure, still mostly usability evaluation is performed with reasonable good result. Instead of using the standard list of Heuristics given by Nielsen (See Appendix B), the list of features is used. There combination is used usually in later stages of product development when fully functional product or module (in case of modular development) is ready.

Similarly due to unavailability of resources, the exact number of evaluators cannot be used when any UEM is supposed to be implemented. For example about 4-6 or more evaluators are recommended for Heuristic Evaluation (Nielsen, 1992), but
it was observed that only 1-2 team members can be dedicated for evaluation of the product.

Due to this the exact idea behind this method is not met and the method can’t produce satisfactory results. Similarly to conduct Feature Inspection, the complete functional product is required with suitable number of evaluators, but some resources mostly show unavailability near the completion of project. So feature inspection cannot be performed efficiently.

From the categories identified in Section 9.2 of this thesis report, the Insufficient Requirement is an important category. After Requirement elicitation, the designer starts designing the template, while the development of database and analysis of requirement starts in parallel with designing, at this stage most of time no evaluator or tester play any role.

When developers code the application and handover to evaluator then the evaluator understands the application and selects the appropriate procedure for evaluation. No attention is given to usability when product delivery time is near. More focus would be on functionality and low error rates.

Although the involvement of customer is very advantageous during the product development, it was observed during interview that customer involvement sometimes causes frustration and difficulty in adoption of any new method or process (See Section 9.2.6). The lack of knowledge and continuously changing the requirements from customer’s side, make it difficult for the development team to develop such a desirable product.

The customer is normally more active at some stages such as Requirement Elicitation, Design and Deployment. The designers and testers complete their preparations according to the requirements. However, in the later stages or during design, the change in the requirements causes problems for the testers.

Heuristics Evaluations, Feature inspection and Cognitive walkthrough are the most commonly used UEMs in the industry. Although they are not deployed as mentioned in literature, but the concept and procedure remains the same. The modified things are the involvement of evaluators; roles of evaluators, time spent on evaluation and the phase where it is applied.

For example in Pluralistic Walkthroughs Evaluation method (See Section 6.3), every evaluator write down each action which he wants to perform in as much detail as possible. But in reality no evaluator follows this procedure. Either it is done in mind without any documentation or informally mentioned in that process.

In the following section, some suggestions and recommendations are given to the web industry on the basis of data gathered during this specific thesis.

9.4 RECOMMENDATIONS

To achieve the maximum UEMs efficiency and good output, it is important for web organizations to put more attention and focus on the implementation of Usability Evaluation. After analyzing the data gathered during this specific study,
there are some recommendations which can be helpful for organizations in this regard.

Organization’s practices (of the selected interviewees) and the literature are compared to generate the recommendations. Following are the most important 5 recommendations on the basis of this specific thesis are:

- **Changing the mindset of evaluators and the customer regarding usability and its evaluation.**

  The data collected during this thesis shows that the appropriate attention is not given to usability and UX (See Section 9.2.5 & 9.2.6). It is recommended to motivate the evaluators to involve the user and to use the proposed UEMs instead of traditional testing. Similarly the user should understand the importance of Usability and UX of the product.

  By compromising little time, the user can get a high quality with good usability product at the end. Also the understanding of usability contributes in changing the mindset of user to put more attention on the usability evaluation in parallel to functionality of the product.

- **Clear, complete and unambiguous requirements contribute in the right selection of UEMs at the right time during development.**

  Selection of appropriate UEMs for the product is based on requirements. The requirements should be clear and complete, so that when evaluator receives the requirement list, s/he is able to select the appropriate UEMs (See Section 9.2.9). Furthermore the evaluator should be informed if any change happened in requirements, so that s/he can modify arrangements according to new requirements.

- **Usability evaluation should not be limited to particular phase(s).**

  Usability evaluation can be conducted at different phases during the development process. The usability evaluation at design and coding phases are useful from maintenance point of view while the overall usability evaluation at testing and deployment phases produce quality product.

- **Giving trainings and enhancing education level can be beneficial from the evaluation point of view.**

  Organizations should keep interest in enhancing the abilities and education level of their employees. It is noted from the interviews that neither specific trainings nor courses can be conducted to enhance the abilities of evaluators (9.2.3, 9.2.5 and 9.2.10). The organizations as well as the evaluators should improve their education level with latest technologies to produce better results.

- **The role and respect of evaluators should be maintained.**

  The evaluators are treated in such a way that they feel their involvement and responsibility in the team (See Section 9.2.8). Involving evaluator at the time of
requirement elicitation is beneficial from the evaluation point of view. Furthermore it is recommended to reduce the communication gap between evaluators and other team members (See Section 9.2.7).
"The only relevant test of the validity of a hypothesis is comparison of prediction with experience”  
(Milton Friedman, 1912)

The validity in research contributes to ensure that the results are accurate and verified. There are validity threats which should be address in every research report.

Many validity criteria are given in different studies, such as Wohlin’s validity threats (Wohlin et al., 2000) and Trochim’s assessment criteria (Trochim, 2006).

This report uses the concepts and categorization mentioned by Trochim’s assessment criteria to identify the possible threats to the research findings.

The chapter starts with the brief introduction of validity threats along with the threats relevant to this study in detail.
10.1 VALIDITY THREATS

Every research (qualitative or quantitative in nature) requires validation (Trochim, 2006). The validation of research findings helps the reader to judge whether the findings are accurate and credible or not. Many validity threats have been proposed by different authors. Although some are same in nature somehow, but differ with terminologies and description.

Appropriate use of validity criteria plays an important role to show the credibility of research. Some researchers argue that quantitative validity can be used for qualitative data and research. In doing so the alternative criteria shows different perspectives (Trochim, 2006).

Traditional quantitative criteria given by Wohlin i.e. (internal, external, conclusion and construct) (Wohlin et al., 2000) are used exclusively in quantitative research. These criteria have not been used to validate the research findings of qualitative research.

One main reason is that by discussing the external validity, the idea of statistical analysis is used for generalizing the results, but on the other hand qualitative research deals with subjective analysis rather than statistics. Furthermore, there are no means to judge the reliability of qualitative data (Trochim, 2006).

Selection of validity criteria for qualitative and quantitative research is confusing and more work is required to clear this concept, so that new researcher can use the appropriate criteria to validate their research.

Validity criterion which is used in this thesis is mentioned by Trochim (Trochim, 2006). The main reason of using this is that these criterions give broader overview of threats to validity for qualitative research. The assessment criteria given be Trochim (Trochim, 2006) are:

- Credibility
- Transferability
- Dependability
- Confirm-ability

The brief description of these validity threats and how they are used in this thesis are explained in the following section.

10.1.1 Credibility

Credibility of results plays an important role in research (Trochim, 2006). This validity criterion includes the credibility and believes on results from the participant's point of view. The research during this thesis is conducted in two phases to make the results and report more credible from the participant's point of view. The data is said to be valid and credible if consistency exists between data gathered through different sources.
The research starts with literature review. Many research articles and reports have been studied. In later stages the empirical research in the form of interviews and observations (See Chapter 7 & 8) are conducted.

A brief introduction about the thesis subject including the focus of literature review is presented initially in the interview sessions. One important reason of explaining is to keep the interviewee interested and connect the findings to literature review focus, as a means to achieve consistency and thereby credibility. The face to face interviews (See Section 8.1.4) are conducted to collect data that can verify, refuse, complement and enrich understanding of general claims found in literature.

To get reliable data from interviewee, each step is validated twice like data analysis, research questions etc. although the data collection was done once it was are validated by the interviewee at the end of the interview sessions.

Sometime interviewees do not know the terminologies and concepts used in academia. To make the feedbacks consistent, all questions were asked in a simple language and validate them by observation. All diverse answers from others from consistency point of view were asked again at the end of interview sessions. To make the results credible, interviews were conducted in native language by using daily life language, the use of such terminologies which cause ambiguity or reduce the understanding of questions were not used at any time during interview.

Furthermore to get reliable information, all interviews are conducted at their work places where actual organization's setup is present. In this context it is easier for the interviewee to remember and relate to own work practice contingencies as the present physical and organizational surrounding triggers their memory. This approach increases seriousness from the interviewee, as according to Trochim (Trochim, 2006), it is only participants can judge the credibility if the results related to their situation and practice.

10.1.2 Transferability

Transferability involves the generalization and transferring of research results to some contexts (Trochim, 2006). According to Trochim, the researcher who generalized the research work is the responsible for judgment of what are to be transferred (Trochim, 2006).

To consider the transferability of this thesis, about 10 companies in Pakistan were contacted for their participation, but only 4 companies show willingness to participate in this study. Some constraints like time, budget, accessibility, availability and willingness may limit the research findings. Furthermore although 4 web companies of Pakistan interviewed but the findings can be transfer to those companies which have setup like the selected interviewees.

While analyzing the data gathered from interviews, the results are transfer/generalized to such companies which have same setup like the selected interviewees. The main reason is that all the interviewed companies have same setup and approximately similar business processes so generalizing is easy and logical in this way.
Moreover by considering transferability, results can be well suited for companies in Asian as well as European regions with similar setup. Culture, language, working times may differ but business setup and services were similar which help to generalize the results to those companies. It was tried to involve those companies which have web development as their main services.

The main reason for including such type of companies is that the thesis is mainly focus on web development organizations. All companies are from Pakistan where the thesis author has contacts. It helps in gathering data, easiness in communication with native language and provides feedback which is easy to understand for both author and the interviewee.

It is tried to choose the companies which have same services so that it is easy to generalize the results. In addition the background, education level and cultural differences are also kept in mind while conducting the interviews.

Moreover to keep the transferability in mind the discussion during interview sessions were mostly for overall project status at the company, not specific project was discussed. The main reason is that if particular project was failed due to some reasons or is very success with no relation with usability then the findings and answers would be different. Although such type of communication was conducted informally.

**10.1.3 Dependability**

According to Trochim, dependability deals with ever changing context in which the research is being conducted (Trochim, 2006). The research should be in a way that it explains all the changing that occurs in context and how these changes affect the research (Trochim, 2006).

The understanding of academic terminologies was one of the main threats while conducting the interviews. Most of the interviewees did not know the terminologies used in academia. It may reduce the credibility of results. Questions were asked in such way that the interviewee feels free to describe their process in his own wording. Furthermore the terminologies which are easily understandable and widely used in daily life are use instead of academic terminologies.

One possible threat that can affect the findings of the thesis is the selection of interviewee companies. It was tried to select the companies with similar services, but some of organizations also provide services in addition to web developments. Furthermore the number of employees may affect the findings of the research. If all companies have similar number of employees then there will be no such type of threat, the variation of employees is not so big in the selected companies.

**10.1.4 Confirmability**

Confirmability deals with the degree to which the results can be confirmed (Trochim, 2006). The procedure of the interview and verifying the data throughout the study is documented to reduce validity threat.
Different strategies have been used to increase the Confirmability of the thesis. Results of each interview and observation were prepared without any delay to reduce the risk of missing and skipping information. It was developed field notes i.e. in as much as in detail as possible given the circumstances. In addition, the questions which were answered ambiguously or unclearly were asked again and confirmed again at the end of the interview sessions.

The questions were prepared so that they are useful in getting information with proper and reasonable wording. The main points were highlighted while taking the notes. After interview session all the field notes were summarized and re-written in separate document without ignoring any information.

The mood and interviewee's reactions also observed during the interview to get the consistent and reliable results. The semi structured interviews and all the procedures were also noted.
SECTION IV – EPILOGUES

Chapter 11: Conclusion and Future Work
Chapter 12: References
11 CONCLUSION AND FUTURE WORK

CHAPTER 11

"Please be good enough to put your conclusions and recommendations on one sheet of paper in the very beginning of your report, so I can even consider reading it”.
Winston Churchill (1874-1965)

This chapter contains the conclusion of this thesis study. There are some interesting areas which may need future work. The conclusion is stated in section 11.1 with proceedings the revisiting the research questions in section 11.1.1. Section 11.2 explains the future work of this topic.

11.1 CONCLUSION

World wide web (www) has achieved an important role in the communication, information sharing and services delivery within last few years. Due to wide use of web applications, the usability of web application plays an important role. The users will be satisfied if the websites are conforming to the required functionality with desired quality level.

Different identifications and terminologies exist about Usability and UX in the literature which may confuses the general user. Although these terminologies are similar in some sense but they differentiate from context point of view.

Although extensive research have been conducted which identify different type of usability issues like page loading time, color scheme, font size etc, this thesis helps the web industry by identifying and categorizing the usability issues in four factors i.e. user, tool, technology and context.

The results of this thesis study also showed that poor usability leads to poor user experience (UX), but it is not definite that good usability leads to good UX. Most of the time some usability attributes contributes more in the satisfaction of one user but sometimes some another. Furthermore it can be concluded that there exist relationship between usability of the product and UX either positively or negatively depending upon the influence of usability on UX.

Despite the importance of usability evaluation, there are some factors which influence the adoption of UEMs. The main focus of this thesis study is to identify these factors and obstacles. The main categories which influence the adoption of UEMs identified in this thesis studies are Budget Constraints, Time Constraints, Usability Importance, Resource Availability, Education and Expertise, Evaluator’s Role, Customer Involvement, Insufficient Requirements, Communication Gap and Cultural Difference.

In addition a number of suggestions are also given to the development organizations that how they can adopt the UEMs by considering the development phases. These suggestions and recommendations are helpful in adopting the correct
and appropriate UEMs at appropriate time. The organizations should understand and give attention to usability in order to produce high quality products. In addition, it is easy to adopt appropriate UEMs by reducing the influence of identified factors.

11.1.1 Research Questions Revisited

This thesis is based on six research questions. This section describes that how these questions have answered to fulfill the objective of this thesis study.

RQ1. What are the different concepts and terminologies for usability and user experience in the literature?

Different concepts and terminologies are identified during this thesis. The contribution of this thesis study is to identify different terminologies and definitions, models and ISO standards and come up with all possible and important terminologies which are used in literature in a single report (See chapter 2&3).

According to ISO/IEC 9126-1, the usability is defined as “The capability of the software product to be understood learned, used and attractive to the user, when used under specified conditions” (ISO/IEC9126, 1991). Similarly different other concepts and terminologies from different authors and models have been identified in chapter2 and 3 which reflect the answer of this research question.

RQ2. Which are the usability issues that the users encounter when using web applications?

This thesis contributes in identification of usability issues that the user can encounter when they use the application. The chapter 4 solely describes these issues in detail which can arise due to user, technology, type of tasks and context. Extensive literature review is conducted to give the answer of this question.

Different studies (See Section 4.3) identified some usability issues in their report. The contribution of this thesis is to categorize the usability issues into user, technology, type of tasks and context categories.

RQ3. What is the relationship between usability and user experience for websites?

It is shown from the literature review that usability and UX have some relationship with each other. Section 4.4 describes such relationship with context to web applications. For example, the bad usability of web application results the poor UX.

The user is frustrated when s/he cannot complete his task efficiently e.g. if user wants to read the newspapers online, then due to slow speed internet connection, the web page is so heavy that it takes more time. In this case the users become frustrated and show his irritation towards the site.

The relationship between usability and UX depends mainly on the context in which the product is being used. It is found from literature review that usability is good for one user but at same time it is bad for others which cause the variation in UX.
Similarly there are some other factors (Section 4.4) which describes that how usability can affect the user experience both in good and bad ways. These factors may include time, cost, referral and trust.

**RQ4. What are the different usability evaluation methods?**

Different usability evaluation methods are proposed in literature by different authors. Chapter 5 and 6 tried to answer this question, by focusing on usability inspection methods. There are two main categories exists for evaluating the usability of the product i.e. *Formative and Summative*. Three main types of evaluation methods are found in literature i.e. *inquiry, testing and inspection*.

By further exploring the inspection methods, different methods have been identified which can be implemented at different phases during the development life cycle. These methods includes *Heuristic Evaluation, Cognitive walkthrough, Perspective based evaluation, Feature inspection and Pluralistic walkthrough*.

Detailed description of each method is presented in Chapter 6 to understand their working in addition to answer this question.

**RQ5. How the identified usability inspection method(s) can be used to evaluate the usability of websites during development phases?**

This research question is answered through empirical research which composed of 4 interviews with web development organizations in Pakistan. The data gathered from interviews are then analyzed with GT.

By answering this question, it is found that companies are not pay attentions to usability evaluation and especially in selection of UEMs. After interviewing and analyzing the results it is found that a gap is present between academia and practice (See Section 9.4). In addition, companies’ use UEMs but they are not in their original form, i.e. they can use combination of two methods but in reality they do not know the name and description of those methods.

The recommendations are also given by which organizations can adopt the appropriate UEMs during product development.

**RQ6. Which organizational factors influence the adoption of these usability inspection methods?**

Some organizational factors are identified after interviews with companies (See Section 9.2). These interviews produce the list of factors which influence the adoption of usability inspection methods.

These factors include the *Time constraint, budget, resource availability, evaluator’s role, Usability Importance, Customer Involvement, Communication Gap, Insufficient Requirements and Cultural Difference*.

The above section describes that how research questions are answered in this thesis study. Both literature and empirical research are used to find the answers. The next section describes some future work which was found interesting during this thesis.
11.2 FUTURE WORK

This section mentions the areas which have many paths and open for future research.

- **Development of UEMs Selection Criteria**

  Although some authors suggested some criteria and rules for the selection of UEMs, but still there is need to develop a unified set of standards used to select the UEMs.

- **Changing Mindset towards UEMs**

  It will be good contribution in usability world to research how mindset of user and developers can be changed towards UEMs. The importance of traditional testing is not negligible but adoption of standards UEMs is also important from the point of view of product usability. So success factors and procedures which help in adoption of UEMs may be a good area.
12 REFERENCES


Framework for Understanding, 6th World Multiconference on Systemics, Cybernetics and Informatics. Orlando, Florida, US.


ISO13407 1999. Human-centred design processes for interactive systems.


SECTION V – APPENDIXES

Appendix A : Interview Questionnaire
Appendix B : Nielsen’s Heuristics List
APPENDIX A: INTERVIEW QUESTIONNAIRE

Name: 
Organization Name: 
Designation: 
Working Experience: 
Gender: 
Qualification: 

Q1:- How do you rank usability as an important quality attribute?

Q2:- Is usability evaluation as important as traditional testing in Web development?
   a:- Yes: To what extent you consider it important over traditional testing?
   b:- No: How do you balance usability evaluation with tradition testing?

Q3:- How many employees do you have in your organization?

Q4:- Do you involve User in Usability Evaluation process?
   a:- Yes: What is your role and responsibilities?
   b:- No: How do you keep in touch with evaluation process?

Q5:- Do you analyze the context of use of application in requirement analysis?
   a:- Yes: How do you analyze it, visit their place, read documents etc.?
   b:- No: How do you imagine the context in which application will be used?

Q6:- How do you evaluate usability of web applications?
   a:- With Usability Evaluation Methods
   b:- With Traditional Testing

Q7:- Does your organization conduct any research activity?
   a:- Yes
   b:- No

Q8:- If Yes, then What
   a:- Writing Articles
   b:- Attending Conferences & Seminars
c:- Reading Articles

d:- Conducting Surveys, other than project related

e:- Collaboration with Academic/Research Institutes

Q9:- Do evaluators have any type of formal training/course for usability evaluation/Testing?

a:- Yes

b:- No

Q10:- How many Usability Inspection Methods are you familiar with?

a:- Heuristic evaluation

b:- Cognitive Walkthroughs

c:- Perspective Based Usability Inspections

d:- Pluralistic Walkthroughs

e:- Feature Inspection

Q11:- Which inspection method(s) do you use for usability evaluation?

a:- Heuristic evaluation

b:- Cognitive Walkthroughs

c:- Perspective Based Usability Inspections

d:- Pluralistic Walkthroughs

e:- Feature Inspection

Q12:- At Which level do you evaluate the Usability of an application?

a:- Analysis

b:- Design (Prototyping)

c:- Coding

d:- Testing

e:- Deployment

Q13:- How many evaluators involve in Usability evaluation?

Q14:- What are the designations of evaluators who involved in Usability evaluation?
Q15:- Usually what are the qualifications of Evaluators?

Q16:- Rank the Usability attribute(s) you consider more while evaluating the application? (5 = Very Important, 4 = Important, 3 = Moderately Important, 2 = Of Little Importance, 1 = Unimportant)

a:- Efficiency
b:- Learn-ability
c:- Effectiveness
d:- Satisfaction
e:- Memor-ability
f:- Errors/ Safety
g:- Operability
h:- Load Time
i:- Functionality
j:- Context of Use
k:- Attractiveness
l:- Understandability
m:- Helpfulness
n:- Flexibility

Q17:- How much of total time do you spend on Usability evaluation during development life Cycle?

a:- 10-20%
b:- 20-30%
c:- 30-40%
d:- If Other (Please Specify)

Q18:- What are the factors which restrict you to use Usability Evaluation Methods?

Any Comments (About Usability Evaluation):
## APPENDIX B: NIELSEN’S HEURISTICS LIST

Table 16: Neilson’s Heuristics (Appendix B)

<table>
<thead>
<tr>
<th>Neilson’s Heuristics (Nielsen, 1992)</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visibility of system status</strong></td>
<td>The system should always keep users informed through appropriate feedback within reasonable time.</td>
</tr>
<tr>
<td><strong>Match between system and the real world</strong></td>
<td>The system should use familiar and conventional terms in logical order instead of using the system oriented terminology.</td>
</tr>
<tr>
<td><strong>User control and freedom</strong></td>
<td>The system should support <em>undo</em> and <em>redo</em> functions, as users often choose mistakenly wrong path and needs emergency exit to leave the undesired state.</td>
</tr>
<tr>
<td><strong>Consistency and standards</strong></td>
<td>The system should have different words, situations and acts for different things. It is not suitable that user confused with same words but different meaning. Always follow the platform conventions on which the system will be used.</td>
</tr>
<tr>
<td><strong>Error prevention</strong></td>
<td>To prevent the error always give confirmation option to users before they commit the action. The error message should be used carefully, as they prevent the problems.</td>
</tr>
<tr>
<td><strong>Recognition rather than recall</strong></td>
<td>The user’s memory load should be minimizing by making the actions and options clear. It is not appropriate for the users to remember information at different phases of use. The help/instructions for use should be clear and easily accessible.</td>
</tr>
<tr>
<td><strong>Flexibility and efficiency of use</strong></td>
<td>The system is capable to accommodate both experience and inexperienced users by using accelerators. The users should be allowed to tailor their frequent or last actions.</td>
</tr>
<tr>
<td><strong>Aesthetic and minimalist design</strong></td>
<td>Irrelevant and the information which are seldom used reduce the visibility and relevance of required information, so they should be avoided in the system.</td>
</tr>
<tr>
<td><strong>Help users recognize, diagnose, and recover from errors</strong></td>
<td>Error messages should be constructive and in plain language. They indicate the problems and suggest the reasonable solution.</td>
</tr>
<tr>
<td><strong>Help and documentation</strong></td>
<td>The system should provide with documentation and helping manuals which concentrate on the user’s tasks and list of productive steps precisely.</td>
</tr>
</tbody>
</table>