Usability Heuristics for Designing Web Data Entry Forms

Submitted by:

Saadia Shabbir

371-FBAS/MSSE/S13

Supervised by:

Supervisor: Ms Salma Imtiaz

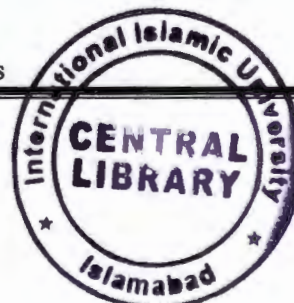Co-Supervisor: Sir Muhammad Nasir

Department of Computer Science and Software Engineering

Faculty of Basic and Applied Sciences

International Islamic University Islamabad

[2016]

Department of Computer Science and Software Engineering

International Islamic University Islamabad

Date: <u>28-7-2016</u>

Thesis Approval

This is to certify that we have read the thesis submitted by **Saadia Shabbir** Registration No: **371-FBAS/MSSE/S13**. It is our judgment that this thesis is of sufficient standard to warrant its acceptance by International Islamic University, Islamabad for the degree of **MS in Software Engineering.**
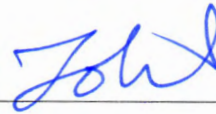
<u>External Examiner:</u>

Dr M .Zohaib Zafar Iqbal

Associate professor

Department of Computer Science

National University of Computer and Emerging Sciences (Fast-NU)

<u>Internal Examiner:</u>

Ms Saima Imtiaz

Lecturer

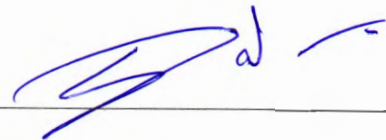*Department of computer science and software engineering*

<u>Supervisor:</u>

Ms Salma Imtiaz

Assistant professor

Department of computer science and software engineering
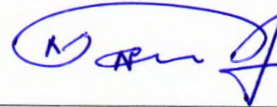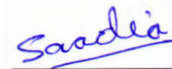
<u>Co-supervisor:</u>

Mr. Muhammad Nasir

Lecturer

Department of computer science and software engineering

A dissertation Submitted To

Department of Computer Science and Software Engineering

Faculty of Basic and Applied Sciences,

International Islamic University, Islamabad

As a partial fulfillment of the requirement for the award of the

Degree of *MS in Software Engineering*

Declaration

I hereby declare that this Thesis **"Usability Heuristics for Designing Web Data Entry Forms"** neither as a whole nor as a part is copied out from any source. It is further declared that I have done this research on the basis of my personal efforts, under the proficient guidance of my supervisors. If any part of the system is proved to be copied out from any source or found, I shall stand by the consequences.

Saadia

Saadia Shabbir

371-FBAS/MSSE/S13

Acknowledgement

I would like to express my humble gratitude Allah almighty, the most merciful and compassionate who has been so kind in conferring his blessings upon me and providing me the energy, courage, quest and sanity to accomplish my responsibilities and to successfully complete this thesis.

I would like to express my immense gratitude to my whole family especially my parents who have always been loving, caring and supportive for me. It was just their kind support and prayers that made me accomplish my work in a successful way

I express my gratitude to my supervisor Mr. Muhammad Nasir and Ms Salma Imtiaz who kept my morale high by their suggestions, appreciation and humbleness. They kept me motivated and guided me throughout the project development.

I am especially thankful to my teacher Dr Naveed Ikram who guided me throughout my thesis work.

I am also thankful to my friends who accompanied and encouraged me throughout my course of studies in this university and especially during the project.

Saadia Shabbir

Thesis in Brief

Thesis title: **"Usability Heuristics for Designing Web Data Entry Forms"**

Objective: To compose an optimal set of usability heuristics for designing Web data entry forms for a web management information system, specifically designed for collecting data from the field workers regarding polio eradication in Pakistan ,that can address majority of usability problems related to web data entry forms

Undertaken By: **Saadia Shabbir**

371-FBAS/MSSE/S13

MS in Software engineering

Faculty of Basic and Applied Sciences

International Islamic university Islamabad

Supervised By: **Ms Salma Imtiaz**

Co-supervised By: **Sir Muhammad Nasir**

Documentation Tools: Microsoft word 2010

Microsoft excel 2010

Spss version 23

Adobe pdf reader

Operating system used: Microsoft windows 8.1

Abstract

Context: Websites are the most frequently used application type.Over the past couple of decade's Web Data Entry Forms have become the commonly used medium for online data entry.Websites perform various functions for example e-commerce, file sharing, blogs. All these functions require users to submit their personal information in order to create an account, purchase an item, and give feedback and to obtain a service. Therefore Web data entry forms are used by majority of websites as a communication medium between users and website owners to facilitate and customize online transactions and to improve data entry accuracy and efficiency. Hence the ease of use of Web Data Entry Form is quite important and thus, usability plays an important role in it.

Problem: Study of literature shows that various sets of heuristics have been proposed for Web Data Entry forms. However most of the web data entry form heuristics have not been validated and consist of limitations. As these heuristics are not validated and don't cover all aspects .Therefore there is no consensus as to which set of heuristics are most suitable and effective in addressing majority of usability problems regarding web data entry forms. Thus there is a need to compose an optimal set of usability heuristics and to validate the optimal set of usability heuristics

Objective: The main focus of this research thesis is to compose an optimal set of usability heuristics that are suitable in addressing majority of the usability problems regarding web data entry forms and are effective in designing web data entry forms. Similarly to validate the optimal set of usability heuristics by performing usability testing

Research method: A systematic mapping study is conducted in order to identify the data entry problems faced by users and to identify the usability heuristics that exist in literature for designing web data entry forms. The usability heuristics obtained through systematic mapping study are not enough and consisted of limitations. Therefore online help repositories, online help manuals, online articles, websites and books are searched to increase spectrum of usability heuristics. It helps in finding industry based usability heuristics. The industry based heuristics consists of heuristics based on experience and best practices of usability experts and practitioners. It helps in finding heuristics which are effective in designing web data entry forms and addresses majority of the usability problems regarding web data entry forms. The usability heuristics obtained are categorized as Usability Heuristic set 1(Common Heuristics) and Usability Heuristic set 2(Common plus Others heuristics).An

experiment is designed by implementing Web Data Entry Forms for polio information web application based on usability heuristic set 1 and usability heuristic set 2.The usability of implemented polio information Web data entry forms is evaluated by performing usability testing with a group of users.

Results: Statistical findings show that a significant difference is observed between usability of web data entry forms designed with usability heuristic set 1and usability heuristic set 2 in terms of four usability scales that are attractiveness, perspicuity, efficiency and novelty. While no significant difference is observed in two usability scales that is dependability and stimulation

Conclusion: It is concluded that the polio information web data entry forms designed with usability heuristic set 2(Common plus Others Heuristics) is better, than the web data entry forms designed with usability heuristic set 1(Common Heuristics)

Table of Contents

Table of tables

Table of figures

Chapter 1
Introduction

1. Introduction
1.1. Usability and HCI

HCI (Human Computer Interaction) basically deals with two aspects namely design and evaluation of interactive computing systems .It consists of three components that is humans, which means person or group of individuals who are interacting with the system in order to perform a certain task. Computer, consists of devices such as keyboard, mouse or embedded systems. Interaction, is the communication of information between users and computer systems. For example in order to login, a person enters his email id and password into a computer system. The computer returns an output displaying the welcome message and home page of that system to use, if persons email id and password is right. [1].The goal of human computer interaction is to create usable software products or user interfaces in order to enhance the usability of software products [2]

Usability plays a major and important role in developing a software in Human Computer Interaction (HCI) field. Usability is a part of HCI research and design field and in order to design a user satisfied human computer interaction usability plays a very vital role. Usability [3] is the ease of use and learnability of the system where ease of use effects user satisfaction and performance. According to international standard organization (ISO) 9241-11 [1] [3] usability of a software product can be defined as "*The extent to which the user can use the product in order to achieve their goals efficiently, effectively and with higher satisfaction*" The basic goal of usability is to help users to perform their tasks. According to Nielsen usability can be defined as a quality attribute which improves ease of use during design process [4] .Usability consists of five quality attributes or components namely learnability, efficiency, memorability, errors and satisfaction which are described below

1.1.1. Learnability [1] [3] [4]:
Learnability means that how easy it is for the users to learn the system functionality and accomplish their tasks

1.1.2. Efficiency [1] [3] [4]:
Efficiency means that after getting familiar with the system how quickly the user can perform tasks.

1.1.3. Memorability [1] [3] [4]:

Memorability allows irregular users to use the system without learning it .It reflects that how well user has re-established expertise with the system functionality

1.1.4. Error Prevention [1] [3] [4]:

It discusses that how many errors are made by the user while using the system and whether those errors can be resolved easily

1.1.5. User Satisfaction [1] [3] [4]:

It describes user satisfaction with the system i.e. does the user feels satisfied while using the system.

To improve usability of a software product there exists many usability techniques and methods such as usability evaluation methods and usability inspection methods that are described below

1.2. Usability Evaluation Methods

Usability evaluation methods consists of Usability Inspection Methods, User testing, Inquiry methods Analytical and stimulation methods [5].In Inspection methods usability problems are found on the basis of usability professional's expertise. Usability inspection methods [6] [5] consists of heuristic evaluation, cognitive walkthrough, perspective based inspection and guidelines review. Heuristic evaluation consists of a group of usability specialists who examines each element and dialog of software system against a set of usability principles which are known as heuristics. Cognitive walkthrough consists of usability specialist to evaluate user interface design based on cognitive model of learning and use. In Perspective based inspection evaluation is conducted by experts on the basis of design perspectives, inspectors' tasks, or metric calculation [5] .Whereas in guidelines review the consistency of website objects are verified by using a set of usability guidelines.

User testing involves real users interacting with the system to perform a set of predefined tasks in order to assess the usability issues within a system [5] [7]. In user testing usability can be measured by using empirical methods such as observational methods and questions. Usability testing known as empirical user testing involves measuring the performance of users while performing tasks. The measurement is done with regard to the ease of use, the task completion time, and the user's experience of the software application [8]. Usability testing is effective in finding severe

problems[9] .In inquiry methods the users give feedback regrading user interface through the methods such as questionnaire, focus group and interview .They are used for gathering subjective data from the users Analytical modelling and simulation methods uses different types of models to predict usability

1.3. Web Data Entry Forms

Websites are the most frequently used application type [10,11,12,14,15,16,17,18,19,35,43].Over the past couple of decade's Web Data Entry Forms have become the commonly used medium for online data entry.Websites perform various functions for example e-commerce, file sharing, blogs. All these functions require users to enter data for further processing. Therefore the ease of use of Web Data Entry Forms is quite important and thus, usability plays an important role in it.

Data entry Forms are used on a website for performing transactional tasks [10] in which the users are required to fill online web data entry forms to create an online account, purchase an item and to obtain services. Web data entry forms can be used as registration forms, checkout forms in order to initiate transactions between users and companies' .They can also be used as data input forms to search or share information [11] [12]

Web data entry forms are used by majority of websites as a contact point or communication medium between users and website owners i.e. companies, government institutions [13] [14]. It helps to facilitate and customize online transactions as well as to improve data entry accuracy and efficiency. Majority of the users visit online websites such as online shopping websites or ecommerce websites with the purpose of online shopping, purchasing items, registration or obtaining services quickly rather than filling a web data entry form. Therefore in this situation the users are shown a web data entry form to complete in order to proceed and complete their shopping process. However in this context a web data entry form can be perceived as an obstacle or hurdle [13] .Therefore the design of web data entry forms is crucial for the success of online web transactions .The Design of web data entry form should be usable, intuitive and interactive in order to facilitate users and to provide guidance to them regarding the process of form filling to prevent errors. A small variation in the design of web data entry form can result in errors and can increase or decrease the user satisfaction, errors or the interaction speed [11]

An important aspect of creating interactive web data entry forms is to check that the information submitted through the form is validated .Similarly, the most important aspect of web data entry forms are the error messages ,which point at the problem and provide solution to solve it as quickly as possible .The Web Data Entry Form can facilitate and customize online transactions, improve data entry accuracy and efficiency, detect and mitigate errors and helps in preventing errors through form validation.

An online web data entry form consists of various elements such as input fields, radio buttons, check boxes, drop down menus and list boxes to provide form filling options to the users. It consists of several aspects such as form content, form layout, input types, error handling and form submission to promote usable form interaction .Usability plays a very important role in web data entry forms, so that the users can fill the form easily and quickly .A good and usable web data entry form design prevents errors during data entry by facilitating users to easily and quickly correct errors which are often difficult to prevent. Therefore the ease of use of Web Data Entry Form is quite important

1.4. Gap Analysis

Literature highlights that various sets of heuristics have been proposed by different researchers for Web Data Entry Forms [10] [11] [12] [13] [14] [15] [17] [24] [32] [35] [43] [44]. However most of web data entry form heuristics have not been validated [11] [12] [13] [17] [24] [32] [40] [44] and consists of limitations. As these heuristics are not validated and do not cover all aspects .Therefore there is no consensus as to which set of heuristics, are most suitable in addressing majority of usability problems regarding web data entry forms as well as effective for designing web data entry forms. Thus there is a need to compose an optimal set of usability heuristics for designing web data entry forms which are suitable in addressing majority of the usability problems regarding web data entry forms as well as effective in designing web data entry forms. Similarly to validate these optimal set of usability heuristics

1.5. Research Question

In this research thesis following research questions were addressed:

RQ1). What data entry problems are reported by researchers in Theory?

RQ2).What Usability Heuristics exists in the Theory for designing Web Data Entry Forms?

RQ3).What is optimal Set (i.e. most effective Set) of heuristics for designing Web Data Entry Forms?

1.6. Expected Outcome

The expected outcome is an optimal set of usability heuristics for designing web data entry forms for polio information web application. The optimal set consists of a set of usability heuristics that are suitable in addressing majority of the usability problems regarding web data entry forms as well as effective in designing web data entry forms. These optimal set of usability heuristics can facilitate users, provide ease of use as well as guidance to them while interacting with the web and filling the Web Data Entry Forms.

1.7. Research Contribution

In this research thesis an optimal set of usability heuristics for designing polio information web data entry forms are presented. These optimal set of usability heuristics provides most effective set for designing web data entry forms which helps in addressing majority of usability problems regarding web data entry forms. It helps in creating usable, intuitive, interactive and easy to use web data entry forms. Similarly it facilitate users and provide guidance to them regarding form filling process i.e. how to fill the web data entry form in order to prevent and mitigate erroneous entries. Ignorance of these usability heuristics results in un-usable web data entry forms with errors and less user satisfaction. This work is a source of motivation, as it highlights the data entry problems faced by users while entering data into web data entry forms. It also highlights the usability heuristics that exists in literature for designing web data entry forms as well as the industry based heuristics for designing web

data entry forms, which are collected from online repositories, online articles books and websites in order to compose an optimal set of usability heuristics. It provides an optimal set of validated usability heuristics, which helps in addressing majority of usability problems regarding web data entry forms and is effective as well as useful in designing web data entry forms .It can also be used by websites in order to enhance usability, user experience, user satisfaction and to facilitate as well as assist users regarding form filling process

1.8. Research Method
1.8.1.Research Process
The research process and its diagrammatical representation is given in figure 1 shown below

```
┌─────────────────────────────────────┐
│         Research Question           │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│      Systematic Mapping Study       │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│    Identifying Data Entry Problems  │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│      Analyzing Existing Heuristics  │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│ Composing Optimal set of Usability  │
│            Heuristics               │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│     Implementation (Experiment)     │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│ Usability testing (Research         │
│ Validation)  of Composed Heuristics │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│              Results                │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│    Conclusion and Future Work       │
└─────────────────────────────────────┘
```
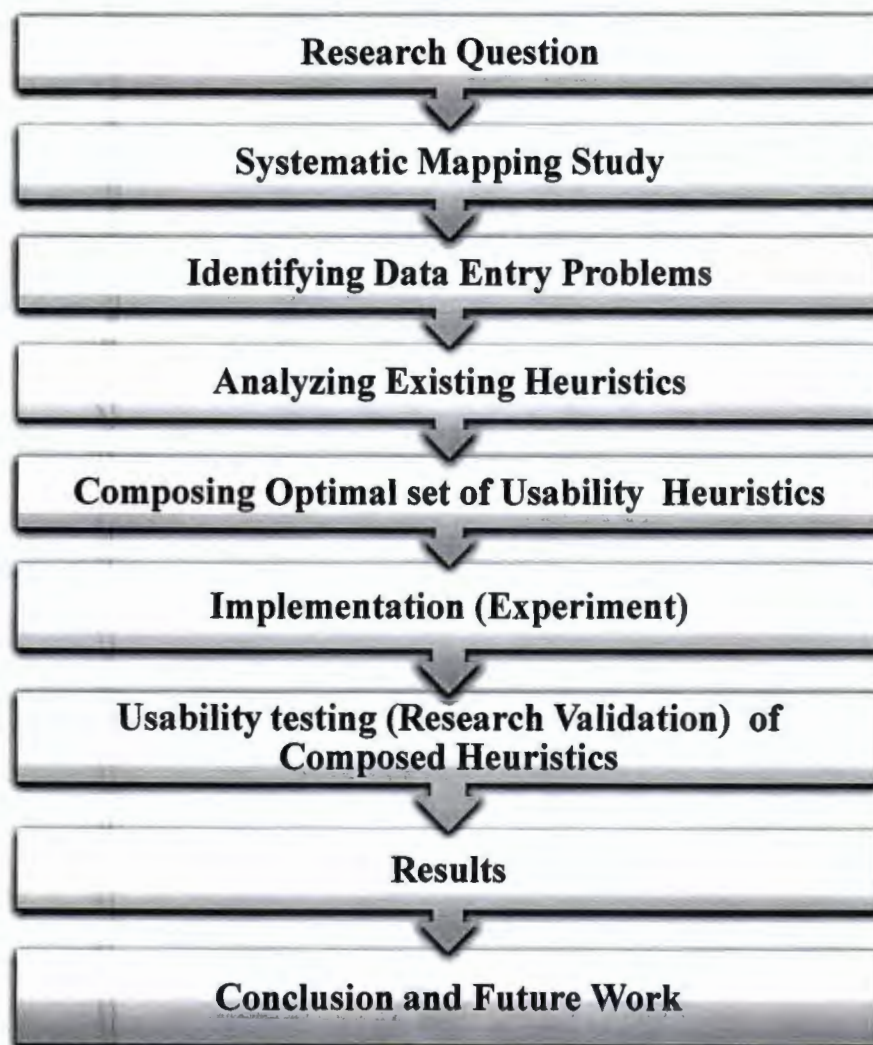
Figure 1: Research Process

1.9. Research Objective

The objective of this research is to:

- Analyze the usability problems related to Web Data Entry Forms
- Identify the usability heuristics that exist in theory for designing web data entry forms
- Compose an optimal set of usability heuristics for polio information web data entry forms that are suitable in addressing majority of the usability problems regarding web data entry forms as well as effective in designing them
- Conduct an experiment by designing polio information web data entry forms with usability heuristic set 1 (Common Heuristics) and usability heuristic set 2 (Common plus Others Heuristics)
- Evaluating the usability of object that is polio information Web Data Entry Form developed in our experiment by performing usability testing

1.10.1 Study Context

In this research thesis an experiment is conducted in which the web data entry forms are designed on the basis of usability heuristic set 1 and usability heuristic set 2 for polio information web application.

1.10.2 Data Collection

All the data regarding, data entry problems faced by users and the usability heuristics that exists for designing web data entry forms is collected by conducting a Systematic Mapping Study. The data collected through systematic mapping study is not enough and consist of limitations. Therefore online repositories, online help manuals, online articles, books and websites are searched, to increase our spectrum of usability heuristics and to obtain industry based heuristics that are derived from experience and best practices of usability experts or practitioners.

1.10.3. Data Analysis Method

Trend analysis technique is used to analyze the data collected through systematic mapping study in different digital libraries

1.10.4. Evaluation Method

After implementing polio Information web data entry forms designed using usability heuristic set 1 (Common Heuristics) and usability heuristic set 2(Common plus Others Heuristics), they are evaluated by performing usability testing with real users. Usability testing of Polio information Web Data Entry Forms provide the results that whether the Web Data Entry Form designed using usability heuristic set 1 is better in comparison with web data entry form designed using usability heuristic set2 or vice versa. A semantic differential questionnaire is used as an inquiry method to take feedback from user and is self-administered and printed.

1.10. Research Method

A systematic mapping study is conducted in order to identify the data entry problems faced by users as well as the usability heuristics that exist in literature for designing web data entry forms. The usability heuristics obtained through systematic mapping study are not enough and consisted of limitations. Therefore online repositories, help manuals, online articles, websites and books are also searched to increase our spectrum of usability heuristics as well as to obtain industry based heuristics. These industry based heuristics consists of usability heuristics that are based on experience and best practices of usability experts or practitioners .This helps in obtaining heuristics which are effective in designing web data entry forms and addresses majority of the usability problems regarding web data entry forms. The collected usability heuristics that exists literature for designing web data entry forms and the industry based heuristics obtained from online repositories are categorized as usability heuristic set 1(Common Heuristics) and usability heuristic set 2(Common plus others heuristics).An experiment is designed to compare the usability of two set of heuristics. To implement Web Data Entry Forms for polio information web application based on usability heuristic set 1 and usability heuristic set 2 .The usability of implemented polio information web data entry forms designed with usability heuristic set 1and usability heuristic set 2 are evaluated by performing usability evaluation i.e. usability testing with a group of users. The inquiry method such as questionnaire is used to gather subjective data from the user in order to capture user experience and to assess usability .Thus it determines that whether the composed usability heuristics set 1 and usability heuristic set 2 is beneficial or not

1.11. Thesis Outline

The research thesis is organized as follows: chapter 1 provides Introduction, Background, Research Objective, Gap Analysis, Research Motivation and Research Process. Chapter 2 describes systematic mapping study and mapping of data entry problems with heuristics and literature. Chapter 3 describes the categorization of web data entry form heuristics with Nielsen and Schneiderman usability heuristics in detail. Chapter 4 presents experiment design and implementation by describing dependent variables, hypothesis formulation, and the screen shots of system implemented (i.e. polio information application domain).Chapter 5 describes usability testing of polio information web data entry forms designed with usability heuristic set 1 and usability heuristic set 2 .Chapter 6 discusses results and analysis and chapter 7 describes conclusion, discussion and future work

Chapter 2

Systematic Mapping Study

2.1. Systematic Mapping Study

The objectives of conducting systematic mapping study are as follows:

- To provide an overview of a research area and allows to identify the type and quantity of research as well as the results available within it that research area

- A mapping study is performed at a higher level with the aim to identify research gaps as well as the evidence to conduct future research

- We conducted a systematic mapping study in two phases with the following objectives:
    1. To address the first research question by identifying the data entry problems faced by users that exits in theory
    2. To address the second research question by identifying the usability heuristics that exists in theory for designing web data entry forms

Therefore a systematic mapping study is conducted to provide coverage of research area .It ensures that none of the data entry problems faced by users while filling web data entry forms as well as the usability heuristics that exist in theory for designing web data entry forms are missed

The protocol used for system mapping study is shown below:

2.1.1 Systematic mapping process

Systematic mapping study consists of following processes and outcomes:

Process steps
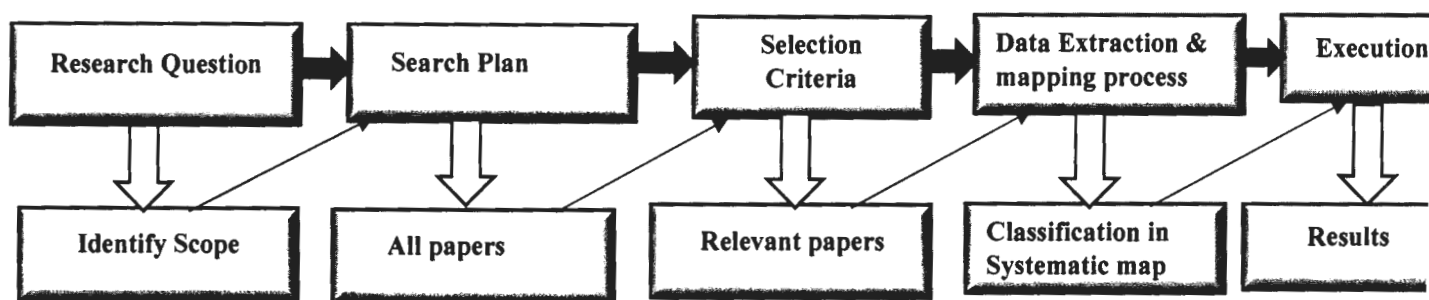
Outcomes

Figure 2: Systematic Mapping Process

In the systematic mapping process diagram shown above

⇩ [Shows outcome which is generated from each step of systematic mapping process]

↗ [It represents how outcome becomes input of each step of system mapping process]

The first phase of systematic mapping study was used to study data entry problems faced by users in order to do classification and gather primary studies regarding the data entry problems that are faced by users while filling web data entry forms

2.1.1.1 Data Entry Problems

a. Research Question (Identify Scope):

The first step of systematic mapping study is *"Research Question "*in which the research questions should be defined on the basis of objective of research. As an outcome the scope of research is identified which is used as an input to 2nd phase of systematic mapping study i.e. Search plan

We conducted Systematic mapping study in order to study the following research questions

RQ1) what data entry problems are reported by researchers in theory?

b. Search Plan (All papers):

The second step of systematic mapping study is **"Search plan"** also known as search strategy in which the primary studies are identified by using search strings in different digital libraries or databases. In our systematic mapping study the primary studies regarding data entry problems faced by users in web data entry forms are identified both manually and by using search string in the following digital libraries

• Digital Libraries

The following digital libraries are used:

1. IEEE Explorer
2. ACM digital library
3. Science Direct
4. Springer Link
5. Google Scholar

- **Search String**

A Pilot testing is performed on the search string. The following search string is used in different digital libraries to identify the primary studies regarding the data entry problems faced by users in web data entry forms

(Web AND (Data Entry AND (Form OR Screen)) AND (Problem OR Error OR Issues))

IEEE Xplorer=**16 results**

ACM digital library= **41 results**

Springer link=**100 results**

Science direct=**70 results**

Google scholar =**80 results**

c. Selection Criteria (Relevant papers)

After obtaining the primary studies i.e. initial set of papers from the digital libraries, the relevant papers or studies are selected by applying inclusion and exclusion criteria. The inclusion and exclusion criteria describes that which papers are be included or excluded. During selection of papers we closely examined the title, keywords and abstract of each study in order to determine that whether that paper or study is relevant. In case of the papers whose abstract did not give sufficient information, than the full papers are downloaded. Therefore the abstract, introduction and conclusion was read in order to get relevant papers .The following inclusion and exclusion criteria is used to select relevant papers:

- **Inclusion Criteria**

The following inclusion criteria is used to select relevant papers:

- Only those studies are included that described the usability problems related to Web data entry Forms.
- Only Conference and Journal papers are included
- Time period for systematic mapping Study is set between year 2000 to year 2014
- Research papers written in English language are included only

- **Exclusion Criteria**

The following exclusion criteria is used:

- The papers related to voice based , gesture based and touch screen based keyboard data entry are excluded

- All idea papers, grey literature such as Master's thesis, PHD thesis and technical reports are excluded
- Research Papers not written in English Language are excluded
- The papers discussing data entry problems for desktop based and mobile based application are excluded

d. Data Extraction Strategy:

The following data extraction strategy is used for extraction of data entry problems papers from different digital libraries
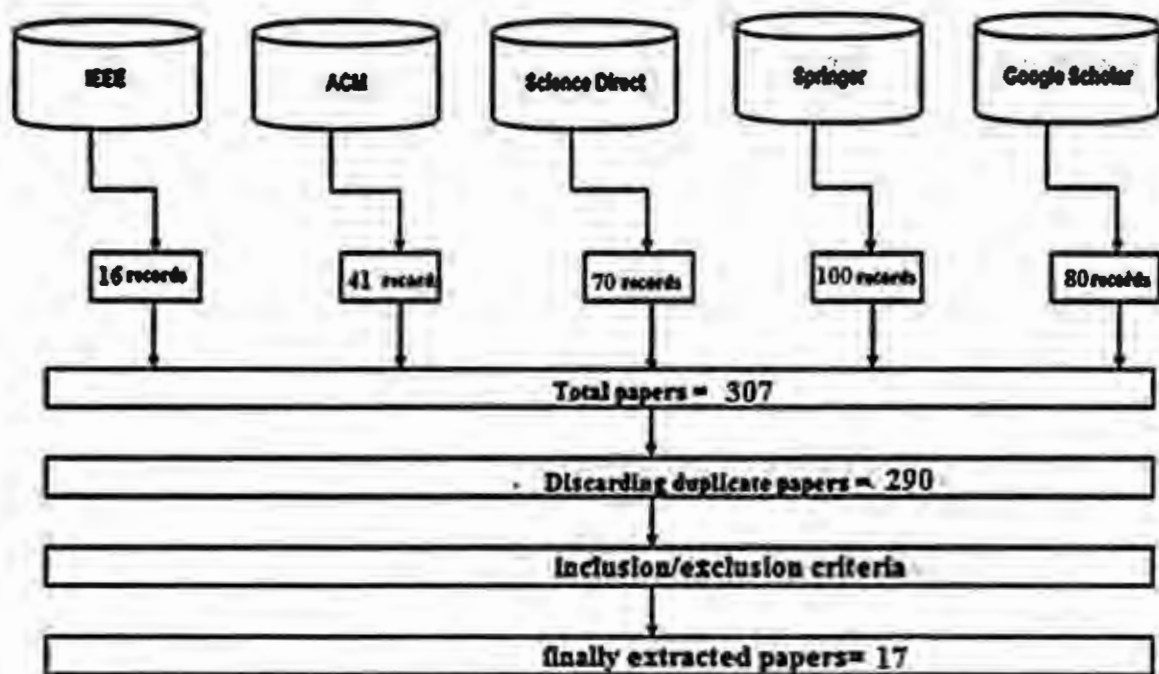
Figure 3: Data Extraction Strategy for data entry problems papers

e. Data Extraction Process (Classification)

A Microsoft excel sheet is used to document the data extraction process in order to do classification. Each column in the excel sheet contains category of classification scheme The following data is extracted from each paper in the excel sheet during data extraction process

- Date of publication to view the number of latest studies
- List of Data entry problems faced by users
- All the general details such as Author name ,Source or Publisher, Number of citations, Name of journal and conference in which the paper is published
- Type of study i.e. whether it is a journal paper or a conference paper

f. Execution of Systematic Mapping Study

- **Results**

    The total number of finally extracted data entry problems papers with respect to the digital libraries are described below:

    IEEE: 6

    ACM: 7

    SPRINGER LINK: 1

    SCIENCE DIRECT: 1

    GOOGLE SCHOLAR: 2

    TOTAL: 17

Data Extraction Questions	Total Results	Percentage
Journal papers	Total: 7	Percentage:41%
Conference papers	Total:10	Percentage:59%

Table 1: Data extraction results for data entry problems

The second phase of systematic mapping study was used to study the usability heuristics that exists for designing web data entry forms in order to do classification and gather primary studies regarding the heuristics that exist in literature for designing web data entry forms

2.1.1.2. Heuristics for designing web data entry forms

a. Research Question (Identify Scope):

As mentioned above the first step of systematic mapping study is **"research question"** in which the research question is defined in order to identify the scope of research. As an outcome the scope of research is identified which is used as an input to 2nd phase of systematic mapping study i.e. Search plan

We conducted a systematic mapping study to address the following research question

RQ2) What Usability Heuristics exists in the theory for designing Web Data Entry Forms?

b. Search Plan (All papers)

In our systematic mapping study all the primary studies regarding the usability heuristics that exists in literature for designing web data entry forms are identified both manually and through search string in the following digital libraries

• Digital libraries
The following digital libraries are used:

1. IEEE Explorer
2. ACM digital library
3. Science Direct
4. Springer Link
5. Google scholar

• Search string
A Pilot testing is performed on the search string. The following search string is used in the above mentioned digital libraries to identify the primary studies regarding the usability heuristics that exits for designing web data entry forms

■ Usability AND (Review OR Analysis OR Assessment OR Evaluation OR Inspection) AND (Data Entry AND (Form OR Screen))

Ieee Xplorer results= 9

ACM results=32

Springer results =207

Science Direct results=93

Google scholar=85

c. Selection Criteria (Relevant papers)

After obtaining the primary studies i.e. Initial set of papers, the relevant papers or studies are selected by applying inclusion and exclusion criteria. The inclusion and exclusion criteria describes that which papers are to be included or excluded. During selection of papers we closely examined the title, keywords and abstract of each study in order to determine that whether that paper or study is relevant. In case of the papers whose abstract did not give sufficient information, than the full papers are downloaded. Therefore the abstract, introduction, conclusion and proposed methodology are read in order to get relevant papers The following inclusion and exclusion criteria is used to select relevant papers:

- **Inclusion Criteria**
  - Studies presenting usability Heuristics for designing web data entry form are included
  - Only Conference & Journal papers are included
  - Time period for systematic mapping study is set between year 2000 to 2014
  - Research papers written in English language are included only

- **Exclusion criteria**
  - Studies presenting usability heuristics for voice based data entry, speech based, gesture based data entry and touch screen based keyboard data entry are excluded
  - All the idea papers, grey literature such as Master's thesis, PHD thesis and technical reports are excluded
  - Research Papers not written in English Language are excluded

d. Data Extraction Strategy:

The following data extraction strategy is used for extraction of papers regarding usability heuristics that exists for designing web data entry forms digital libraries
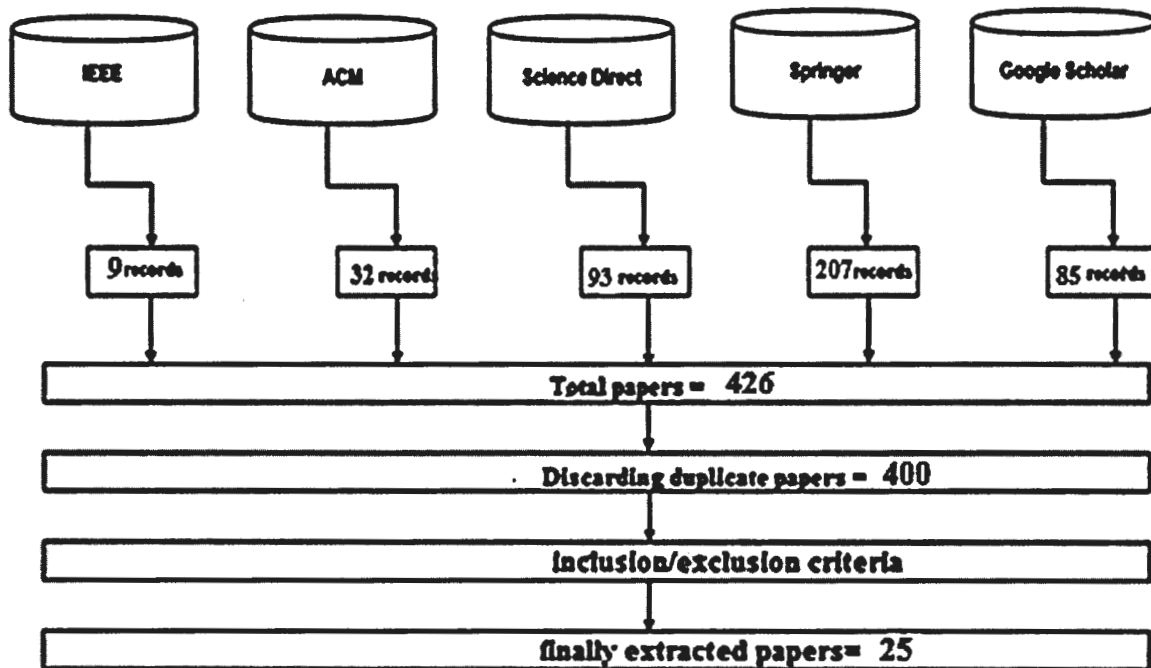
Figure 4: Data extraction strategy related to heuristics for designing web data entry forms

e. Data Extraction Process (Classification)

A Microsoft excel sheet is used to document the data extraction process in order to do classification. Each column in the excel sheet contains category of classification scheme

The following data is extracted from each paper in excel sheet during data extraction process

- Date of publication to view the number of latest studies
- Are the usability heuristics being validated and which usability evaluation technique is used?
- Is heuristic evaluation being performed?
- All the general details such as Author name ,Source or publisher, Number of citations, name of journal and conference in which the paper is published

- Type of study such as whether it is a journal paper or a conference paper

f. Execution of Systematic Mapping study

- **Results**

    The total number of finally extracted papers related to heuristics for designing web data entry forms with respect to the digital libraries are described below:

    IEEE: 4

    ACM: 11

    SPRINGER LINK: 3

    SCIENCE DIRECT: 5

    GOOGLE SCHOLAR: 2

    TOTAL: 25

Data Extraction Questions	Total	Percentage
Are usability heuristics being validated	**Total: 10**	**Percentage: 40%**
Journal papers:	**Total:12**	**Percentage:48%**
Conference papers:	**Total:13**	**Percentage:52%**
Is heuristic evaluation being performed	**Total:3**	**Percentage:12%**

Table 2: Data extraction results related to heuristics designed for web data entry forms

2.1.1.3. Mapping of Data Entry problems with heuristics and limitations

All the relevant papers obtained regarding data entry problems faced by users that exists in theory are mapped into broad categories. For example all the data entry problems related to incorrect data entry are mapped into "incorrect data entry problem category". This mapping of problems is done in order to observe that for which category a specific problems exists as well as to avoid duplication of studies. Similarly all the usability heuristics that exists in literature are mapped into broad category of heuristics. For example all the usability heuristics related to error messages were

mapped into broad category of error messages with limitations of heuristics. This mapping of usability heuristics is done in order to observe heuristics that exists for each category and limitations of heuristics.

2.1.1.3.1. Data Entry Problems

a) Incorrect Data Entry

Al-Saleh, 2012 [10] emphasizes that Complex data entry fields or the data entry fields in a web data entry form which involves complex responses increases the likelihood that user enters invalid or incorrect data. It emphasizes the importance of inline validation for Data entry fields in Web Data Entry Forms that involves complex responses or answers and have high probability that the user enters incorrect information. It emphasizes that incorrect and erroneous data entry errors can occur due to the ignorance of immediate feedback in web data entry forms

A. Javier et al,2011 [12] emphasizes that while entering date into the web data entry forms data entry errors can occur due to wrong date entries by the user. This happens if user selects wrong entries from menu or if the user press wrong keys on the keyboard

M. Levis et al,2008 [16] states that the most vulnerable part of web application are its web data entry forms .An essential aspect of creating usable web data entry form (that are used to collect information from users) is to check the validity of information entered by the user. Therefore the data entered through the form must be validated .It discusses that one of the biggest problem with web data entry form is that many websites fail to use mechanisms or validation process to validate the basic data input by user in order to confirm that the basic data input by user is valid and correct .They trust the user and lets him validate his own data input which results in invalid input and database full of useless information It describes that in many websites validates the email address but incorrectly .For example if the user enters email address with two @ symbol or two dot symbol than the user is specified that incorrect email address is entered[16]. However it does not checks the order of @ and dot in email address i.e. if the user enters incorrect sequence it is still considered as valid input. Therefore email address does not uses an activation or validation process in order to confirm that a valid email is entered by user. Similarly if the user enters numeric and special characters into personal details web

data entry form it is still considered as a valid data input. Therefore no validation process or mechanism is used in order to confirm that valid personal details are entered by user

S. Mirjam et al,2012 [18] emphasizes the importance of error messages which act as an important factor for data entry web forms, which helps to indicate the problems that occur when data is entered in web data entry forms and provides solution regarding how to solve them. In web data entry forms the data entry errors can occur due to incorrect typing e.g. if a user enters a password once and is required to re type the password again as a result the user types wrong password again .Therefore an error message of passwords don't match can occur due to incorrect typing. It also discusses [18] that in web data entry forms there is no standardized way of presenting error messages within web forms such as location of error messages at the top of the form or below the form results in inconsistencies across different sites, causes confusion. Similarly the location of error messages at the top of the web data entry forms lowers the predictability i.e. likelihood and results in confusion as well as incorrect data entry.

S. Shrikant et al,2013[19] describes a pilot study that was conducted using experimental interface to evaluate the frequency of data entry errors that occur when neither the local language nor mother tongue is used for data entry by the rural users in India. The rural users have less access and awareness with computers which could result in data entry errors. In this study data entry errors occur due to missing digit, wrong digit and double data entry.

Yuan Ling et al, 2013 [20] describes that data entry errors occur in electronic medical record system forms due to missing data or missing sections

b) Incorrect Data Format

A. Javier et al,2011 [12] describes that the most common issue regarding date entry input is the design of date entries and emphasizes that while entering dates in web data entry forms errors occur due to wrong date format entry . Thus it is important to provide guidance to the users about the expected format to consider while entering date in web data entry form. This can avoid ambiguities and errors which occurs due to wrong format .Date formatting errors occurs due to wrong format. For example when the user enters correct date but chooses wrong format such as the user is required to enter date in month-day-year format but user firstly enters day than month and year or when the user is required to enter date in two digits format but the user enters date as single digit. Date formatting errors occurs if format restrictions are not stated

S. Mirjam et al,2012 [18] emphasizes the importance of error messages which act as an important factor for data entry web forms, which helps in indicating problems that occur while entering data in web forms and provides solution regarding how to solve them. In this paper the data entry errors occurs in web forms if incorrect format is used for date entry .For example the user is required to enter date in date month and year format but the user firstly enters month than date and year or the user is required to enter year in 4 digit format but user only enters 2 digits .Therefore an error message of incorrect format is shown to user

Yuan Ling et al,2013 [20] describes that data entry errors occurs in electronic medical record system due to incorrect format of data such as if only numbers are required to be entered and user enters some other format

c) Missing Format Specifications in Web Data Entry Form

Seckler mirjam, 2014[14] conducts an empirical eye tracking lab experiment in which the participants are asked to enter information in either original or improved version of three online forms which are taken from authentic company websites and according to Seckler [14] and [15] data entry errors occurred frequently in web data entry forms due to missing format specification e.g. Users are annoyed as they did not know the rules of specification for username and password field

d) Quality of Data in Data Entry

C. kuang et al. (2010) describes that data quality is the most challenging problem while filling an online web data entry form. The challenging problem of data quality occurs [21] [22] due to lack of expertise in form design, field constraints not correctly specified and due to validation logic

e) Absence of Help in Web Data Entry Forms

Carlos Alarcon, 2013 [23] describes that in web data entry form the user expects to see a board with some clue or advice as what data must be entered. The absence of such advice or clue makes the user uses his or her intuition to see how the system reacts.

f) Insufficient Identification of Required and Optional fields

Seckler mirjam, 2014[14] conducts an empirical eye tracking lab experiment was conducted in which the participants were asked to enter information in either original or improved version of three online forms which were taken from authentic company websites. According to seckler [14] and [15] data entry errors occurs frequently in web data entry forms due to insufficient identification of required and optional fields

g) Un-appealing Layout of Web data Entry Forms

Seckler mirjam,2014 [14] and [15] discusses that the most frequent issues mentioned by participants in both original and improved versions of forms was the unappealing layout of web data entry form containing too many data entry fields .

h) Captcha Fields in Web Data Entry Forms:

Seckler mirjam, 2014 [14] describes that captcha fields in web data entry forms becomes burdensome for users and leads to wrong entries which annoys users

S. Mirjim [18] describes that in web data entry forms data entry errors occurs if incorrect confirmation code or captcha is entered by user. For example if a user enters a wrong confirmation code also known as captcha than an error message of incorrect confirmation code is shown and a new captcha is generated

i) Navigation in Longer Forms

Johannes 2013 [24] describes that forms are embedded in user interface (UI), in order to enable users to engage in online activities such as e commerce and describes a real world example and scenario that in form based medical documentation software data entry is complex and complicated because the length of most of the web data entry forms requires a lot of scrolling. Johannes [24] describes that longer web data entry forms requires a lot of scrolling which leads to loss of context for user and causes complex data entry

Johannes Harms, 2014[25] discusses the issue of navigation in longer web data entry forms. Johannes describes that longer forms requires a lot of scrolling which leads to loss of context for user and complicates data entry

j) Repetitive Data Entry

Shaohua Wang, 2013[26] describes that users are required to enter information in web data entry forms to interact with web applications such as online shopping and therefore the users are required to enter the same data repetitively which could be tedious task for user to type the same information again and again

Marco Winkler,2011[27] addresses the problem of repetitive data entry, that entering personal data into web data entry forms repetitively can be tedious and leads to redundant information

The data entry problems faced by users while filling web data entry forms are described in the table enlisted below

Category	Data Entry Problems	Journal or Conference	Reference
Incorrect Data Entry	1. Many websites fail to use mechanisms or validation process to validate the basic data input by user which results in invalid input and a database full of useless and incorrect information.	Journal	[17]
	2. Complex data entry fields or the data entry fields in a web data entry form which involves complex responses increases the likelihood that the user enters invalid or incorrect data	Conference	[10]
	3. In web data entry forms data entry errors occurs due to incorrect typing e.g. if user enters a password once and is required to enter password again in same field and the user types wrong password .Therefore an error message of passwords don't match is shown	Journal	[18]
	4. There is no standard way of presenting error messages within web data entry forms. This leads to inconsistencies across different sites and causes confusion	Journal	[18]
	5. Location of error messages at top of form leads to inconsistencies and lowers the predictability	Journal	[18]

6. Wrong date is entered by user which happens due to wrong entries selected by user from menu	Journal	[12]
7. Data entry errors occurs due to missing data or missing sections	Conference	[20]
8. Data entry errors occurs due to missing digit, wrong digit and double data entry.	Conference	[19]
Incorrect Data Format 9. Date formatting errors occur if date is entered by user in wrong format. It occurs if the format restrictions are not stated	Journal	[12] [18]
10. Data entry errors occurs due to incorrect format such as if only numbers are required to be entered and user enters some other format	Conference	[20]
Missing format specification 11. Data entry errors occurs frequently in web data entry forms due to the missing format specification e.g. The users are annoyed as they did not know the rules of specification for user name and password field	Conference	[14][15]
Quality of data in data entry 12. The challenging problem of data quality occurs while filling an online web data entry form due to lack of expertise in form design, if field constraints are not correctly specified and due to validation logic	Conference, Journal	[21][22]
Absence of help in web data entry form 13. Absence of clue or advice in web data entry forms as to what type data is entered by the user.	Journal	[23]

Insufficient identification of required and optional fields	14. Data entry errors occurs frequently in web data entry forms due to insufficient identification of required and optional fields	Conference	[14][15]
Unappealing layout of web data entry forms	15. Web data entry forms containing too many Data entry fields	Conference	[14][15]
Captcha fields	16. Captcha fields in web data entry forms becomes burdensome for users and leads to wrong entries which annoys users	Conference, Journal	[14] [18]
Navigation in longer forms	17. Longer web data entry forms requires a lot of scrolling which leads to loss of context for user and complex data entry	Conference	[24][25]
Repetitive data entry	18. Entering personal data into web data entry forms repetitively can be tedious and leads to redundant information	Conference	[26][27]

Table 3: Data entry problems in literature

Usability Heuristics for Designing Web Data Entry Forms

2.1.1.3.2. Usability Heuristics for Designing Web Data Entry Forms

a) Inline Validation in Web Data Entry Forms

Al Saleh et al,2012 [10] describes effective ways of presenting inline messages in web data entry forms and emphasizes the importance of inline immediate feedback. Inline immediate feedback can be categorized as confirmation type feedback, suggestion type feedback and limit type feedback. Confirmation type feedback consists of inline messages on web forms which provides confirmation that whether the user has entered the data correctly. In Suggestion type feedback a set of valid answers are presented in the form of suggestions to the users, so that the user can choose from them the possible answer. It discusses an eye tracking study which was conducted to analyze the behavior of different users while filling web data entry forms .Results shows that a large amount of users respond to inline immediate feedback when the feedback message is related to error handling or warning in comparison to confirmation message feedback [10]. It does not examines the user interaction with inline immediate feedback especially with warning or confirmation messages

M. Levis et al. (2008) [16] provides validation of email address but incorrectly .For example if the user enters email address with two @ symbol or two dot symbol than the user is specified that incorrect email address is entered .It does not checks the order of @ and dot in email address i.e.   If the user enters incorrect sequence it is still considered as valid. Therefore email address does not uses an activation or validation process to confirm that a valid and correct email address is entered by user [16]. Similarly if the user enters numeric and special characters into personal details web data entry form it is considered as a valid data input Therefore personal details does not uses an activation or validation process to confirm that a valid and correct personal details are entered by user

b) Form Layout

Seckler mirjam, 2014 [14] presents an empirical eye tracking lab experiment in which the participants are asked to enter information in either original or improved version of three online forms which were taken from authentic company websites. The basic goal was to study the effect of a set of usability heuristics or guidelines proposed by the authors [14]

[15] on the usability of both original and improved version of web data entry forms. It describes that in web data entry forms use format familiar to user's i.e. Allowing users to provide answers in a format familiar to them in case of unambiguous answers. Do not use unnecessary data entry fields and multicolumn layout in web data entry forms .The size of data entry fields matches with the expected length of answer. The heuristics proposed in both studies [14] and [15] focuses only on online newspaper registration forms and do not explore longer forms with more than one page e.g. e government forms. Similarly the most frequent issues in improved versions of web data entry forms are the unappealing design of web data entry forms containing too many data entry fields and burdensome captcha fields which leads to wrong entries [14][15]

c) **Multiple Selection of Options**

Seckler Mirjim [14] and [15] describes to use radio buttons for up to four options and drop down menu for more than four options. Similarly use Drop down menu and checkboxes to restrict number of options. The heuristics proposed in both studies [14] and [15] focuses only on online newspaper registration forms and do not explores longer forms with more than one page e.g. e government forms. Similarly the most frequent issues in improved versions of web data entry forms was the unappealing design of web data entry forms containing too many fields and burdensome captcha fields which leads to wrong entries [14][15]

Javier et al [32] describes that for selecting multiple options use checkboxes and list boxes .The heuristics presented for multiple selection of options are not validated i.e. empirically tested using real forms in realistic user situations to see whether they really improve usability of web form design[32]

d) **Form Submission in Web Data Entry Forms:**

Seckler Mirjim [14] and [15] discusses that at the end when the web data entry form is filled and the form is submitted disable the submit button to avoid multiple form submissions .Disabling submit button takes longer time and annoy users. The heuristics or proposed in both studies [14] and [15] focuses only on online newspaper registration forms and do not explores longer forms with more than one page e.g. e government forms.

Similarly the most frequent issues in improved versions of web data entry forms are unappealing design of web data entry forms containing too many data entry fields and burdensome captcha fields which leads to wrong entries [14][15].

e) Design of Date Entries in Web Data Entry Forms

Javier et al 2011 [12] describes that the most common issue regarding date entry input is the design of date entries and emphasizes that while entering dates in web data entry forms two different type of errors occurs that are incorrect date format and incorrect date entry Thus it is important to provide guidance to the users about the expected format to consider it while entering date in data entry form, in order to avoid ambiguities and errors which occurs due to wrong format and wrong entry of date. In this study an empirical online study is conducted with one hundred and seventy two participants for comparing different design versions that are used for designing input field for date entries. Date is entered by using six design versions such as using three separate input fields for day month and year entry. For year using data entry field that is twice the size of month and day field. Use three drop down menu for day month and year entry. Use one input field with date formatting requirements inside or to the left of input field and using calendar for date entry This study is [12] conducted in a rigorous lab setting so the participants do not entered real dates but copied from memory in user interface which results in date entry format errors. Therefore validity of presented findings are less. Similarly the date entry tasks are very repetitive. The heuristics that is findings reported in this paper for entering date are not validated i.e. empirically tested in real and natural environment using real forms in realistic user situations, to see whether they really leads to better usability, [12]

Seckler Mirjim [14] and [15] discusses that for date entries use drop down menu or an input field and place the formatting requirements inside the input field or at the left of input field to avoid date formatting errors. The heuristics proposed in both studies [14] and [15] focuses only on online newspaper registration forms and do not explores longer forms with more than one page such as e government forms. Similarly the most frequent issues in improved versions of web data entry forms is the unappealing design of web data entry forms

containing too many data entry fields and burdensome captcha fields which leads to wrong entries [14][15]

f) Format Restrictions

Seckler Mirjim [14] and [15] discusses to use format specification for the data entry fields that needs to be described in a specific format. The heuristics proposed in both studies [14] and [15] focusses only on online newspaper registration forms and does not explores longer forms with more than one page i.e. e government forms. The participants assigned to improved versions of forms mentioned that the most frequent issues are the unappealing design of web data entry forms containing too many fields and the burdensome captcha fields

Javier et al [17] describes to use field format restrictions in online web data entry forms to impose rules with regards to the content and format of data entry fields such as minimum password length or date entry format. This study discusses that there are two important factors to communicate format restrictions that is timing and content restrictions. In timing the format restrictions appears in the form of an error message after an erroneous input occurs.. Use format example or state format specification to communicate content restrictions. Javier et al [17] discusses four different ways to impose format restriction in online web data entry forms such as no visual format restriction, format example, format specification and using both format example and format specification. No visual format restrictions informs user with an error message rather than format restrictions in case of erroneous input. Format example provides a small amount of information in the form of an example with respect to the format. Use format specification to stat the desired format. In this study the imposed rules of restrictions are artificial .It [17] does not analyzes that which type of restrictions are easy or difficult to understand and even with these format restrictions users made errors. The study is conducted in a rigorous lab setting and the tasks are not embedded in real settings like shopping or registration process Similarly the heuristics presented in this paper are not validated i.e. empirically tested using real forms in a realistic setting to see whether they can lead to usable form design[17]

g) Error Messages in Web Data Entry Forms:

Seckler Mirjim [14] and [15] discusses that after the form is filled and submitted show error messages all together embedded in the web data entry form. Error messages in web data entry forms must be noticeable by using either color or symbols .The heuristics proposed in both studies [14] and [15] focuses only on online newspaper registration forms and does not explores longer forms with more than one page e.g. e government forms. The participants assigned to improved versions of forms mentioned that the most frequent issues are the unappealing design of web data entry forms containing too many data entry fields and the burdensome captcha fields [14]

S. Mirjam et al., 2012 [18] emphasizes the importance of error messages which act as an important factor for data entry web forms. It helps in indicating problems that occur while entering data in web forms and provides solution regarding how to solve them. It presents a study of web conventions to evaluate the possible location of error messages in web data entry form. In the study of web conventions online shops are analyzed .It describes that the location of error messages are shown by six embedded approaches namely right and left of erroneous input field, above and below the erroneous input field, top and bottom of form .Therefore an empirical online study is conducted with three hundred and three participants, To examine the possible location of embedded error messages in web data entry form and how these embedded locations of error messages differ regarding efficiency, effectiveness and user satisfaction[18].Results of online experiment shows that error messages placed near erroneous input fields leads to better performance, than the error messages at the top or bottom of form. This study focuses only on location of error message and does not explores other graphical possibilities of error messages i.e. How to point towards an error for instance to frame or highlight erroneous input field with additional color or symbols [18]. The study focusses only on online shopping forms and does not explores longer forms or more than one error message per form [18].

Javier et al [28] discusses online form validation that is it discusses various ways how an error message must be presented to users. This paper discusses that errors can be categorized in two ways such as first time errors and consecutive errors. First time error refers to the

errors which occurs for the first time when an input field is filled by the participants and it appears all at once after the form is submitted. Whereas consecutive errors occurs if some fields are submitted wrong again. It studied and tested only error messages embedded directly within the form such as AEA (afterward embedded all at once), AEO (afterward embedded one by one) and IE (immediate embedded). All the dialog methods for presenting error messages are discarded. In AEA method after the user submits the data the form is returned to the users with error messages placed at the right side of data entry field. In AEO method the form is returned to the user and only one error message is placed on the right side of erroneous fields in immediate embedded the error message appears on the right side and it disappears after successful correction. [28] The results show that the best way of presenting error messages is to provide embedded error messages one by one or all at once after user completes the web data entry form. This study focuses only on presentation of error message and does not investigate other aspects related to error messages

h) Improving Data Quality in Web Data Entry Forms

C. kuang et al. [21] describes that data quality is the most challenging problem while filling an online data entry form and can be improved during data entry. The challenging problem of data quality occurs due to lack of expertise in form design, field constraints not correctly specified. In this paper a set of adaptive feedback mechanisms and design observations are proposed for data entry by working with a team of professional data entry clerks for an international health and research program in Uganda [21]. The design observations i.e. heuristics are presented for drop down menu, radio button labels, and auto complete option in text fields to improve the efficiency and quality of data entry. In this study [21] and [22] the design observations or heuristics provided for data entry that are feedback must be a part of user's visual path, feedback should be accurate and the visual layout of form and individual questions should be consistent. In this study [21][22] the design observations that are implemented and tested consists of defaults corresponding to highly likely answers, dynamically ordering auto complete suggestions, highlighting other likely options, and providing automatic warnings when the user enters an unlikely value. An experimental study is conducted to evaluate the adaptive feedback mechanisms with real forms and data entered by professional data entry clerks to measure the improvement in quality in real world data entry environment.

i) Navigation in Longer Forms

Johannes [24] describes that forms are embedded in user interface (UI) to enable users to engage in online activities such as e commerce etc. Form filling can be improved in terms of user experience and usability, if the forms satisfy the requirements of 'form UI' metaphor. This study describes a real world example and scenario of form based medical documentation software. In the form based software the data entry is complex as well as complicated because the length of majority of the forms requires a lot of scrolling. Therefore it describes the relevant research goals for form filling interfaces such as focus and context navigation, collaborative form filling and combined input fields to improve usability and for comfortable data entry [24]. Longer forms require a lot scrolling and it leads to loss of context for user. Therefore focus and context navigation is used in which shows only those parts of forms with user focus and displays the rest of the form in a compact or aggregated way. Collaborative form filling supports cooperative form filling in which multiple user's works on shared artifacts. Whereas combined input fields, combines complex fields into one smart field to allow comfortable and efficient data entry. This study proposes that focused and context principle must be applied for navigation in longer forms but the focus and context principle is not evaluated i.e. validated

Johannes harms [25] discusses navigation in longer forms. Longer forms on one web page requires a lot of scrolling and if these forms are split into multiple pages than both options hides the form fields which leads to loss of context for the user .To address this problem focus and context principle is applied for navigation in longer forms. In focus and context principle the navigation includes multiple steps and it displays only the contextually relevant information that the user can navigate to. Its purpose is to show the specific areas of interest in a detail and to give a compact overview about other areas to make information feasible. The user focus of interest determines that which part of the form must show full details and which part to show the aggregated information [25]. In this paper a design space analysis was presented in order to discuss how focus and context principle is applied on web form design to improve navigation in longer forms. The design space consists of two components namely degree of interest (DOI) and level of detail (LOD).DOI determines the relevant subset of information that the user is likely to consider and LOD concerns what to omit in order to make space.[25]

j) Identification of Required and Optional Fields

According to Pauwels [29] describes to mark required fields clearly in order to make users efficient and to prevent errors. Thus the user can find the required fields easily with respect to the current tasks. The marking of required fields contributes to efficiency and error prevention in online web data entry forms [29] .This study describes that required fields must be clearly visible at first sight to facilitate form filling process for novice users. The aim of this study is to explore the required fields mark with asterisk or colored background as well as to examine which among these leads to fewer errors. Asterisk or custom icon is defacto standard to mark required fields [11] .It is placed near required fields in order to reduce visual clutter. In this study an experiment is conducted with 24 participants in which the participants are given two versions of web data entry forms. The forms are not submitted until all the required fields are completed and a questionnaire is used to measure user satisfaction. It uses asterisk or color background to mark required fields as independent variable whereas dependent variable is the number of errors a participant makes while performing a task. Results show that the required fields mark with color background leads to less errors and increases user satisfaction. The disadvantage of using require fields marked with color background is the inability of screen readers to recognize color marking. This study does not answers that whether findings of this study are applicable to other types of forms also [29]

Seckler Mirjim [14] and [15] discusses to use either asterisk or color to mark required fields in order to separate them from optional fields. The heuristics proposed in both studies [14] and [15] focuses only on online newspaper registration forms and does not explores longer forms with more than one page such as. e government forms. The participants assigned to improved versions of forms mentioned that the most frequent issues are the unappealing design of web data entry forms containing too many data entry fields and the burdensome captcha fields

Tullis et al [30] evaluates various techniques to distinguish between required and optional fields in a web data entry form. Use bold labels, chevrons, check marks, color background to mark required and optional fields in order to distinguish them. Similarly group required and optional fields in two separate group boxes[30].Results shows that the best way to distinguish between required and optional fields is to group them separately

k) Alignment of Labels and Grouping in Web Data Entry Forms

Subhrajit [31] performs an eye tracking study to analyze various label positions in online web data entry forms. In this study [31] an eye tracking study is performed with 11 academic post graduate students to investigate and find an optimal position or alignment of labels in online web data entry forms. The forms that are given to subjects for entering data consists of grouped forms, left aligned labels, right aligned labels and top aligned labels. In all these forms given to the subjects the form layout and arrangement of form fields is consistent and the only difference or variation among these forms is the alignment of labels with respect to the corresponding entry fields [31] and grouping of form fields. Result showed that left aligned labels results in longer completion time ,higher and multiple eye fixations due to the extended distance between the labels and the inputs the and as the user has to jump from one column to another. Whereas top aligned and right aligned labels results in less eye movements and less completion time. Grouped forms in which the fields were grouped lead to faster completion time

The usability heuristics that exists in literature for designing web data entry forms are enlisted in the table shown below

Systematic Mapping Study

Category	Usability heuristic	Limitations	Journal-Conference	Reference
Inline validation in web data entry forms	Inline immediate feedback	• It does not examines the user interaction with immediate inline feedback especially with warning or confirmation messages	Conference, Journal	[10] [16]
	Validation of email address in web data entry form	• It provides no validation process or mechanisms on email address and personal details in web data entry forms in order to confirm that a valid and correct email address as well as personal details are entered by user.		
Form layout	Use familiar format	• The heuristics proposed focusses only on online newspaper registration forms and does not explores longer forms with more than one page e.g. e government forms	Conference	[14][15]
	Avoid unnecessary input fields			
	Avoid multicolumn form layout	• The participants assigned to improved version of web data entry forms describes that the most frequent issues in improved versions are the unappealing design of web data entry forms containing too many data entry fields and the burdensome captcha fields		
	The size of input field should match the expected length of answer			

Usability Heuristics for Designing Web Data Entry Forms

Multiple selection of options	Use radio buttons for up to four options and drop down menu for more than four options Using checkboxes, drop down menu and radio buttons for restricting the number of options	• The heuristics proposed focuses only on online newspaper registration forms and does not explores longer forms with more than one page i.e. e government forms • The participants assigned to improved version of web data entry forms described that the most frequent issues in improved versions are the unappealing design of web data entry forms containing too many data entry fields and the burdensome captcha fields	Conference	[14][15]
	Using checkboxes and list boxes for multiple selection of options	• The heuristics proposed are not validated that is empirically tested using real forms to see whether they can improve usability	Journal	[32]
Form Submission in web data entry forms	Avoid including reset buttons Disable submit button to avoid multiple submissions	• The heuristics proposed focusses only on online newspaper registration forms and does not explores longer forms with more than one page e.g. e government forms • The participants assigned to improved version of web data entry forms described that the most frequent issues in improved versions are the unappealing design of web	Conference	[14][15]

Design of date entries in web data entry forms	Using only one input field and placing the format requirements left or inside the text box Using calendar and drop down menu for date entry Using three input fields for day, month and year entry	• data entry forms containing too many data entry fields and the burdensome captcha fields • Disabling submit button can take longer time which can annoy users • The heuristics reported for entering date are not validated that is empirically tested in real and natural environment using real forms • The participants did not enter real dates but copied from memory in user interface which might result in data entry format error • The Date entry tasks are very repetitive something not found on an online form • The heuristics proposed focused only on online newspaper registration forms and did not explored longer forms with more than one page e.g. e government forms • The participants assigned to improved version of web data entry forms described that the most frequent issues in improved versions was the unappealing design of web data entry forms containing too many data entry fields and the burdensome captcha fields	Journal, Conference	[12][14]

			Journals, Conference	[14][18][28]
Error messages	Embedded error messages at the top or bottom of form Embedded error messages near erroneous input fields Pop ups Noticeable error messages Error messages should be shown altogether embedded in the form	• The study focuses only on online shopping forms and did not explored longer forms or more than one error message per form • The study focuses only on the location of error messages and did not investigated other aspects related to error messages such as graphical possibilities of error messages that is how to highlight erroneous input field with colour or symbols • The participants assigned to improved version of web data entry forms described that the most frequent issues in improved versions was the unappealing design of web data entry forms containing too many data entry fields and the burdensome captcha fields	Journals, Conference	[14][18][28]
Improving data quality in web data entry forms	Feedback should be a part of user mandatory visual path Visual layout of forms and questions should be consistent Feedback should be accurate		Journal, conference	[10][21][22]

	Setting defaults Ordering of options Providing warning message			
Navigation in longer forms	Focus and context navigation in longer forms	• The heuristics are not evaluated i.e. validated	Conference	[24][25]
Format restrictions	Field format restrictions in web data entry forms	• The study is conducted in a rigorous lab setting and the tasks are not embedded in real settings like shopping process • The heuristics presented are not validated that is empirically tested using real forms to see whether the can lead to usable form design • The study focuses only on online shopping forms and did not explore longer forms or more than one error message per form	Conference, Journal	[14] [32]
Identification of required and optional fields	Required fields should be clearly marked by using colour or asterisk	• Required fields marked with colour background results in inability of screen readers to recognize colour marking • The study did not answered that whether findings from this study is applicable to other types of forms also	Conference	[14][29][30]

	• The study focuses only on online shopping forms and did not explore longer forms or more than one error message per form • The participants assigned to improved version of web data entry forms described that the most frequent issues in improved versions are the unappealing design of web data entry forms containing too many data entry fields and the burdensome captcha fields	Conference	[31]
		Conference	[26][27]
Alignment of labels	Using top aligned, left aligned and right aligned labels		
Repetitive data entry	Auto filling and autocomplete in web data entry forms		

Table 4: Usability heuristics for designing web data entry form that exist in literature

Chapter 3

Categorization of Web Data Entry Form Heuristics

3.1. Categorization of Web Data Entry Form Heuristics

The usability heuristics obtained through systematic mapping study are not enough and consist of limitations. Therefore In order to expand the spectrum of usability heuristics we searched online help repositories such as msdn, online help manuals such as various guidelines or checklists for web data entry form usability, online articles regarding web data entry forms usability such as articles on Nielsen and Norman Group , websites such as www.usability.gov and online books from google scholar. This helps in obtaining industry based heuristics. Industry based heuristics consists of usability heuristics which are gathered by various researcher from different sources of knowledge and are compiled by them as guidelines or checklists. These industry based heuristics are derived on the basis of experience and best practices of usability experts or practitioners.

We collected all the usability heuristics for designing web data entry forms from existing literature, as well as industry based heuristics from online repositories, online help manuals, websites and books. For categorization of the collected usability heuristics for designing web data entry forms we considered Nielsen usability heuristics [33] and Schneiderman eight golden rules of interface design [34]. As Nielsen and Schneiderman are the founder of usability and their usability heuristics are commonly referred as well as consists of high level of abstraction .Therefore we used Nielsen and Schneiderman usability heuristics as a broad category. After going through the details of our collected usability heuristics for designing web data entry forms we categorized our usability heuristics into broad categories of Nielsen and Schneiderman usability heuristics.

While categorizing our usability heuristics into the respective category, multiple occurrences of similar heuristics are avoided and are written once under the category .The usability heuristics that are categorized into broad category of Nielsen and Schneider man usability heuristics are known as *Common Heuristics* and the usability heuristics that are not categorized into Nielsen and Schneiderman usability heuristics are known as *Others Heuristics*. Therefore we got two set of usability heuristics i.e. Usability Heuristics set 1 which consists of a set of Common Heuristics for designing web data entry forms and Usability Heuristics set 2 which consists of a set of Common plus Others Heuristics for designing web data entry form.

Common heuristics are used in both polio information web data entry forms designed using usability heuristic set 1 and usability heuristic set 2.Whereas others Heuristics are used only in polio information web data entry forms designed using usability heuristic set 2.

Initially Common Heuristics are described which will be implemented in both polio information web data entry forms designed using usability heuristic set 1 and usability heuristic set 2

3.1.1. Common Heuristics

3.1.1.1. Category Name: *Visibility of system status* **(Nielsen)** *&* Informative feedback **(Schneiderman)**

- **Heuristic 1:** *Inline Immediate Feedback* [10] [11]

Inline validation [10] is essential in web forms, when the complexity of fields in a form increases the possibility that user would enter invalid or incorrect data. Inline validation can provide confirmation type feedback, suggestion type feedback back and limit type feedback. Confirmation type feedback consist of inline messages on web forms confirming that the user has entered the data correctly e.g. confirming that user has entered email correctly.[10] In Suggestion type feedback a set of valid answers are presented in the form of suggestions to users e.g. in Saudi airlines websites on selecting the departure and arrival airports the user just types the first letter of airport in the form and immediately a set of valid inline suggestions appears in the form of drop down list containing all valid airport names.

- **Heuristic 2:** *Providing Warning Messages* [10] [21] [35]

Automatic warning message should be provided, when the user has entered an unlikely value and is about to make a serious error, in order to make sure that the user hasn't selected an option in error. For example if user enters a weak and incorrect password a warning message should appear [10]

- **Heuristic 3:** *Show the user progress clearly* [36][37]

If the web form is longer and it consists of several steps or spans across multiple pages, it is important to make sure that the user are provided with constant feedback on their progress in order to keep users informed of system progress and to let them know how

much more time they will require to finish web form submission. For example displaying percentage completed or step 1 out of 4

- **Heuristic 4:** *Input prompt* [14] [16] [38] [53]

An input field is pre-filled with an example text or question that prompts the user what to do or type. In input text fields, the Input Prompt pattern is often combined with scripting that removes the prompting text once the user's focus is on that box [38]. Once the user enters data in the input field, the prompting text disappears so that the input field is free for the user to fill out. For example for date entry the formatting requirement (**dd.mm.yyyy**) is placed inside the input field that disappears when the user clicks into the input field. The prompting text can be 'enter email addresses or 'search'

- **Heuristic 5:** *Accurate feedback* [21]

Feedback should be accurate. Specifically, when warnings or defaults are generated very frequently [21]

3.1.1.2. Category Name: Match between system and real world **(Nielsen)**

- **Heuristic 6:** *Use familiar format* [14] [15] [39]

Let people provide answers in a familiar format e.g. It is more easier and natural for the user to use type in box to type the personal details that is name, address rather than selecting from a list of options .For easily mistyped answers use checkbox or radio button rather than type in box. The user may not know what the question is asking until the list of options is available. Radio buttons or checkboxes are the most visible method of displaying the options. When there are very few options (4 or less), radio buttons or check boxes work better than a drop-down menu

- **Heuristic 7:** *Use familiar terms and names for labels* [37]

While considering labels it is important to use only those names and terms for labels that users will understand and recognize. Similarly try to avoid using your own terms in labels

- **Heuristic 8:** *Use familiar widgets* [40]

Use widgets that are familiar to users and it should not be assumed that all users are familiar with all available widgets and they know how the widgets works .Unfamiliar widgets can

slow some users .It was showed in a study that some users that is particularly old users were unfamiliar with drop down lists and did not know how to use drop down lists. Therefore while choosing widgets designers must consider all these issues. For example in some web data entry forms instead of text entry field circled widget was used in an unconventional manner that is unfamiliar for user. Similarly when the user clicks on a data entry field a web page of different links is opened from which the user selects the respective option and therefore drop down list would be most suitable and familiar widget [40].

3.1.1.3. Category Name: User control and freedom **(Nielsen) &** permit easy reversal of actions **(Schneiderman)**

- **Heuristic 9:** *Providing undo and redo actions* [35] [41]

Providing undo and redo actions to allow users to undo their earlier choices and also reverse their changes [35]

- **Heuristic 10:** *Design for easy navigation* [42]

Enable user to determine current position easily by allowing the user to move through the form, either forward or back to an earlier question [42]

3.1.1.4. Category Name: Design dialog to yield closure **(Schneider man)**

- **Heuristic 11:** Providing confirmation message [14] [15]

After the form is successfully submitted a confirmation site is shown to the user which expresses a success message i.e. Thanks for submission and tells the user what will happen next [14]

3.1.1.5. Category Name: Flexibility & efficiency of use **(Nielsen) &** Enable frequent users to use shortcuts **(Schneiderman)**

- **Heuristic 12:** *Display default values* [35] [40] [41]

Provide default values when the user fills a form .It should be displayed whenever a likely default choice is defined, in order to speed data entry and to reduce the likelihood of errors occurring. The initial or default item could be the most frequently selected item or the last item selected by that user [40]

- **Heuristic 13:** _label units of measurements_ [40] [43]

When using data entry fields, the desired measurement units must be specified with the field labels rather than requiring users to enter them. For example designers must include measurement units such as minutes, ounces, or centimeters, etc. as part of the data entry field label, in order to reduce the number of keystrokes and to speed up the data entry process [40]

- **Heuristic 14:** _Provide auto-tabbing_ [37] [40] [43]

Auto-tabbing can reduce data entry times for frequent users, by not requiring users to manually tab from one input field to other [40]

- **Heuristic 15:** _Minimize use of shift key_ [40]

Design data entry forms in which there is a minimize use of shift key and it does not requires user to enter characters by using shift key .Using shift key enforces a demand for extra time and attention[40]. Therefore the web designers must include symbols such as percent sign or dollar sign near data entry fields instead of requiring user to enter those characters [40]

- **Heuristic 16:** _Flexible input field_ [11] [14] [37]

Input fields can be flexible enough to accept multiple formats of a valid answer [11]. In web data entry forms flexible input field allows users to answer questions in any format they want to. For example there are different ways a valid phone number could be specified i.e. by using help text near phone number field ,so that the people know how to enter the phone number or by using three text boxes of fixed length , to allow user to enter the phone number in a specific format[11]. However the phone number field can be made flexible by allowing user to enter phone number in any format they wish to instead of using a specific format

- **Heuristic: 17:** _Single column form layout_ [14] [15] [36] [53]

Avoid multi column layout of web data entry form i.e. a form should not be divided into more than one column. Similarly in each row only one question should be asked. Single column vertical form arrangement is preferable as scanning down the web data entry form

reduces the number of eye movements in comparison with scanning the form from left to right in order to fill out the form. [36]

- **Heuristic 18:** *Using check boxes for multiple selection* [14] [32] [40]

Checkboxes allow users to select one or more than one item from a list of possible choices. Therefore checkboxes are used for multiple selection of items. The advantage of using checkboxes in is that all the answers are visible at the same time. For example if the user wants to select more than one file type or wants to order more than product than check boxes are most appropriately used control [40][32]

- **Heuristic 19:** *Using radio buttons for mutually exclusive selections* [40] [54]

Radio buttons are used when there is a list of two or more options which are mutually exclusive [54] .Similarly radio buttons are used when users are constrained to select one item from a list of mutually exclusive options. One of the radio buttons choices must be assigned as default choice. A study reports that radio buttons are preferable over drop down lists and open lists for mutually exclusive selection as they results in reliably better performance than dropdown lists

3.1.1.5. Category Name: Consistency & Standards **(Nielsen)** & Strive for consistency **(Schneiderman)**

- **Heuristic 20:** *visual layout of form should be consistent* [21] [35] [42]

The visual layout of form and individual questions must be consistent which can be done by following consistent standards for interaction design [21].Similarly create consistent interfaces for the tasks that are essentially the same, in order to help the user to easily find all the information. Follow uniform conventions for layout, formatting, phrasing, interface controls and for the tasks that closely resemble each other [42]

- **Heuristic 21:** *Consistent labelling convention* [40] [41]

Use consistent labelling convention [41] and ensure that the data entry field's labels are worded consistently. Make sure that the same label is given to the similar data entry item which appears on different pages .Therefore label data entry fields consistently[40] and do not use phrases or single words for some field labels and nouns, verbs for others

3.1.1.6. Category Name: Error prevention **(Nielsen)** & Error handling **(Schneiderman)**

- **Heuristic 22:** _Data format cueing in labels_ [43]

Provide a cue of data format in a field label for example Date (MM/DD/YY):_____ [43]

- **Heuristic 23:** _Using embedded error messages_ [14] [15] [18][28]

Show error messages after the form is filled and submitted .The most common approach of displaying error messages is by showing them all together embedded in the web data entry form[14][18]. Embedded error messages can be presented at various locations such as at the top or bottom of form, at the right or left of erroneous input fields, above or below the erroneous input field [18][28]

- **Heuristic 24:** Use appropriate input widgets for easily mistyped entries [14] [39]

Checkboxes, radio buttons and drop down menus must be used for data entries that can be easily mistyped and to restrict the number of options. They must be used when it is not clear to users in advance that which type of answer is expected from them .For example if a user is books a hotel room on website and requires to type the full official name of hotel correctly that is ("Cheviot Country Hotel and Golfing Centre") [39].In this case there is a high possibility that the user can make a mistake due to spelling or by using an abbreviation that differs from that hotels own preference [39]. Therefore depending upon the design of web data entry form text field are not used and any other form element that is checkboxes, radio buttons or drop down menu can be used

- **Heuristic 25:** _Field format restrictions_ [12] [13] [14] [17]

If answers are not required in a specific format than it should be stated in advance by using format specification. The most efficient way to communicate format restrictions in web data entry forms is to use format example and format specification .e.g. minimum password length or date entry format [13] [14]. By providing details of any format restriction in advance help respondents to report their answer in the desired format and it leads to significantly fewer errors and trials [17]

- **Heuristic 26**: *Distinguishing clearly between required and optional fields* [11] [14] [29] [30] [36] [40] [41] [43]

In web data entry forms mark required and optional fields clearly in order to allow users to easily distinguish between required fields and optional fields. Currently websites use asterisks in front of required field label , background color to highlight required fields or u chevrons to indicate required fields .For example the most popular and effective method to clearly distinguishing between required and optional data entry fields is to use asterisk (*) next to the required fields or label required fields with "required" label . The required fields should be clearly marked in order to make users efficient and to prevent errors

- **Heuristic 27:** *Avoid including a reset button* [14] [15]

Reset buttons should not be provided in web forms, as they can be clicked by mistake [14][15]. For example a user fills longer forms and hits the reset button by mistake which results in erased and lost data

- **Heuristic 28:** *Using a drop-down menu to avoid date formatting errors* [12] [14]

Use Drop-down menu avoid the formatting errors that occurs while entering date .But it was perceived less efficient [12]

- **Heuristic 29:** *Partition Long Data Items* [40] [43]

Long data items must be portioned into shorter sections which helps to detect and reduce erroneous entries. For example a partitioned 10 digit phone number field allows user to enter phone number in three groups NNN-NNN-NNN [40].similarly pin number and social security number can also be partitioned [40]

- **Heuristic 30:** *Accessible protected areas [35]*

Protected areas [35] are inaccessible and to allow users to access their own personal information. The protected areas can be made accessible and therefore can only be accessed through passwords

3.1.1.8. Category Name: Help users recognize, diagnose and recover from errors **(Nielsen)**

- **Heuristic 31:** _Validation checks and pop up_ [11] [18] [36] [43]

Before a form is submitted it must be validated. Forms can be validated by using client side error validation, validation checks and inline validation. Client side error validation is also known as data format validation. In data format validation the users are informed immediately regarding the error made by them .Therefore they don't need to check the database after they have submitted form for errors [36]. For example if user has entered an email address in invalid format than it shows an error message immediately to user so that the user can correct it before moving to the next field. Validation checks are used to make sure that that the error messages are clear, errors can be resolved easily and error validation is performed [43]. Pop up that known as alert boxes which displays the error message in a new web browser window

- **Heuristic 32:** _Error message should provide meaningful response_ [13] [14] [35] [44]

Error message should be polite and written in familiar language to provide constructive advice to users which tells the user what to do to recover from the error rather than only pointing at the error. For example if a product is not available than instead of saying "out of stock",. The error message should tell the user when the product is available [44]

- **Heuristic 33:** _Provide suggestion actions when user makes error_ [35] [36]

When the user makes an error a suggestion list of correct input values must be provided to the users so that they can recover from error .For example in yahoo.com when a user creates a new account and types the yahoo id he wants to create, then a suggestion list of valid yahoo id appears that the user can choose to create an account

- **Heuristic 34:** _highlighting incomplete fields_ [35] [45]

When a form is incomplete, the missing or incomplete fields as well as the data entry field having error must be highlighted, in order to attract user attention on the incomplete and erroneous fields [45]. So that it becomes apparent that where the error has occurred

- **Heuristic 35:** _Never clear the already completed fields._ [13][14][35]

After an error occurs never delete or clear the already completed fields as it can be frustrate the users

- **Heuristic 36**: *Descriptive and clearly visible error messages* [14] [44]

Error messages must be visible i.e. noticeable using color, icons and text to highlight the problem area [44]. Error message must be written in a descriptive and familiar language which explains clearly what the error is and how it can be corrected. [14]

3.1.1.8. Category Name: Help and documentation (Nielsen)

- **Heuristic 37:** *Help is clear and direct* [35] [41] [43]

Use help to provide sufficient guidance to the users. Provide additional text or graphical information for ambiguities. Help must be direct, clear and simple and express it in plain English with no jargons

- **Heuristic 38:** *Hints for form fields* [41]

In web forms data entry fields must contain hints, model answers or example in order to demonstrate that how the expected input would be [41]

- **Heuristic 39:** *tool tip for form fields* [41] [46]

Tool tips are used to provide additional help regarding input field. A tooltip allows a user to see hints when they hover over an item indicating the name or purpose of the item.[46]

- **Heuristic 40:** *User-activated inline help* [12][47]

User activated inline help uses an icon, button, image that is placed next to the input field to let users know that the relevant help is available. Therefore the user can click on it when they need help. For example skype registration form contains a user activated inline help that is triggered when the question mark icon placed next to the input field is clicked [47]

3.1.1.9. Category Name: Aesthetic and minimalist design (Nielsen)

- **Heuristic 41:** *Avoid un necessary input* [11] [13] [14]

The web form should be simple, short and should not contain unnecessary inputs. This can be done   by removing questions that are not absolutely necessary or that can be answered at some other time or by using smart defaults. For example [11] in PayPal registration form the people are required to select the type of credit card (i.e   master card, visa card or American express cards) used by them for payment and similarly also enter their credit card number .however this unnecessary question because the master card numbers starts

with 51to 55,American express card start with 34 to 37 and visa cards start with 4 digit ,so from this information it can be inferred that what type of credit card is used by user instead of asking both credit number and type of credit card. By using smart defaults in which the number of choices or options that are to be selected by users are reduced and whenever possible a default selection (that is a preselected option) within a set of radio buttons

The Common Heuristics described above for polio information web data entry forms designed using usability heuristic set 1 and usability heuristic set 2 are enlisted in the form of concept matrix in the following table

Categorization of Web Data Entry Form Heuristics

Matrix of Common Heuristics & Categories

Categories / Heuristics	Nielson: Visibility of system status / Schneider: Informative feedback	Nielson: Match btw system & real world	Nielson: User control & freedom / Schneider: Permit easy reversal of actions	Schneider: Design dialogs to yield closure	Nielson: Flexibility & efficiency of use / Schneider: Enable frequent users to use shortcuts	Nielson: Consistency & Standards / Schneider: Strive for consistency	Nielson: Error Prevention / Schneider: Error Handling	Nielson: Help users recognize, diagnose & recover from errors	Nielson: Help & documentation	Nielson: Aesthetic & minimalist design
1	Inline Immediate feedback [10] [11]	Use familiar format [14] [15] [39]	Undo & redo of actions [35] [41]	Providing confirmation messages [14][15]	Display default values [35][40][41]	Consistent visual layout of form [21][35][42]	Data format cueing in labels[43]	Validation checks and pop-ups [11][18][36][43]	Help is clear and direct [35] [41][43]	Avoid un necessary input [11][13][14]
2	Providing warning messages [10][21][35]	Use familiar terms and names for labels [37]	Design for easy navigation [42]		Label units of measurements [40] [43]	Consistent labelling conventions [40] [41]	Embedded error messages [14][15][18][28]	Error message should provide meaningful response [13][14][35][44]	Hints for form fields[41]	
3	Show the user progress clearly [36] [37]	Use familiar widgets [40]			Provide Auto-Tabbing [37][40] [43]		Appropriate input widgets for easily mistyped entries [14] [39]	Provide suggestion actions when user make error [35] [36]	Tool tips for form fields[41][46]	

Categorization of Web Data Entry Form Heuristics

4	Input prompt [14][16][38][53]	Minimize use of shift key [40]	Field format restrictions [12][13][14][17]	Never delete the completed fields after an error has occured [13][14][35]	User-activated inline help [11][47]
5	Accurate feedback [21]	Flexible input field [11][14][37]	Distinguishing clearly between required and optional fields [11][14][29][30][36][40][41][43]	Use descriptive and clearly visible error messages [14][44]	
6		Single column form layout [14][15][36][53]	Avoid including a reset button [14][15]	Highlighting incomplete fields [35][45]	
7		Using check boxes for multiple selection [14][32][40][54]	Use drop down menu to avoid formatting errors [12][14]		
8		Using radio buttons for mutually exclusive selections [40][54]	Partition long data items [40][43]		

Usability Heuristics for Designing Web Data Entry Forms

Categorization of Web Data Entry Form Heuristics

			Accessible protected areas [35]				
9							

Table 5: Concept matrix of Common Heuristics for designing web data entry forms

Now others Heuristics are discussed which are implemented only in the polio information web data entry forms designed using Usability heuristics set 2 and are discussed below:

3.1.2. Others Heuristics

3.1.2.1 Category: *Designing field and labels layout for promoting readability and efficiency*

It consists of following heuristics

- Grouping of form fields
- Label "data entry fields" clearly
- Label buttons clearly
- Using sentence case labels
- Labels close to data entry fields
- Use optimal position of labels
- Proper size of data entry fields
- Prioritize buttons

Source: U.S. Dept. of Health and Human Services (2006). The Research-Based Web Design & Usability Guidelines, Enlarged/Expanded edition. Washington: U.S. Government Printing Office,

Explanation:

The layout of the "Web data entry forms" can promote **readability** by logically organizing the form content into meaningful sections, by textual headings in order to reflect meaningful relationship among different parts of an input, so that the user can comprehend well and can easily fill the structured forms[40]. Clear, distinct and descriptive labels can be used for labeling the required data entry fields and buttons. Avoid arbitrary labels like (group 1, group 2) for data entry fields and avoid generic names such as submit, save, go for buttons labels [40] [47].

Similarly sentence case labels should be used for data entry field labels in which only the first letter should be capital. The labels and all the related information should be placed very close to the data entry fields in order to allow user to easily relate the required entries and the labels and avoid placing labels far away from the data entry fields as it can slower user entry . Use an optimal position of labels in forms that is either top aligned, left aligned, and right aligned labels so that the users can easily read the form with less eye movement.

Create data entry fields that provides large amount of space for long entries and allows user to see all of their entered data without scrolling. Prioritize buttons by using location or by highlighting them. Among a group of buttons the button that is more likely to be used by user or the most frequently used button should be placed at the first position i.e. left side. Similarly the buttons or actions that allows user to move forward should be placed at the right side and the buttons that allows user to move backward should be placed at left side [52]

- **Example1:**
  Amazon.com allows users to **Online purchase and sell items** e.g. books, computer based equipment etc. through amazon's online marketplace system by signing in and If the users are new to amazon.com then they can create account and get themselves registered by filling the amazon.com registration form shown in Fig 1.The registration form uses **clear, distinct, and descriptive and sentence case labels** for both required data entry fields and button and does not uses generic name like 'submit or save' for button . The field's labels are placed at an optimal location that is near data entry fields and are properly aligned .Therefore the user can easily read the form with less eye movements and can comprehend it well.

Figure 5: Readability in web data entry forms

- **Example 2**

Wufoo is an online form builder that helps individuals and organizations in creating online payments, online contact forms and event registration forms . The "contact form" collects name, email addresses and other information from the user so that one can use personal and business information in the future. The "contact form" designed in fig 2 consists of large size data entry fields that provides **large amount of space** so that the user can enter their email address and message and could easily view all of their entries without scrolling.

URL:http://www.wufoo.com/gallery/templates/forms/contact-form/
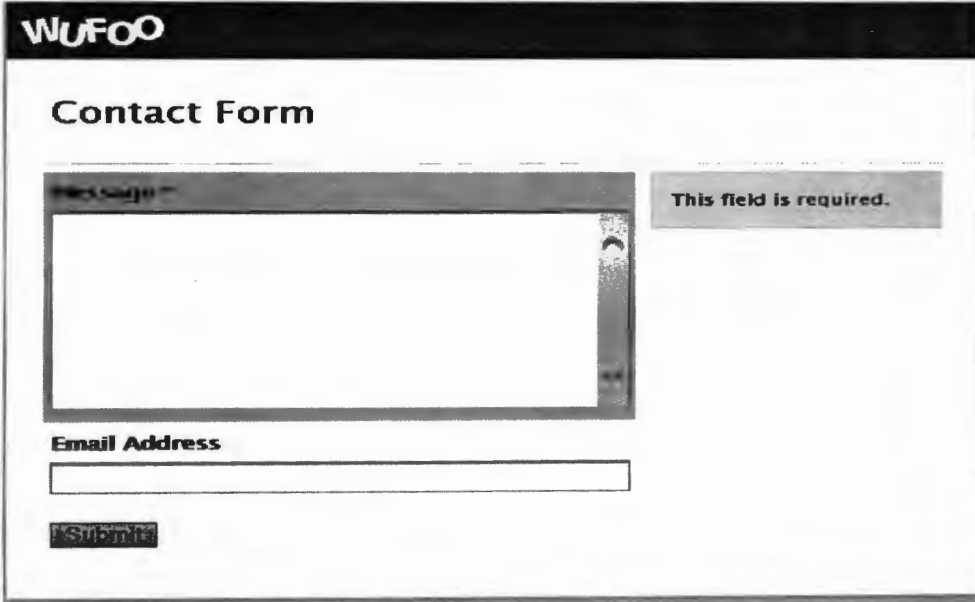
Figure 6: Using proper size data entry fields

- **Example 3**

Myway.com is a search engine like yahoo that allows users to create **an email account** by signing up and filling up the registration form. In the my way.com email registration form shown in fig 3 the input fields are **grouped** in to relevant and meaningful sections and each section is represented by a bold gray heading. In the registration form user name and password related details are grouped into "create my way account" section. The details related to password hint and secret question/answer are grouped into "if you forget your password" section. The details regarding zip code/postal code and first name are grouped into "personalize your experience" section.

URL: http://registration.myway.com/register.jsp

Figure 7: Grouping of form fields

- **Example 4:**

In the wizard control form shown in figure 4 the most frequently used button such as next button is placed at the right side to allow user to move forward and the back button is placed at the left side to allow user to move backward. Similarly the help button which is most likely to be used by the user is placed at the right side and cancel button on left side

URL: https://www.syncfusion.com/products/windows-forms/wizard

Figure 6: prioritize buttons in web data entry forms

3.1.2.2. Category: <u>Maintaining user focus on entry locations</u>

It consists of following heuristics

- Form with the user's focus sections should be displayed
- Focused fields should be visually distinct.

Source: Harms, Johannes." Research Goals for Evolving the 'Form' User Interface Metaphor towards more Interactivity", published in Human Factors in Computing and Informatics, volume 7946 of Lecture Notes in Computer Science, pages 819–822, 2013, Springer Berlin Heidelberg.

Harms, Johannes , Wimmer, C., Kappel, K., Grechenig, T."Design Space for Focus+Context Navigation in Web Forms" published In Proceedings of the EICS '14 ACM Symposium on Engineering Interactive Computing Systems, 2014, ACM.

Raphael Caixeta. "10 Tips for Optimizing Web Form Submission Usability ", January 7 2011, from http://sixrevisions.com/user-interface/10-tips-for-optimizing-web-form-submission-usability

Explanation

The web data entry form layout should be designed in such a way that while the user is doing required entries, **the focus and attention of user should be maintained on the desired entry locations** .So it becomes apparent that on which form field and section the user is right now or on that point of time. Therefore the user attention can be drawn to the current active or focused field by making them visually distinct. In case of longer forms the user can be kept focused by showing only user focused sections <u>(that is relevant and required sections of forms)</u> and displaying the rest of the form in an aggregated and compact way to allow easier navigation in longer forms.

- **Example 1**

Google.com was founded in 1998 and it allows users to search as much information as they want. It also allows users to create a Gmail account by signing up with google accounts. If the users are new to gmail.com then they can create an account by filling the "sign up form" shown in fig 4. In the gmail.com sign up from the **current focused field that is first name field is highlighted with blue border** in order <u>to make it visually distinct and to maintain user focus and attention on the entry location</u> to make it apparent that on which field the user is right now.

URL:https://accounts.google.com/signup

Figure 8: Highlighting focused input fields

- **Example 2:**

The web form shown in figure 5 is built with DNN Centric form creator .It consists of three sections i.e. *personal details, Inquiry details and other details*. In this longer form the user focus and attention can be drawn by using plus symbol for displaying only user focus sections e.g. *personal details* and *other related details* section and the rest of the form that is *inquiry details section* can be shown in a compact and aggregated way by using minus symbol to allow easy navigation in longer forms.

URL:http://dnncentric.com/en-us/dnnmodules/customformcreator/demos/formwithcollapsiblecategories.a

Figure 9:Displaying only those sections of the longer forms with the user's focus

3.1.2.3. Category: *Form layouts should promote affordance*

It consists of following heuristics:

- Intuitive order of fields and options,

- Form field length should match expected length of input

- Likelihood based ordering of options

Source. Bargas-Avila, O. Brenzikofer, S. Roth, A. Tuch, S. Orsini, and K. Opwis, "Simple but crucial user interfaces in the World Wide Web: introducing 20 guidelines for usable web form design," published in *"User Interfaces (INTECH '10)",* book entitled by *Rita Matrai (Ed.)* pp. 1–10,, 2010,.*ISBN: 978-953-307-084-1,*

Mirjam Seckler, Silvia Heinz, Javier A. Bargas-Avila, Klaus Opwis, and Alexandre N. Tuch." Designing usable web forms: empirical evaluation of web form improvement guidelines", published in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '14), pp. 1275-1284 ,2014,ACM, New York, NY, USA.

Kuang Chen, Joseph M. Hellerstein, and Tapan S. Parikh, "Designing adaptive feedback for improving data entry accuracy", published in *Proceedings of the 23nd annual ACM symposium on User interface software and technology* (UIST '10), pp.239-248, 2010, ACM, New York, NY, USA,

Explanation

Design "web data entry form" that promotes **affordance**. Affordance provides clues regarding how an input field should be filled and how answers can be structured. According to Norman [47], affordance means that the user knows what to do by just looking at form/user interface, hence no picture, label or instructions are needed. Therefore use commonly known ordering to arrange the form fields and options which should be based on **user's knowledge, intuition, assumptions and experience** in both real world and computer based domain and if no meaningful order is possible than arrange them in an alphabetical order. Right **size of input fields** should be used in the form's layout, in other words the form field length should match the expected length of input in order to provide affordance so that the user know what to enter in the form. Likelihood based ordering should be used in which the most likely and highly ranked options appears at the top of drop down menu in order to provide affordance so that the user know what to select.

- **Example 1**

In the "sign up form" shown below the user fills the form and submits it. Upon the submission of form the user notices errors because of **unintuitive** form design. In intuitive form design, users fills the form based on their knowledge & experience, thus automatically assumes that the fields are arranged in a commonly known order that is intuitive order of options with first name field in the start, then last name field, and then address field . But in the unintuitive form design shown in fig 6, the last name field is placed at the start then the first name and in the last the address field so the user can make errors.

URL:https://moz.com/blog/your-users-arent-intuitive-which-is-why-your-forms-need-to-be

Figure 10: Unintuitive form design

- **Example 2**

Facebook.com is a social networking site that was launched in February 2004 by Mark Zuckerberg. It allows users to create user profiles, update and post status and add other users by signing up and filling the facebook.com registration form. The registration form the fields and options are arranged in commonly known order that is intuitive order of options with first name field placed in the start, then last name field, email address or mobile number field, password field and date of birth field. So the registration form follows intuitive form design in which the users fills the form based on their knowledge & experience, thus automatically assumes that the fields are arranged in a commonly known order. Hence, It provides affordance that is clues regarding how an input field should be filled, so that the user knows what to do by just looking at the form

URL: https://www.facebook.com

Figure 11: Intuitive Form design

- **Example 3**

Mbna corporation allows the users to register for credit cards services online by filling the "registration form" shown in fig 7 .The "registration form" consists of *credit card number field, credit card limit field and date of birth.* In the "registration form", **the length of credit card number field matches with the actual length of credit card number** hence preventing the user to enter more than 16 digits in the credit card field.

URL:

https://www.bankcardservices.co.uk/NASApp/NetAccessXX/EnrolmentScreen?newSession=true&country=uk&language=en&org=1

Figure 12: **Form field length should match expected length of input field**

- **Example 4**

Wufoo.com is an online form builder that helps individuals and organizations in creating online payments forms, online contact forms, event registration forms and employment application form. The "employment application form" collects employment history, educational background, salary requirements, contact information and allow users to upload their resume so that the application and hiring process can be made easy. In this application form the **length of date, month and year field matches the actual length of date month and year field,** that is 2 digits for date and month fields and 4 digits for year field. Similarly the **length of phone number text field matches with the actual length of phone number,** hence preventing the user to enter more than 10 digits in the phone number field. The rest of the fields are of consistent length that provides enough space to complete answer. Therefore the field length provide affordance that is clues regarding how an input field should be filled in

URL: http://www.wufoo.com/gallery/templates/forms/employment-application/

Figure 13: Form field length matches the expected length of input and provides affordance to users

- **Example 5:**

Boots.com is a pharmacy chain which allows users to view and purchase products online by doing registration and creating an account .In the registration form of boots.com shown below there is a likelihood base ordering of options .that is when the user selects the title a drop down menu appears with the most likely options at the top of the menu instead of alphabetical based ordering

URL: https://www.boots.com/webapp/wcs/stores/servlet/UserRegistrationAdd?qses=

Figure 14: Likelihood based ordering of options

Matrix of Others Heuristics & Categories

Category / Heuristics	Designing field and labels layout for promoting readability and efficiency	Maintaining user focus on entry locations	Form layouts should promote affordance
1	Grouping of form fields [11] [35] [41] [48] [53] [54]	form with the user's focus sections should be displayed [24] [25][53]	intuitive order of fields and options,[13][14] [37]
2	Label "data entry fields" clearly[40][43][47]	Focused fields should be visually distinct.[36]	form field length should match expected length of input[13][14] [41]
3	Label pushbuttons clearly [40][47]		Likelihood based ordering of options [21] [37] [47]
4	Using sentence case labels[47] [49]		
5	Labels close to data entry fields[37][40][43]		
6	Use optimal position of labels (top aligned, left aligned or right aligned labels) [31] [53][54]		
7	Proper size of data entry fields[40]		
8	Prioritize buttons[40][52]		

Table 6: Concept matrix of Others Heuristics for designing web data entry forms

Chapter 4

Experiment Design and Implementation

4. Experiment Design and Implementation

4.1. Aim of Experimental Research

Experimental research is used to investigate the possible cause and effect relationship i-e there exists a relationship between the cause and the effect for which hypothesis is stated [55].An experiment consists of a set of trails and each trail consists of a combination of object, subjects and treatment . Its basic purpose is to evaluate a hypothesis or relationship. One of the main advantages of conducting an experiment is that we can perform statistical analysis and can control subject object and instrumentation in an experiment [55]. An experiment process consists of following activities

4.1.1 Experiment Definition

Experiment definition is the first activity of experiment process .The purpose of experiment definition is to define goals of an experiment according to definition framework

4.1.1.1. Goal

The goal of an experiment   needs to be defined to ensure that before planning and execution process takes place all the important aspects of experiment are defined. By using goal question definition template [55] or definition framework, the goal of our experiment is defined which is described below

"Analyze *web data entry forms for polio information web application designed with usability heuristic set 1 and usability heuristic set 2* **for the purpose of** *evaluation* **with respect to** *usability (i.e. ease of use)* **from point of view of** *participants of usability testing*

4.1.1.2 Definition Framework

Definition framework is used to capture the goal of the experiment [55] and consists of following steps:

   a) **Object of Study**
      Object of study concerns with the entity that is studied in an experiment [55]. The object to be studied in this experiment are the web data entry forms designed with usability heuristic set 1 and usability heuristic set 2 for polio information web application

b) Purpose

The purpose of this experiment is to evaluate impact of usability heuristics set 1 and usability heuristics set 2 on the usability of polio information web data entry forms. Usability heuristics set 1 consists of a set of Common Heuristics and usability heuristic set 2 consists of a set of Common Heuristics plus Others Heuristics

c) Quality Focus

Quality focus describes the effect that is studied in an experiment. The main effect studied in this experiment is usability of web data entry forms designed for polio information web application .In this experiment usability is studied in terms of usability dimensions such as attractiveness, perspicuity, efficiency, dependability novelty, and stimulation

d) Perspective

Perspective means the viewpoint from which the results of experiment are interpreted [55]. In our experiment the results will be interpreted from the point of view of participants of user testing

e) Context

Context describes the environment in which the experiment is conducted .It briefly discusses the subjects that are involved in the experiment and their characteristics. Moreover it also describes the object of study and its characteristics [55]. The context of our experiment consists of a group of undergraduate students that is two BSSE students of same degree and same session having good and basic understanding of PHP, CSS and HTML who are selected to implement web data entry forms for polio information web application by using either usability heuristic set 1 or usability heuristic set 2. Whereas the usability evaluation is performed by a conducting usability testing with a group of 30 undergraduate students of Software Engineering

Therefore the definition framework of our experiment is as follows:

Object of Study	Purpose	Quality Focus	Perspective	Context
polio information web data entry form designed with usability heuristic set 1 and usability heuristic set 2	Evaluation	Usability in terms of attractiveness, Perspicuity, Efficiency Dependability Stimulation and novelty	Participants of usability testing	1.Application domain of web data entry form 2.Experience of subjects 3 Team size and workload of subjects

Table 7: Definition Framework

4.1.2. Experiment Planning

After experiment definition phase, experiment planning takes place. The purpose of experiment planning is to describe how experiment is conducted [55].The planning phase of an experiment consists of following steps:

4.1.2.1. Research Question

We conducted this experiment to address following research question

RQ) what is the effectiveness of usability heuristics set 1 and set 2 in designing of web data entry forms

4.1.2.2. Hypothesis Formulation

In the planning phase the goal of experiment is formalized in a formal hypotheses. The hypotheses should be formulated in the following two types [55]. This experiment consists of following null hypothesis and alternative hypothesis.

a) Null hypothesis H_0

H_0: There is no significant difference between the usability of web data entry forms designed with usability heuristic set 1 and usability heuristic set 2

b) Alternative hypothesis H_1

H_1: There is a significant difference between the usability of web data entry forms designed with usability heuristic set 1 and usability heuristic set 2

4.1.2.3. Variables Selection

The major objective of this research thesis is to study the impact of usability heuristics set 1 and usability heuristic set 2 on usability of polio information web data entry forms. Therefore in this experiment the following variables are studied:

a) Independent Variables

In our experiment Usability Heuristics set 1 and set 2 for designing web data entry forms for polio information web application are the manipulated independent variables. Whereas the experience, work load and team size of the subjects (that is BS students) are the controlled independent variables.

b) Dependent Variable

In our experiment Usability (i.e. Ease of use) is the dependent variable. Usability is studied for each subject in terms of following usability dimensions: attractiveness, perspicuity, efficiency, dependability, novelty and stimulation

c) Factor

In our experiment factor is Usability Heuristics set for polio vaccination web data entry forms

d) Treatment

Treatment is applied by both subjects and objects .The treatment in our experiment is Usability Heuristic set 1(Common Heuristics) and Usability Heuristic set 2(Common plus Others Heuristics) .Both treatments are applied individually to see the effect of consequences of changes in Usability of web data entry forms designed for polio information web application

e) Outcome

The outcome of this experiment is to report an optimal set of heuristics that addresses majority of the usability problems related to web data entry forms as well as effective in designing web data entry forms

The detail of experiment is shown below
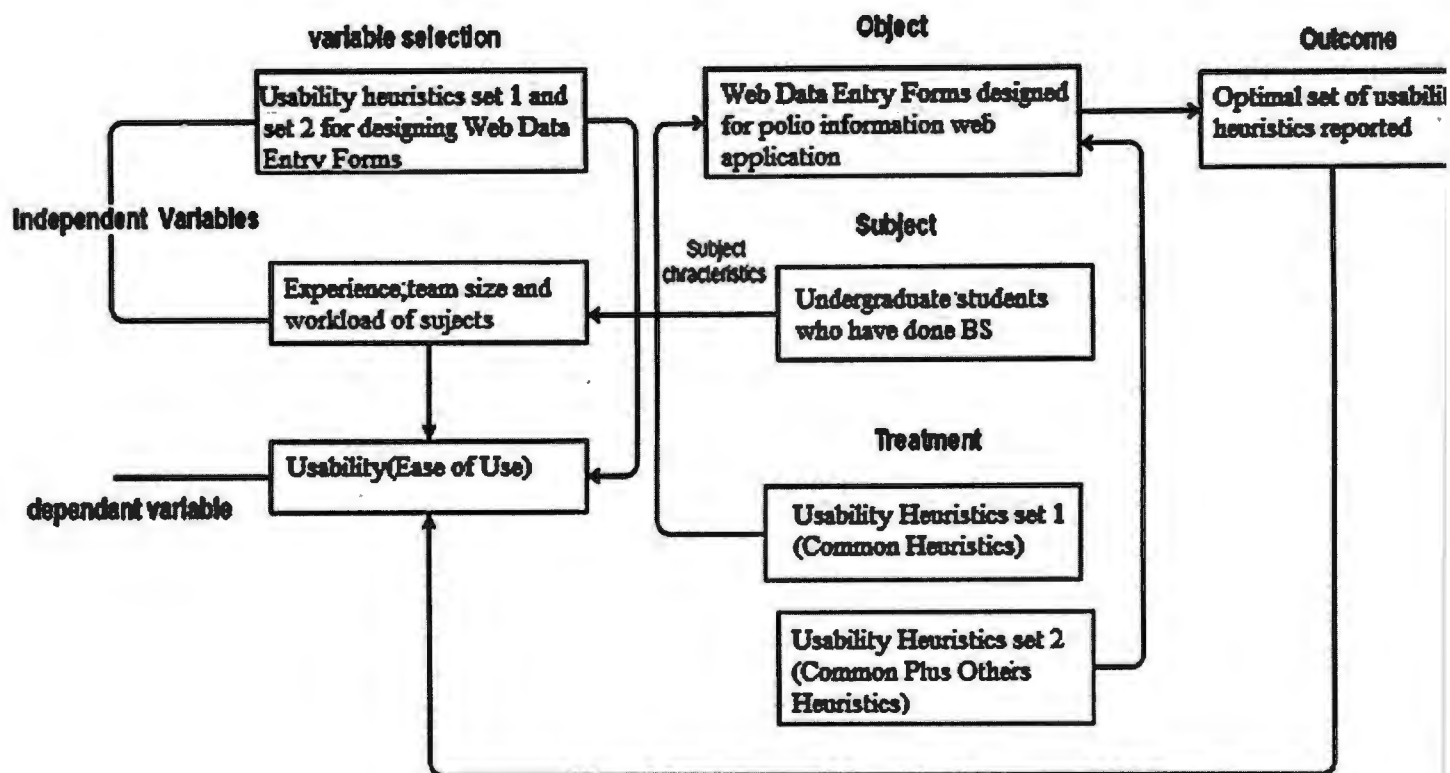
Figure 15: Experiment detail

4.1.2.3 Selection of Subjects

a) Sampling

In an experiment selection of subjects is also known as selecting sample from population. [55] The sampling of population can be based on probability sampling or non-probability sampling. In probability sampling there is a known probability of selecting each subject .whereas in non-probability sampling the probability of selecting each subject is unknown.[55] In our experiment the subjects are selected on the basis of probability sampling techniques. Therefore simple random sampling is used to randomly select subjects for implementation. Thus a group of 2 BSSE students of same degree and same session having good understanding of php css and html are selected randomly for implementing web data entry forms for polio information web application. Whereas for usability evaluation of web data entry forms simple random sampling is performed and therefore a group of 30 undergraduate students i.e. BS students are selected randomly

4.1.3. Experiment Design
An experiment design consists of following activities

4.1.3.1 Design Principles
While designing an experiment the design principles that needs to considered are randomization, blocking and balancing [55]. In our experiment the following research design principle is used

a) Randomization
In randomization the subjects that is persons or group of individuals are selected randomly and are randomly assigned to each treatment. In our experiment randomization design principle is used. According to randomization design principle a group of 2 BSSE students of same degree and same session having good understanding of PHP, CSS and HTM are selected randomly .The subjects are randomly assigned one treatment at a time i.e. either usability heuristic 1 (Common Heuristics) or usability heuristic set 2(Common plus Others Heuristics) for implementing web data entry forms for polio information web application,

Whereas for usability testing the subjects i.e. 30 undergraduate students are selected randomly and are randomly assigned the two treatments that is either the polio information web data entry forms designed using usability heuristic set 1(such as common guidelines) or the polio information web data entry forms designed using usability heuristic set 2(such as common guidelines and others guidelines) in order to perform usability evaluation

4.1.3.2. Design Type
An experiment consists of following design type

- One factor two treatments
- One factor with more than two treatments
- Two factors with two treatments
- More than two factors each with two treatments

Our experiment uses one factor with two treatment design type which is described below

a) One Factor with Two Treatments

In this design type a comparison is done among two sets of treatments and comparison is done for each treatment with respect to the dependent variable [55]. In our experiment one factor and two treatments design type is used because firstly our experiment consist of one factor and two treatments that is shown below:

Factor: *" usability heuristics set for designing web data entry forms"*

Treatment 1: *"usability heuristics set 1"*

Treatment 2: *" usability heuristics set 2"*

Secondly as we want to compare two treatments that is usability heuristics set 1 and usability heuristics set 2 with respect to the usability of polio information web data entry forms.

The experiment design type used for comparing the two treatments are as follows:

▪ Completely Randomized Design

This experiment design setup uses randomized design in which both treatments uses the same object and the subjects are assigned randomly to each treatment .In this design setup each subject is assigned only one treatment at a time that will be applied on one object. In our experiment for implementing polio information web data entry forms the group of two BSSE students which are selected according to random selection method are randomly assigned only one treatment that is either usability heuristics set 1(Common Heuristics) or usability heuristic set 2 (Common plus Others Heuristics) .The treatment is applied on one object namely Polio information web data entry forms which is also shown below.

Subjects	Usability Heuristic set 1	Usability Heuristic set 2
2		X

Table 8: Completely randomized design type

4.2. Implementation
4.2.1 Polio Information Web Data Entry Forms

The object that is implemented in our experiment are the web data entry forms designed for a web based information management system i.e. designed specifically for collecting data from the field workers regarding polio eradication in Pakistan. The Web data entry forms are designed for polio information application domain due to following reasons namely Polio is a very critical and emerging issue in Pakistan, There exists no web data entry forms for polio information application domain. During polio campaigns the field workers have to enter each record manually in paper form. Therefore there is no automated system for entering polio information data.

The web based information management system regarding polio eradication in Pakistan is based on four campaigns namely pre-campaign, post-campaign, intra- campaign and area/household monitoring .The purpose of these campaigns are to monitor as well as analyze the polio vaccination details. Similarly to report status that whether each child is given polio vaccination in the respective district, tehsil ,province and union council of Pakistan and is proper follow up being done by vaccination teams.

The object i.e. polio information web application consists of a set of four polio information web data entry forms that are pre-campaign checklist, post-campaign checklist, intra-campaign checklist and area/household monitoring checklist. The Pre campaign web data entry form contains all the polio vaccination details that must be considered before polio campaign starts .It contains polio information regarding microplan validation, training of vaccination teams, status of union council polio eradication committee and status of district council polio eradication committee in a respective district, tehsil, province and union council of Pakistan. The intra-campaign web data entry form contains all the polio vaccination details that needs to be followed by all vaccination teams during intra campaign activity in all districts, tehsil and union council of Pakistan .For example are the vaccination teams given training ,are the vaccination teams reporting missed children. Whereas the post campaign web data entry form contains all the polio vaccination that must be followed after the polio campaign is finished in a respective district, tehsil, province and union council of Pakistan. However area/household monitoring web data entry form

monitors and reports the vaccination status of children seen and finger marked. Similarly it also mentions reason for missed children so that proper follow up   is carried out

The polio information web application domain selected for designing of web data entry consists of all the   basic form controls such as text entry fields, text area, radio buttons, checkboxes ,drop down menus , list boxes etc. that occur commonly in web data entry forms for any type of web application. The only difference lies in terms of form content i.e different field labels names, radio buttons names etc. Therefore the polio information web application domain is representative of population. Thereby if the results (i.e. usability heuristic set 1 or set 2) are applicable on this application domain than the results can be generalized for other types of web application also. But we need future trials of an experiment also

4.2.2. Selection of Subjects

The polio information web data entry forms are designed using usability heuristic set 1(Common Heuristics) and usability heuristic set 2(Common plus Others Heuristics) by a group of two BSSE students of 8th semester having same degree, same session and good understanding of PHP, CSS and HTML. The two BSSE students are randomly assigned either usability heuristic set 1 or usability heuristic set 2 for implementing web data entry forms for polio information web application .Among these two students, one student has to design polio information web data entry forms using usability heuristic set 1 (which consists of only Common Heuristics) While other student has designed the polio information web data entry forms using usability heuristic set 2 (which consists of Common Heuristics plus Others Heuristics).

The polio information web data entry forms designed using usability heuristic set 1 and usability heuristic set 2 by both students consists of a login page to provide user authentication and set of four web data entry forms that is pre-campaign checklist, post-campaign checklist, intra- campaign checklist and area/household monitoring checklist. The students were given a time duration of one month for implementation and they were required to complete the implementation within the required time period.

4.2.3. Guidelines

Guidelines can include process descriptions, checklist and are required to guide subjects in an experiment. [58] In our experiment the following guidelines were given to the group of two BSSE students for implementing web data entry forms for polio information web application

a) To prepare subjects for implementation, the two BSSE students were given a demo/ presentation and documents regarding polio information web data entry forms .so that subjects can gain familiarity with the system and understand all the requirements.

b) Among two BSSE students selected for implementation, one was given usability heuristic set1 (Common Heuristics) and the other one was given usability heuristic set 2 (Common plus Others Heuristics) in paper form so that they could follow those usability heuristics set for implementing polio information web data entry forms

c) The students were also given a set of manual forms related to polio information web application based on four campaigns such as pre campaign, post campaign, Intra campaign and area/household monitoring to follow while designing the polio information web data entry forms in order to have an idea regarding the layout of the polio information web data entry forms. The manual forms are also provided in appendix

4.2.4. Implementation Results

The first section discusses the screen shots of polio information web data entry forms designed using usability heuristic set 1 and second section discusses the screen shots of polio information web data entry forms designed usability heuristic set 2 which is also described below

a) **Polio information web data entry forms designed using usability heuristic set 1(Common Heuristics)**

The polio information web data entry forms designed using usability heuristic set 1 which consists of common heuristics are shown below:

- **Login page**

  The login page provides user authentication that is the user can login in polio information web application by entering user name and password

Figure 16: Login page in polio information web data entry forms designed using usability heuristic set 1

- **Home page**

  The home page allows users to open the respective web data entry forms and it contains data regarding all the campaigns namely pre-campaign, post-campaign, intra campaign and area/household monitoring

| Polio Monitoring Data Entry Forms | | | Pre Campaign | Intra Campaign | Post Campaign | Household | | | Logout |

Pre Campaign Checklist Result   View Polio Data Entry Forms

1	punjab	Islamabad	Rawalpindi	UC122	dco office	15/05/2015	12:22	yasir,saqib mahwish		
2	punjab	Rawalpindi	Rawalpindi	ward 9#	misriyal road ward 9#	19/05/2015	15:00	yasir,mahwish		
3	punjab	Rawalpindi	Taxila	S.k	Sarai kholar	14/05/2015	01:30	Yasir		
4	punjab	Rawalpindi	Rawalpindi	UC121	DCO Office	15/05/2015	12:00	yasir,saqib,mahwish		
5	punjab	Rawalpindi	Rawalpindi	ward 9#	misriyal road ward 9#	19/05/2015	02:00	yasir,mahwish		
6	punjab	Rawalpindi	Taxila	S.K	Sarai kholar	14/05/2015	01:30	Yasir	M Nadeem	
7	punjab	Rawalpindi	Rawalpindi	UC124	DCO office	15/05/2015	12:30	yasir,saqib mahwish		🗑
8	punjab	Rawalpindi	Rawalpindi	ward 9#	misriyal road ward 9#	19/05/2015	01:00	yasir,mahwish	Asmatullah noor jahan	🗑
9	punjab	Rawalpindi	Taxila	S.k	Sarai kholar	14/05/2015	01:30	yasir	M Nadeem	🗑
10	punjab	Rawalpindi	Rawalpindi	UC125	Dco office	15/05/2015	10:00	Yasir,saqib,mahwish		🗑
11	punjab	Rawalpindi	Rawalpindi	ward 9#	misriyal road ward 9#	19/05/2015	10:30	yasir,mahwish	Asmatullah noor jahan	🗑
12	punjab	Rawalpindi	Taxila	S.K	sarai kholar	14/05/2015	01:30	yasir	M Nadeem	🗑
13	punjab	Rawalpindi	Rawalpindi	UC126	DCO office	15/05/2015	12:00	Yasir,saqib,mahwish		🗑

Pre Campaign checklist

Intra Campaign checklist

Post Campaign checklist

Household monitoring checklist

Figure 17: Home page of polio information web data entry forms designed using usability heuristic set 1

- ## Pre-campaign checklist form

Go back   Pre Campaign Checklist

0% Completed

Select Province *   Punjab ▾

Select District *   Islamabad ▾

Enter Tehsil Name *   i.e Taxila

Enter Union Council Name (UC) * Dadyal
                                 Gujar khan
Enter Village Name *   Kahota
                                 Kalar Syedan
Enter Monitor Name *   Rawat
                                 Rawalpindi
Visit Date *   Taxila
                                 dd.mm.yyyy   ❓
Visit Time *   hrs:min   ❓

Enter UPEC Chairman Name   i.e Irfan   ⚫

Enter UPEC Chairman Designation i.e Rizwan   UCPW name
                                                     enter union councll
Enter UCO name   i.e Rizwan   pollo worker name
                                                     in alphabets
Enter UCPW name   i.e Rizwan   ❓

Enter SM name   i.e Rizwan   ⚫

1-Clear boundries between two Union Councils?

  ⚫ Yes ⚫ No

2-Clear boundries between two Area in charges?

  ⚫ Yes ⚫ No

3-High risk/nomadic population/settlement mentioned in plan exist on the ground?

  ⚫ Yes ⚫ No

4-High risk/nomadic population/settlement identified in the field included in the plan?

  ⚫ Yes ⚫ No

5-Major landmark like mosques/pre primary-schools mentioned in plan exist on the ground?

  ⚫ Yes ⚫ No

6-Major landmark like mosques/pre primary-schools identified in the field included in the plan?

  ⚫ Yes ⚫ No

7-Randomly select first and last house of any team in an Area in charge plan and cross check it with field?

  ⚫ Yes ⚫ No

8-Tranning venue was comfortable and right spacing available for the participants:

  ⚫ Yes ⚫ No

9-Is the number of participants attending training were as per plan/microplan?

● Yes ● No

Reason for no: [Reason for no]

10-Is the training facilitated by UNICEF,WHO, Government etc jointly?

● Yes ● No

Reason for no: [Reason for no]

11-Availability of traning material like agenda, training manual, board, charts,marker,tally sheet

● Yes ● No

Reason for no: [Reason for no]

12-Tranning agenda was followed

● Yes ● No

Reason for no: [Reason for no]

13-Any recomended methodologies(Role Paly,demontration on all the basic IPC questions etc.) were used to deliver the sessions / Topics used

● Yes ● No

Reason for no: [Reason for no]

14-Is UPEC held 15 days before campaign?

● Yes ● No

Reason for no: [Reason for no]

15-Is upec chaired by UCMO/senior health staff and co-chaired by UC secretary

● Yes ● No

Reason for no: [Reason for no]

16-Are all the members in addition to Chair and co-chair of UPEC like SHO, AICs, LHS, Community Members & representatives, UCO, UCPW, School principles and Religious influentials are part of the UPEC

● Yes ● No

Reason for no: [Reason for no]

17-Are all the AICs submitted the updated and field validated microplans to the UPEC

● Yes ● No

Reason for no: [Reason for no]

18-Is UPEC discussed the security plan in the presence of SHO

● Yes ● No

Reason for no: [Reason for no]

19-DPEC held 10 days before campaign

● Yes ● No

Reason for no: [Reason for no]

20-DPEC chaird by DCO/DC/PA and co-chaired by EDO-H

● Yes ● No

Reason for no: [Reason for no]

21-All the members in addition to Chair and co-chair of DPEC like DPO,EDO-Revenue,EDO-Edu,District coordinator of LHWs Program,District Head of PPHI,District Head of Govt. NGOs and Local representatives of partner organizations UNICEF(DHCSO),WHO(PEO), N-STOP, and Rotary International are part of the DPEC

● Yes ● No

Reason for no: [Reason for no]

22-Is there a meeting minutes of UPEC of HRUCs discussed in the DPEC?

● Yes ● No

Reason for no: [Reason for no]

23-Is the DPEC meeting discussed and formulated the district security plan with special focus on HR Ucs/area of concern?

● Yes ● No

Reason for no: [Reason for no]

[Save]

Figure 18:Pre- campaign checklist form designed using usability heuristic set 1

- ## Post campaign checklist form

0% Completed

Select Province *	Punjab ▼
Select District *	Islamabad ▼
Enter Tehsil Name *	i.e Taxila
Enter Union Counsil Name (UC) *	i.e UC127 ❓
Enter Village Name *	UC121 ❓
	UC122
Enter Monitor Name *	UC123 ❓
	UC124
Visit Date *	UC125 ❓
	UC126
Visit Time *	NA122 ❓
	hrs:min
Enter UPEC Chairman Name	i.e Irfan
	UCO Name
	enter name of union council communication officer
Enter UPEC Chairman Designation	i.e Rizwan
Enter UCO name	i.e Rizwan ❓
Enter UCPW name	i.e Rizwan ❓
Enter SM name	i.e Rizwan ❓

1-Number of under one year children checked in the field for routine vaccination from log book

Yes   ▣

Total Checked	Total Checked
status	Status
Additional comments	Comments

2-Number of under one year children checked in the field during refusal and NA
verification for routine vaccination and cross check in the log book

Yes   ■

Total Checked | Total Checked |

status | Status |

Additional comments | Comments |

3-Has Sm shared the zero dose children list with UCMO/UCPW/UCO

Yes   ■

Total Checked | Total Checked |

status | Status |

Additional comments | Comments |

4-Is the SM updated total refusal children in the log logbook according to the refusal
reported in last campaign?

● Yes ● No
Reason for no: | Reason for no |

5-Is the SM updated total NA children in the logbook as per guidlines from the back of
tally sheet?

● Yes ● No
Reason for no: | Reason for no |

6-Is the SM having updated list of refusal with reason(Refusal Log book) after last
campaign held in the UC?

● Yes ● No
Reason for no: | Reason for no |

7-Is the SM having updated list of NA with reason(NA Log book/Missed Children from)
after last campaign held in the UC?

● Yes ● No

Reason for no: | Reason for no |

8-Is the UCO having updated list of refusal with reason(Refusal Log book) after last
campaign held in the UC?

● Yes ● No

Reason for no: | Reason for no |

9-Is the FCM having registered children in the assigned area?

● Yes ● No

Reason for no: | Reason for no |

10-Is the FCM having registered pregnant women in the assigned area?

● Yes ● No

Reason for no: | Reason for no |

11-Is the FCM having registered routine vaccination status of all the registered children?

● Yes ● No
Reason for no: | Reason for no |

12-Number of converted refusals children checked by TPFM

● Yes ● No
Total Checked: | Le 10 |

Reason for no: | Reason for no |

13-Number of converted refusal children found vaccinated by TPFM

● Yes ● No

Total Checked: Le 10

Reason for no: Reason for no

14-Number of covered NA children checked by TPFM

● Yes ● No

Total Checked: Le 10

Reason for no: Reason for no

15-Number of covered NA children found vaccinated by TPFM

● Yes ● No

Total Checked: Le 10

Reason for no: Reason for no

16-Is SM sharing list of covered refusals against still refusals with UCO on daily basis?

● Yes ● No

if yes: 03

17-Total number of still refusals covered by UCOs

● Yes ● No

if yes: 01

18-Is SM sharing list of covered NA against still NA with UCO on daily basis?

● Yes ● No

if yes: 02

19-Total number of still NAs covered by UCOs

● Yes ● No

if yes: 02

Save

Figure 19: Post campaign checklist form designed using usability heuristic set 1

- ### Intra-campaign checklist form

Go back   Intra Campaign Che...

0% Completed

Select Province *	Punjab ▾
Select District *	Islamabad ▾
Enter Tehsil Name *	i.e Taxila ❓
Enter Union Council Name (UC) *	Dadyal ❓
	Gujar khan
	Kahota
Enter Village Name *	Kalar Syedan ❓
	Rawat
Enter Monitor Name *	Rawalpindi ❓
	Taxila
Visit Date *	dd/mm/yyyy ❓
Visit Time *	HH:MM ●

Enter UPEC Chairman Name   i.e Irfan ●

Enter UPEC Chairman Designation   i.e Rizwan

UCPW Name
enter union council
polio worker name
in alphabets

Enter UCO name   i.e Rizwan

Enter UCPW name   i.e Rizwan ❷

Enter SM name   i.e Rizwan ●

1-Is vaccine carried in a proper vaccine carrier?

● Yes ● No
Validated (information)? Validation

2-Are ice packs used for maintaining cold chain?

● Yes ● No
Validated (information)? Validation

3-Is VVM of the vaccine is valid(Stage 1 and 2)?

● Yes ● No
Validated (information)? Reason for no

4-Is the team recording the name and father name of the missed children

● Yes ● No

5-Is the team recording the complete address of the missed child

● Yes ● No
Reason for no? Reason for no

6-Is the team recording the reason of missed children (Refusal & NA)

● Yes ● No
Reason for no? Reason for no

7-Is the team recording the expected date of return of the missed child

● Yes ● No
Reason for no? Reason for no

8-Is the team going inside the house for vaccination?

● Yes ● No

9-Is the team asking all the 7-9(IPC specific) questions from mother?

● Yes ● No

10-Is the team asking about zero routine dose < 1 year children in all houses?

● Yes ● No

11-Is the team vaccinating the child as per SOPs(not vaccinating in sunlight,450)?

● Yes ● No

12-Is evening meeting held at UC level daily during campaign days under the
chairmanship of UPEC?

● Yes ● No
Reason for no? Reason for no

13-Is evening meeting held at UC level daily during campaign days attended by all stakeholders(govt,UNICEF and WHO)?

● Yes   ● No

Reason for no? Reason for no

14-Is data analysis done in the evening meeting held at UC level?

● Yes   ● No

Reason for no? Reason for no

15-Is evening meeting held at district level during campaign days?

● Yes   ● No

Reason for no? Reason for no

16-Is evening meeting held at district level daily during campaign days attended by all stakeholders(govt,UNICEF and WHO)?

● Yes   ● No

Reason for no? Reason for no

17-Is data analysis done in the evening meeting held at district level?

● Yes   ● No

Reason for no? Reason for no

Save

Figure 20: Intra- campaign checklist form designed using usability heuristic set 1

- **Area/household monitoring checklist form**

Go back

0% Completed

Enter TPM Name *	i.e Rizwan
Select District *	Islamabad ▾
Enter Tehsil Name *	i.e Taxila
Enter Union Council Name (UC) *	i.e UC127
Enter Village Name *	i.e Khanpur
Enter Team No *	Khanpur / rawat / kalar syeedan
Visit Date *	dd/mm/yyyy
Is this a mobile population?	●Yes ●No

Enter House Number *

i.e 05

Enter Head Of House Name *

i.e Rizwan

1-Number of children <5 years seen:

Number of children seen

2-Number of children <5 years seen finger marked:

Number of children seen f

3-Number of children seen 0-11 months?

4-Number of children seen finger marked 0-11 months

Number of children seen

5-Vaccinated but not finger marked

Vaccinated but not finger

6-No team

No team

7-Not available (N/A)?

Not available

8-Refusals

Refusals

9-Correct door chalking?

●Yes ●No

Save
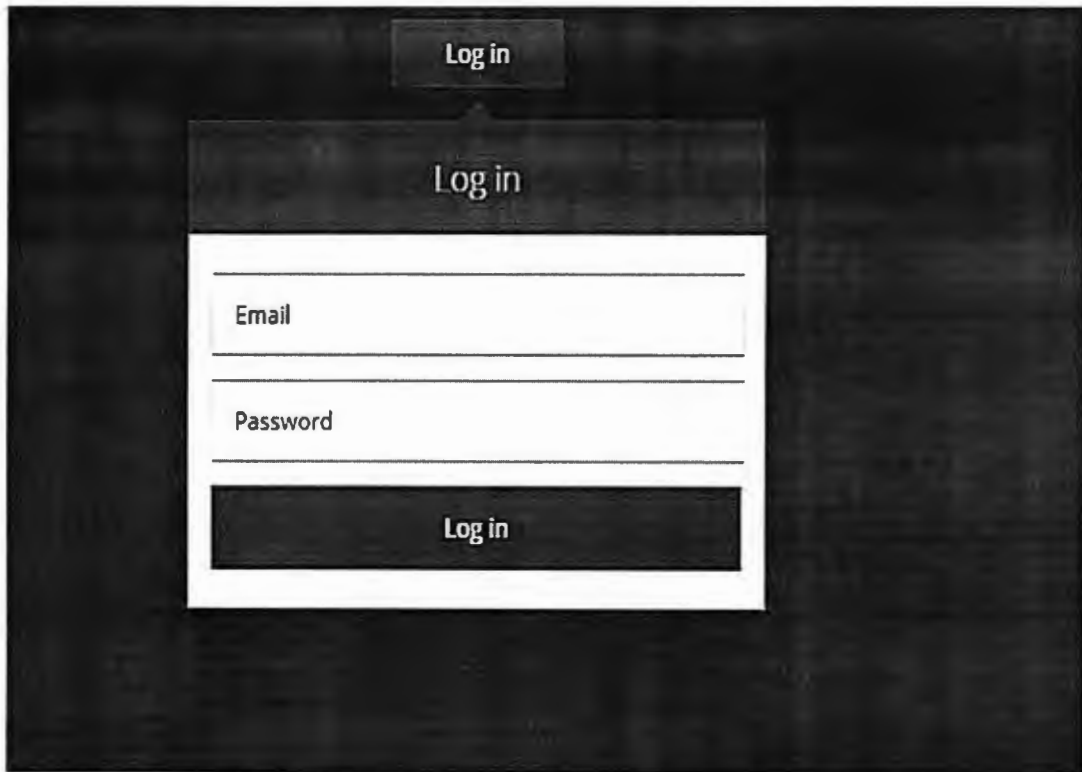
Figure 21: area/household monitoring checklist form designed using usability heuristic set 1

b) **Polio Information web data entry forms designed using usability heuristic set 2(Common plus Others Heuristics)**

The polio information web data entry forms designed using usability heuristic set 2 that is common heuristics plus others heuristics are shown below:

- **Login page**

  The login page provides user authentication and allows user to enter email address and password to login in the polio information web application

Figure 21: Login page in polio information web data entry forms designed using usability heuristic set 2

- ## Home page

The home page allows users to open the respective web data entry forms and it contains data regarding all the campaigns namely pre-campaign, post-campaign, intra campaign and area/household monitoring

		District	Tehsil	Village	Date of visit	time of visit	name of monitors	Action
	ab	Islamabad	Rawalpindi	dco office	15/05/2015	12:22	yasir,saqib mahwish	Delete
	ab	Rawalpindi	Rawalpindi	misriyal road ward g#	19/05/2015	15:00	yasir,mahwish	Delete
	ab	Rawalpindi	Taxila	Sarai kholar	14/05/2015	01:30	Yasir	Delete
	ab	Rawalpindi	Rawalpindi	DCO Office	15/05/2015	12:00	yasir,saqib,mahwish	Delete
	ab	Rawalpindi	Rawalpindi	misriyal road ward g#	19/05/2015	02:00	yasir,mahwish	Delete
	ab	Rawalpindi	Taxila	Sarai kholar	14/05/2015	01:30	Yasir	Delete
	ab	Rawalpindi	Rawalpindi	DCO office	15/05/2015	12:30	yasir,saqib mahwish	Delete
	ab	Rawalpindi	Rawalpindi	misriyal road ward g#	19/05/2015	01:00	yasir,mahwish	Delete
	ab	Rawalpindi	Taxila	Sarai kholar	14/05/2015	01:30	yasir	Delete
	ab	Rawalpindi	Rawalpindi	Dco office	15/05/2015	10:00	Yasir,saqib,mahwish	Delete
	ab	Rawalpindi	Rawalpindi	misriyal road ward g#	19/05/2015	10:30	yasir,mahwish	Delete
	ab	Rawalpindi	Taxila	sarai kholar	14/05/2015	01:30	yasir	Delete
	ab	Rawalpindi	Rawalpindi	DCO office	15/05/2015	12:00	Yasir,saqib,mahwish	Delete
	ab	Rawalpindi	Rawalpindi	Misriyal road ward g#	19/05/2015	02:30	yasir,mahwish	Delete
	ab	Rawalpindi	Taxila	sarai kholar	14/05/2015	01:30	yasir	Delete
	ab	Rawalpindi	Rawalpindi	DCO office	15/05/2015	12:00	yasir,saqib,mahwish	Delete
	ab	Rawalpindi	Rawalpindi	misriyal road Ward#9	19/05/2015	10:00	yasir,mahwish	Delete
	ab	Rawalpindi	Rawalpindi	Sarai kholar	14/05/2015	01:30	yasir	Delete
	ab	rwp	rawalpindi	DCO office	2015-05-15	01:00	yasir,saqib,mahwish	Delete
20	punjab	rwp	rawalpindi	misriyal road ward g#	2015-05-19	12:00	yasir,mahwish	Delete
21	punjab	rwp	Taxila	Sarai kholar	2015-05-14	01:30	yasir	Delete
22	punjab	rwp	rawalpindi	DCO office	2015-05-15	10:00	Yasir,saqib,mahwish	Delete
23	punjab	rwp	rawalpindi	misriyal road ward g#	2015-05-19	11:30	yasir,mahwish	Delete
24	punjab	rwp	Taxila	Sarai kholar	2015-05-14	01:30	Yasir	Delete
25	punjab	rwp	rawalpindi	DCO office	2015-05-15	10:00	yasir,saqib, mahwish	Delete
26	punjab	rwp	rawalpindi	misriyal road ward g#	2015-05-19	09:00	yasir,mahwish	Delete
27	punjab	rwp	Taxila	Sarai kholar	2015-05-14	01:30	Yasir	Delete
28	punjab	rwp	rawalpindi	DCO office	2015-05-15	11:30	Yasir,saqib,mahwish	Delete

Figure 22: Home page in polio information web data entry forms designed using usability heuristic set 2

- ## Pre campaign checklist form

Precampaign Checklist

◄ Go Back

Precampain Data Collection

1	2	3	4	5	6
Basic Information	Microplan	Training of Vaccination Teams	Status of UPEC	Status of DPEC	Save

Step 1 - Basic information

Name of province *

Select Province

Name of district *

Select District

Name of tehsil *

Rawalpindi

Name of union council (uc)*

Le UC 127

Name of village/town *

Le Khanpur

Name of monitor *

ali

Date of visit *

XX/XX/XXXX

Time

	April 2016					
Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Nam

Desi

executive chairman

Name of uco

faisal

Name Of ucpw

Name of sm

Previous   Next

Figure 23: Pre campaign checklist form designed using usability heuristic set 2

- ## Post campaign checklist form

Figure 24: Post campaign checklist form designed using usability heuristic set 2

- ## Intra campaign checklist form

Figure 25: Intra campaign checklist form designed using usability heuristic set 2

- **Area/household monitoring checklist form**

Figure 26: Area/household monitoring checklist form designed using usability heuristic set 2

Chapter 5

Usability Testing

5.1. Usability Testing

The polio information web data entry forms designed with usability heuristic set 1(Common Heuristics) and usability heuristic set 2 (Common plus Others Heuristics) are validated by performing usability evaluation. The usability of both polio information web data entry forms designed using usability heuristic set 1 and usability heuristic set 2 is evaluated by performing usability testing with a group of undergraduate students having same degree and same session

5.1.1. Selection of subjects

For performing usability testing the subjects such as 30 undergraduate students are randomly selected and are randomly assigned into two groups of 15 students .Each group of 15 students are randomly assigned one treatment at a time i.e. either the polio information web data entry forms designed using usability heuristic set 1 (Common Heuristics) or the polio information web data entry forms designed using usability heuristic 2 (Common plus Others Heuristics) in order to perform usability testing as well as evaluate the usability of polio information web data entry forms designed with usability heuristic set 1 and usability heuristic set 2 which is also shown below

Subjects	Usability Heuristic set 1	Usability Heuristic set 2
Group A (N=15)	X	
Group B(N=15)		X

Table 9: Completely randomized design type for usability testing

The usability testing was performed on the polio information web data entry forms designed using usability heuristic set 1 and usability heuristic set 2 that were hosted online on www.itestbuddy.com/entryforms

5.1.2. Guidelines

The following guidelines were given to the subjects that is 30 BS students for evaluating usability of polio information web data entry forms designed using usability heuristic set 1 and usability heuristic set 2:

a) During evaluation each student is given three data sets .Each data set contains three pre-campaign, three post-campaign, three intra-campaign checklist and three area/household monitoring checklist form in manual form which is also provided in appendix

5.1.3 Pilot testing

Before performing real usability testing with real users a pilot study is conducted to assess that whether the 3 sets of data sets that are to be given to the users for performing usability testing are understandable or not understandable to a layman. Data set contains manual forms regarding pre campaign, post campaign, intra campaign and area/household monitoring polio campaigns in Pakistan. The purpose of providing three data set to each subject such as total of 12 manual forms is to engage the users. This helps the subjects can get familiar with the system by entering all the data given in the data set. Therefore 5 students of BS degree are requested to perform pilot testing as we need to know that, is the data set understandable to the users and is the data set enough for the user to get familiar with the system. Similarly we wanted to know that by using this data set would we get correct feedback. The outcome of pilot study suggested some changes which are accommodated after discussion. Therefore the data set contained the tasks that are understandable to users

5.1.4. Data collection

5.1.4.1 Semantic differential scale questionnaire

Questionnaires are the most frequently used data collection method in educational and evaluation research [56]. A questionnaire is a research measurement instrument which consists of a series of questions to gather information from respondent's .Questionnaires are often designed for statistical analysis of the responses. In this experiment semantic differential scale questionnaire is used as measurement instrument while performing usability testing .Its purpose is to assess usability of polio information web data entry forms designed with usability heuristic set 1(Common Heuristics) and usability heuristic set 2(Common plus Others heuristics)

All the subjects i.e. 30 undergraduate students are asked to enter data in either the polio information web data entry forms designed with usability heuristic set 1 or usability heuristic set 2 according to the data set given to them to assess the usability .Therefore semantic differential scale questionnaire is used to take feedback from them regarding the usability of polio information web data entry forms deigned with usability heuristic set 1 or the polio information web data entry forms deigned with usability heuristic set 2.The subjects would rate their experience in terms of usability that is ease of use, how the

subjects feel while interacting with either polio information web data entry forms designed using usability heuristic set 1 or usability heuristic set 2 .The purpose of semantic differential scale questionnaire is to capture user experience, measure their attitude and to assess usability

a. Structure of Semantic differential scale Questionnaire

Semantic differential scale is a ranking based questionnaire which is used for ordinal data .ordinal data is based on non-numeric scales. The Sematic differential scale questionnaire is used during usability testing and it consists of contrasting pairs that is opposite meanings terms near each item for e.g. pleasant-unpleasant, to measure the attitude, feelings, opinions and experience of subjects towards usability of polio information web data entry forms .It consists of a total of 26 items which belongs to six scales or dimensions that contributes to usability i.e. also discussed below. It is based on a seven-point rating scale for each number of attributes. The extreme points represent the bipolar adjectives and the central point is represented as neutral

• Attractiveness [57] [58]
Attractiveness gives an overall impression regarding the polio information web data entry forms i.e. Does the users likes or dislikes the web data entry forms and are web data entry forms friendly or unfriendly .The items of the semantic differential scale questionnaire that belongs to attractiveness are:
- Annoying-enjoyable,
- Good-bad,
- Unlikeable-pleasing,
- Unpleasant-pleasant,
- Attractive-unattractive
- Friendly-unfriendly

• Perspicuity [57] [58]
Perspicuity describes that, is it easy for the users to understand the functionality of polio information web data entry forms that is how to use the web data entry

forms and is it easy for the users to get familiar with it. The items of the semantic differential scale questionnaire that belongs to perspicuity are:

- Not understandable-understandable
- Easy to learn-difficult to learn
- Complicated-easy
- Clear-confusing

- **Efficiency** [57][58]

Efficiency describes that can the users use the polio information web data entry form and perform their task quickly and efficiently (i.e. without unnecessary effort).The items of semantic differential scale questionnaire that belongs to efficiency are:

- Fast-slow
- Inefficient-efficient
- Impractical-practical,
- Organized-cluttered

- **Dependability** [57][58]

Dependability means that does the user feels in control of the interaction. The items of semantic differential scale questionnaire that belongs to dependability are:

- Unpredictable-predictable.
- Obstructive-supportive
- Secure-not secure
- Meets expectations-does not meets expectations

- **Stimulation** [57][58]

Stimulation means that is it motivating, interesting and exciting for the user to use the web data entry forms. The items of semantic differential scale questionnaire that belongs to stimulation are:

- Valuable-inferior
- Boring-exciting
- Interesting-not interesting
- Motivating- demotivating

• **Novelty** [57] [58]

It describes that whether the design of polio information web data entry forms is creative and innovative to use: The items of semantic differential scale questionnaire that belongs to novelty are:

- Creative-dull,
- Inventive-conventional
- Usual-leading edge
- Conservative-innovative

The semantic differential scale questionnaire used during usability testing in order to capture the experience of users is shown below

Please assess the product now by ticking one circle per line.

	1	2	3	4	5	6	7		
annoying	O	O	O	O	O	O	O	Enjoyable	1
not understandable	O	O	O	O	O	O	O	understandable	2
creative	O	O	O	O	O	O	O	Dull	3
easy to learn	O	O	O	O	O	O	O	difficult to learn	4
valuable	O	O	O	O	O	O	O	Inferior	5
boring	O	O	O	O	O	O	O	Exciting	6
not interesting	O	O	O	O	O	O	O	interesting	7
unpredictable	O	O	O	O	O	O	O	predictable	8
fast	O	O	O	O	O	O	O	Slow	9
inventive	O	O	O	O	O	O	O	conventional	10
obstructive	O	O	O	O	O	O	O	supportive	11
good	O	O	O	O	O	O	O	Bad	12
complicated	O	O	O	O	O	O	O	Easy	13
unlikable	O	O	O	O	O	O	O	pleasing	14
usual	O	O	O	O	O	O	O	leading edge	15
unpleasant	O	O	O	O	O	O	O	pleasant	16
secure	O	O	O	O	O	O	O	not secure	17
motivating	O	O	O	O	O	O	O	demotivating	18
meets expectations	O	O	O	O	O	O	O	does not meet expectations	19
inefficient	O	O	O	O	O	O	O	efficient	20
clear	O	O	O	O	O	O	O	confusing	21
impractical	O	O	O	O	O	O	O	practical	22
organized	O	O	O	O	O	O	O	cluttered	23
attractive	O	O	O	O	O	O	O	unattractive	24
friendly	O	O	O	O	O	O	O	unfriendly	25
conservative	O	O	O	O	O	O	O	innovative	26

Figure: Semantic differential scale questionnaire

Chapter 6

Results and Analysis

6. Results and Analysis
6.1. Data Collection
All the data gathered from the users through semantic differential scale questionnaire is entered into two excel analysis sheets. MS excel analysis sheets[57][58] are used to convert the 26 items of semantic differential scale questionnaire into six usability scales such as attractiveness, perspicuity, efficiency, dependability, stimulation and novelty. Two excel sheets are created and used. One excel sheet contains the individual responses or feedback of students who have evaluated the usability of polio information web data entry forms designed with usability heuristic set 1 by performing a set of tasks given in the data set (that is provided in appendix also). Second excel sheet contains the individual responses or feedback of students who evaluated the usability of polio information web data entry forms designed with usability heuristic set 2 by performing a set of tasks given in data sets (that is provided in appendix also)

6.2. Results
The individual responses or feedback of a group of 30 BS students who have evaluated usability of polio information web data entry forms designed with usability heuristic set 1 and usability heuristic are entered into the Microsoft excel analysis worksheet [57][58] by using the following steps

- **Step 1:**

  The excel sheet consists of 1 to 26 item number which is mentioned on the semantic differential scale questionnaire In the excel sheets [57][58] the corresponding ranking scale between (1 to 7) marked by the user is entered with respect to each item no (1-26) mentioned on the questionnaire the which is also shown below

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
4	4	5	4	3	4	5	5	5	3	4	4	3	4	4	5	4	1	3	4	4	3	4	5	4	4	5
5	5	6	3	2	3	5	4	4	2	3	5	4	5	5	5	5	2	3	3	5	2	5	3	3	2	5
6	4	3	4	5	3	4	4	5	3	5	5	3	3	5	4	5	2	4	4	3	4	3	4	3	4	3
7	6	6	2	1	1	5	6	6	1	2	6	1	5	6	6	6	1	1	1	6	2	6	1	2	2	6
8	5	5	3	2	2	6	5	5	2	3	5	2	5	4	5	6	1	2	2	5	3	5	3	1	3	5
9	3	3	6	5	4	3	3	3	2	5	3	5	3	3	3	4	3	4	5	3	5	3	5	5	5	3
10	3	4	5	4	5	3	2	3	4	3	3	5	3	3	3	4	3	5	6	3	5	2	5	6	3	3
11	4	3	4	3	4	5	4	4	3	4	4	4	4	5	4	5	2	4	4	3	4	2	7	6	4	4
12	3	2	5	5	5	2	2	2	3	5	3	5	2	4	3	3	4	4	5	2	5	4	4	4	6	3
13	4	5	3	3	4	5	5	5	2	3	5	3	6	6	5	5	2	4	3	5	3	5	3	2	2	5
14	4	3	4	3	3	4	3	4	2	4	5	3	4	4	3	5	2	3	4	4	4	4	6	2	3	4
15	3	4	5	4	5	4	5	3	3	5	3	4	4	2	4	3	4	5	5	3	5	5	4	4	5	4
16	6	5	1	1	1	6	6	6	1	1	6	2	6	6	6	6	1	1	1	5	1	6	2	1	1	6
17	5	4	3	2	2	6	5	5	2	2	6	3	5	5	5	5	1	1	2	4	2	3	4	3	3	5
18	5	5	2	3	4	5	6	5	2	3	5	3	5	5	5	5	1	2	2	5	2	4	3	3	2	5

Figure 27: Excel sheet results containing item no and corresponding option no marked by user for polio information web data entry forms designed using usability heuristic set 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
4	4	4	4	4	3	4	4	5	3	4	4	3	3	4	5	4	3	4	4	4	4	4	6	3	2	4
5	5	5	3	3	4	5	4	4	3	3	5	4	5	5	4	6	3	3	2	5	3	5	3	3	3	5
6	6	6	2	1	2	6	5	6	2	2	6	2	6	6	6	7	2	1	2	7	2	6	2	2	1	6
7	5	5	4	3	3	4	6	5	2	4	5	3	5	5	4	6	2	3	3	5	3	5	3	3	3	5
8	6	7	2	2	2	6	5	6	2	3	6	2	7	6	6	5	1	2	2	6	1	7	1	2	3	6
9	7	6	1	1	1	6	6	7	1	2	7	1	6	7	7	6	1	1	1	7	1	6	2	1	1	6
10	5	5	3	3	3	5	4	5	3	4	4	3	5	5	5	5	2	3	3	5	3	4	3	3	3	4
11	6	6	3	2	1	7	7	6	2	1	6	2	5	6	6	6	1	1	2	6	2	5	2	2	3	5
12	5	5	2	3	4	5	4	4	2	3	4	2	6	5	4	5	3	3	3	5	3	3	5	2	3	4
13	7	6	1	2	1	6	5	7	2	1	6	1	7	7	7	6	1	2	1	6	2	6	2	1	1	6
14	6	5	2	3	2	5	6	6	1	2	7	1	6	6	5	7	2	2	2	6	2	5	2	2	3	5
15	7	7	1	2	1	5	7	7	1	1	6	1	6	6	7	7	2	1	1	7	1	6	2	1	2	7
16	7	6	2	3	2	7	6	6	2	2	7	1	7	7	6	6	2	2	1	6	2	6	1	3	2	7
17	6	7	3	1	3	6	6	5	1	2	6	2	6	6	5	5	3	2	3	5	1	5	1	2	1	6
18	3	2	5	5	6	2	2	3	4	5	2	4	2	3	2	2	4	6	5	3	5	2	5	6	5	3

Figure 28: Excel sheet results containing item no and corresponding option no marked by user for polio information web data entry forms designed using usability heuristic set 2

- **Step 2**

    There is a randomized order of positive and negative terms in the semantic differential scale questionnaire such as in the questionnaire half of the items start with positive terms or attributes(*e.g. easy to learn-difficult to learn*) and half of the items start with negative terms or attributes(*e.g. not understandable-understandable).* Therefore each item value is scaled or transformed between -3 to +3 ,where +3 represents most positive answer and -3 represents most negative answer and 0 represents neutral answer.

In both excel sheets [57][58] the mean is calculated for six usability scales that are attractiveness, perspicuity, efficiency, dependability, stimulation and novelty for each participant that is shown below

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		ATT	DUR	EFF	STEU	STI	ORI
4	0	1	0	1	0	1	1	1	1	0	0	1	0	0	1	0	3	1	0	0	1	0	-1	0	0	1		0.17	0.75	0.00	1.00	0.75	0.50
5	1	2	1	2	1	1	0	0	2	1	1	0	1	1	1	1	2	1	1	1	2	1	1	1	2	1		1.00	1.75	1.25	1.00	0.75	1.00
6	0	-1	0	-1	1	0	0	1	1	-1	1	1	-1	1	0	1	2	0	0	-1	0	-1	0	1	0	-1		0.67	-0.75	-0.25	1.00	0.25	-0.50
7	2	2	2	3	3	1	2	2	3	2	2	3	1	2	2	2	3	3	3	2	2	2	3	2	2	2		2.17	2.00	2.50	2.50	2.25	2.00
8	1	1	1	2	2	2	1	1	2	1	1	2	1	0	1	2	3	2	2	1	1	1	1	3	1	1		1.50	1.25	1.25	1.75	1.75	1.00
9	-1	-1	-2	-1	0	-1	-1	-1	2	-1	-1	-1	-1	-1	-1	0	1	0	-1	-1	-1	-1	-1	-1	-1	-1		-0.83	-1.00	-0.25	-0.50	-0.50	-1.25
10	-1	0	-1	0	-1	-1	-2	-1	0	1	-1	-1	-1	-1	-1	0	1	-1	-2	-1	-1	-2	-1	-2	1	-1		-0.67	-0.50	-1.00	-0.75	-1.25	-0.50
11	0	-1	0	1	0	1	0	0	1	0	0	0	0	1	0	1	2	0	0	-1	0	-2	-3	-2	0	0		0.00	0.00	-1.25	0.50	0.25	0.00
12	-1	-2	-1	-1	-1	-2	-2	-2	1	-1	-1	-1	-2	0	-1	-1	0	0	-1	-2	-1	0	0	0	-2	-1		-0.83	-1.50	-0.25	-1.00	-1.25	-1.00
13	0	1	1	1	0	1	1	1	2	1	1	1	2	2	1	1	2	0	1	1	1	1	2	2	1			1.33	1.25	1.25	1.25	0.50	1.00
14	0	-1	0	1	1	0	-1	0	2	0	1	1	0	0	-1	1	2	1	0	0	0	0	-2	2	1	0		0.83	0.00	0.00	0.75	0.25	-0.25
15	-1	0	-1	0	-1	0	1	-1	1	-1	-1	0	0	-2	0	-1	0	-1	-1	-1	-1	1	0	0	-1	0		-0.83	-0.25	0.25	-0.75	-0.25	-0.50
16	2	1	3	3	3	2	2	2	3	3	2	2	2	2	2	2	3	3	3	1	3	2	2	3	3	2		2.33	2.25	2.00	2.50	2.50	2.50
17	1	0	1	2	2	2	1	1	2	2	2	1	1	1	1	1	3	3	2	0	2	-1	0	1	1	1		1.00	1.25	0.25	2.00	2.00	1.25
18	1	1	2	1	0	1	2	1	2	1	1	1	1	1	1	1	3	2	2	1	2	0	1	1	2	1		1.17	1.25	1.00	1.75	1.25	1.25

Figure 29: Transformation of values in polio information web data entry forms designed using usability heuristic set 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		ATT	DUR	EFF	STEU	STI	ORI
4	0	0	0	0	1	0	0	1	1	0	0	1	-1	0	1	0	1	0	0	0	0	0	-2	1	2	0		0.67	-0.25	-0.25	0.50	0.25	
5	1	1	1	1	0	1	0	0	1	1	1	0	1	1	0	2	1	1	2	1	1	1	1	1	1	1		1.00	1.00	1.00	1.00	0.50	
6	2	2	2	3	2	2	1	2	2	2	2	2	2	2	2	3	2	3	2	3	2	2	2	2	3	2		2.33	2.25	2.25	2.00	2.00	
7	1	1	0	1	1	0	2	1	2	0	1	1	1	1	0	2	2	1	1	1	1	1	1	1	1	1		1.17	1.00	1.25	1.25	1.00	
8	2	3	2	2	2	2	1	2	2	1	2	2	3	2	2	1	3	2	2	2	3	3	3	2	1	2		1.67	2.75	2.50	2.25	1.75	
9	3	2	3	3	3	2	2	3	3	2	3	3	2	3	3	2	3	3	3	2	2	3	3	2				2.83	2.50	2.50	3.00	2.50	
10	1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	1	1	2	1	1	1	1	0	1	1	0		1.00	1.00	0.75	1.00	0.75	
11	2	2	1	2	3	3	3	2	2	3	2	2	1	2	2	2	3	3	2	2	2	1	2	2	1	1		1.83	1.75	1.75	2.25	3.00	
12	1	1	2	1	0	1	0	0	2	1	0	2	2	1	0	1	1	1	1	1	1	-1	-1	2	1	0		1.33	1.25	0.25	0.50	0.50	
13	3	2	3	2	3	2	1	3	2	2	2	2	3	3	3	2	3	2	3	2	2	2	2	3	3	2		2.83	2.25	2.00	2.75	2.00	
14	2	1	2	1	2	1	2	2	3	2	3	3	2	2	1	3	2	2	2	2	1	2	2	1	1			2.17	1.50	2.00	2.25	1.75	
15	3	3	3	2	3	1	3	3	3	3	2	3	2	3	3	2	3	3	3	3	2	2	3	2	3			2.67	2.50	2.50	2.50	2.50	
16	3	2	2	1	2	3	2	2	2	2	3	3	3	3	2	2	2	2	3	2	2	2	3	1	2	3		2.33	2.00	2.25	2.50	2.25	
17	2	3	1	3	2	2	1	3	2	2	2	2	1	1	1	2	1	1	3	1	3	2	3	2				2.00	2.75	2.00	1.25	1.75	
18	-1	-2	-1	-1	-2	-2	-2	-1	0	-1	-2	0	-2	-1	-2	-2	0	-2	-1	-1	-1	-2	-1	-2	-1	-1		-1.17	-1.50	-1.00	-1.00	-2.00	

Figure 30: Transformation of values in polio information web data entry forms designed using usability heuristic set 2

- **Step 3:**

The Mean, variance and standard deviation are also calculated for each individual item (between 1 to 26) that is marked by the user, In the excel sheet values between -0.8 and 0.8 represents neutral evaluation. Whereas the values>0.8 represents positive evaluation and values< -0.8 represents negative evaluation. The range of scales is between -3(represents extremely bad) and +3(represents extremely good)

3	Item	Mean	Variance	Std. Dev.	No.	Positive	Negative	Scale
4	1	0.3	1.1	1.0	15	annoying	enjoyable	Attractiveness
5	2	0.2	1.5	1.2	15	not understandable	understandable	Perspicuity
6	3	0.4	1.8	1.4	15	creative	dull	Novelty
7	4	0.9	1.8	1.3	15	easy to learn	difficult to learn	Perspicuity
8	5	0.7	1.8	1.3	15	valuable	inferior	Stimulation
9	6	0.5	1.4	1.2	15	boring	exciting	Stimulation
10	7	0.3	1.8	1.3	15	not interesting	interesting	Stimulation
11	8	0.3	1.4	1.2	15	unpredictable	predictable	Dependability
12	9	1.7	0.7	0.8	15	fast	slow	Efficiency
13	10	0.5	1.6	1.2	15	inventive	conventional	Novelty
14	11	0.5	1.3	1.1	15	obstructive	supportive	Dependability
15	12	0.7	1.4	1.2	15	good	bad	Attractiveness
16	13	0.3	1.4	1.2	15	complicated	easy	Perspicuity
17	14	0.5	1.4	1.2	15	unlikable	pleasing	Attractiveness
18	15	0.4	1.1	1.1	15	usual	leading edge	Novelty
19	16	0.7	0.9	1.0	15	unpleasant	pleasant	Attractiveness
20	17	2.0	1.1	1.1	15	secure	not secure	Dependability
21	18	0.9	1.9	1.4	15	motivating	demotivating	Stimulation
22	19	0.6	2.4	1.5	15	meets expectations	does not meet expectations	Dependability
23	20	0.0	1.3	1.1	15	inefficient	efficient	Efficiency
24	21	0.7	1.8	1.3	15	clear	confusing	Perspicuity
25	22	0.1	1.6	1.3	15	impractical	practical	Efficiency
26	23	0.1	2.4	1.5	15	organized	cluttered	Efficiency
27	24	0.7	2.5	1.6	15	attractive	unattractive	Attractiveness
28	25	0.7	1.9	1.4	15	friendly	unfriendly	Attractiveness
29	26	0.4	1.1	1.1	15	conservative	innovative	Novelty

Figure 31: Excel sheet results for polio information web data entry forms designed using usability heuristic set 1

3	Item	Mean	Variance	Std. Dev.	No.	Positive	Negative	Scale
4	1	1.7	1.4	1.2	15	annoying	enjoyable	Attractiveness
5	2	1.5	1.7	1.3	15	not understandable	understandable	Perspicuity
6	3	1.5	1.4	1.2	15	creative	dull	Novelty
7	4	1.5	1.3	1.1	15	easy to learn	difficult to learn	Perspicuity
8	5	1.5	2.0	1.4	15	valuable	inferior	Stimulation
9	6	1.3	1.6	1.3	15	boring	exciting	Stimulation
10	7	1.1	1.8	1.4	15	not interesting	interesting	Stimulation
11	8	1.5	1.4	1.2	15	unpredictable	predictable	Dependability
12	9	1.9	0.8	0.9	15	fast	slow	Efficiency
13	10	1.4	1.5	1.2	15	inventive	conventional	Novelty
14	11	1.4	2.0	1.4	15	obstructive	supportive	Dependability
15	12	1.9	1.1	1.1	15	good	bad	Attractiveness
16	13	1.5	2.0	1.4	15	complicated	easy	Perspicuity
17	14	1.6	1.3	1.1	15	unlikable	pleasing	Attractiveness
18	15	1.3	1.9	1.4	15	usual	leading edge	Novelty
19	16	1.5	1.7	1.3	15	unpleasant	pleasant	Attractiveness
	17	1.9	0.8	0.9	15	secure	not secure	Dependability
21	18	1.6	1.8	1.4	15	motivating	demotivating	Stimulation
22	19	1.7	1.4	1.2	15	meets expectations	does not meet expectations	Dependability
23	20	1.5	1.3	1.1	15	inefficient	efficient	Efficiency
24	21	1.7	1.4	1.2	15	clear	confusing	Perspicuity
25	22	1.0	1.7	1.3	15	impractical	practical	Efficiency
26	23	1.3	2.4	1.5	15	organized	cluttered	Efficiency
27	24	1.6	1.5	1.2	15	attractive	unattractive	Attractiveness
28	25	1.6	1.3	1.1	15	friendly	unfriendly	Attractiveness
29	26	1.3	1.4	1.2	15	conservative	innovative	Novelty

Figure 32: Excel sheet results for polio information web data entry forms designed using usability heuristic set 2

- **Step 4:**

  It concerns with the validity of questionnaire. Therefore the reliability of excel sheet results (containing the item numbers marked by the user on questionnaire) can be verified by making sure that the 1-26 items within the six usability scales are highly consistent .Therefore in excel analysis sheet[57][58] Cronbach alpha value is computed and its value is considered as 0.7. If the alpha value is greater or equal to 0.7, than the six usability scales are highly consistent and all the items within the scale are not misinterpreted by the users. But if alpha value is less than 0.7, than the items with the six usability scales are not consistent and the items are misinterpreted by users which is also shown below. As the Cronbach alpha value is greater than 0.7 for both polio information web data entry forms designed using usability heuristic set 1 and usability heuristic set 2 .Therefore the six usability scales are highly consistent

Attractiveness		Perspicuity		Efficiency		Dependability		Stimulation		Novelty	
Items	Correlation	Items	Correlation	Items	Correlation	Items	Correlation	Items	Correlation	Items	Correlation
1, 12	0.84	2, 4	0.76	9, 20	0.77	8, 11	0.88	5, 6	0.70	3, 10	0.84
1, 14	0.77	2, 13	0.77	9, 22	0.71	8, 17	0.91	5, 7	0.58	3, 15	0.88
1, 16	0.87	2, 21	0.75	9, 23	0.65	8, 19	0.86	5, 18	0.87	3, 26	0.88
1, 24	0.70	4, 13	0.84	20, 22	0.69	11, 17	0.83	6, 7	0.82	10, 15	0.73
1, 25	0.80	4, 21	0.86	20, 23	0.70	11, 19	0.91	6, 18	0.72	10, 26	0.80
12, 14	0.83	13, 21	0.84	22, 23	0.80	17, 19	0.82	7, 18	0.86	15, 26	0.94
12, 16	0.80	DK	0.80	DK	0.72	DK	0.87	DK	0.72	DK	0.85
12, 24	0.80	Alpha	0.94	Alpha	0.91	Alpha	0.96	Alpha	0.91	Alpha	0.94
12, 25	0.64										
14, 16	0.74										
14, 24	0.53										
14, 25	0.89										
16, 24	0.66										
16, 2	0.80										
24, 25	0.58										
DK	0.72										
Alpha	0.94										

Figure 33: Cronbach alpha value in polio information web data entry forms designed using usability heuristic set 1

Attractiveness		Perspicuity		Efficiency		Dependability		Stimulation		Novelty	
Items	Correlation	Items	Correlation	Items	Correlation	Items	Correlation	Items	Correlation	Items	Correlation
1, 12	0.88	2, 4	0.86	9, 20	0.76	8, 11	0.82	5, 6	0.76	3, 10	0.78
1, 14	0.98	2, 13	0.85	9, 22	0.62	8, 17	0.85	5, 7	0.83	3, 15	0.83
1, 16	0.78	2, 21	0.95	9, 23	0.65	8, 19	0.84	5, 18	0.89	3, 26	0.73
1, 24	0.83	4, 13	0.71	20, 22	0.82	11, 17	0.71	6, 7	0.68	10, 15	0.80
1, 25	0.70	4, 21	0.88	20, 23	0.71	11, 19	0.87	6, 18	0.85	10, 26	0.76
12, 14	0.85	13, 21	0.83	22, 23	0.81	17, 19	0.75	7, 18	0.85	15, 26	0.79
12, 16	0.62	DK	0.85	DK	0.73	DK	0.81	DK	0.81	DK	0.78
12, 24	0.77	Alpha	0.96	Alpha	0.91	Alpha	0.94	Alpha	0.94	Alpha	0.94
12, 25	0.61										
14, 16	0.74										
14, 24	0.80										
14, 25	0.72										
16, 24	0.76										
16, 2	0.55										
24, 25	0.75										
DK	0.76										
Alpha	0.95										

Figure 34: Cronbach alpha value in polio information web data entry forms designed using usability heuristic set 2

Therefore in order to make sure that the students have performed usability evaluation i.e usability testing correctly instead of evaluating it bluntly or randomly we calculated Cronbach value. The Cronbach value shows that the results are highly consistent and not misinterpreted by users. Similarly we also monitored the usability testing sessions by monitoring the filling of web data entry forms for polio information web application by students

1.2. Analysis of results using spss

The statistical analysis is performed using spss version 23 as a medium. Independent sample t test is used to test null and alternative hypothesis by calculating the level of significance among the groups. Independent sample t test is used for performing statistical analysis in order to analyze the significant difference among the two groups namely web data entry forms designed using usability heuristic set 1 and web data entry forms designed using usability heuristic set 2 in terms of six usability scales such as attractiveness, perspicuity, efficiency, dependability, stimulation and novelty. Independent sample t test can be applied on only two groups. It is used [53] to compare the means of only two independent groups, in order to determine whether there is a statistical evidence that the associated population means are significantly different.

The mean of six usability scales which is calculated individually for each participant in excel sheet described above was used as an input in Spss and independent sample t test was computed on the basis of those values. The significance value (p value) of 0.05 was set to ensure validity of results.

The output of independent sample t test performed in spss consists of two major parts such as (a) group statistics and (b) independent sample test which are discussed below

6.3.1. Group statistics

Group statistics are the descriptive statistics which calculates sample sizes. (N), mean, standard deviation and standard error mean separately for each group namely web data entry forms using Usability heuristic set 1 and web data entry forms using Usability heuristic set 2 with respect to the six usability scales such as attractiveness, perspicuity, efficiency, dependability, stimulation and novelty. Both groups consists of a sample of 15 students .The group statistics for the six usability dimensions among two groups are shown below:

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Attractiveness	Web Data Entry Forms designed with Usability Heuristics Set 2	15	1.6440	1.04423	.26962
	Web Data Entry Forms designed with Usability Heuristics set 1	15	.6007	1.06220	.27426
Perspecuity	Web Data Entry Forms designed with Usability Heuristics Set 2	15	1.5167	1.17817	.30420
	Web Data Entry Forms designed with Usability Heuristics set 1	15	.5000	1.17640	.30375
Efficiency	Web Data Entry Forms designed with Usability Heuristics Set 2	15	1.4500	1.09054	.28158
	Web Data Entry Forms designed with Usability Heuristics set 1	15	.4500	.97376	.25142
Dependability	Web Data Entry Forms designed with Usability Heuristics Set 2	15	1.6000	1.07238	.27689
	Web Data Entry Forms designed with Usability Heuristics set 1	15	.8667	1.16828	.30165
Stimulation	Web Data Entry Forms designed with Usability Heuristics Set 2	15	1.3667	1.24952	.32263
	Web Data Entry Forms designed with Usability Heuristics set 1	15	.6167	1.17210	.30263
Novelty	Web Data Entry Forms designed with Usability Heuristics Set 2	15	1.3500	1.14096	.29459
	Web Data Entry Forms designed with Usability Heuristics set 1	15	.4333	1.10787	.28605

Table 10: Group statistics

6.3.2 Independent sample test:

1. Levene Test for equality of variance

Levene test for equality is used to test homogeneity of variance by looking under the column named as "Sig" in lev levene test for equality of variance. If sig value is greater than 0.05, then it can be assumed that the variation among the two groups with respect to six usability scales is same that is group variances are equal and we should use first row of t test results namely *"equal variances assumed"*. But if the sig value in the levene test of equality of variance is less than 0.05, then it can be assumed that variation among the six usability scales are not same and we should use second row of t test results namely *"equal variances not assumed"* Therefore in order to decide which row to use, there is a need to see the sig value in the levene test for equality of variance. The levene test results for six usability scales namely attractiveness, perspicuity, efficiency, dependability, stimulation and novelty are described below

- **Attractiveness**
  The significance (p-value) of attractiveness in the levene test is 0.664 which is greater than 0.05, so the variation among the groups are same and we would use first row that is *equal variances assumed* to see t test results.

- **Perspicuity**
  The significance (p-value) of perspicuity in the levene test is 0.517 which is greater than 0.05, so the variation among the groups are same and we would use first row that is *equal variances assumed* to see t test results.

- **Efficiency**
  The significance (p-value) of efficiency in the levene test is 0.803 which is greater than 0.05, so the variation among the groups are same and we would use first row that is *equal variances assumed* to see t test results.

- **Dependability**
  The significance (p-value) of dependability in the levene test is 0.775 which is greater than 0.05, so the variation among the groups are same and we would use first row that is *equal variances assumed* to see t test results.

- **Stimulation**
  The significance (p-value) of stimulation in the levene test is 0.893 which is greater than 0.05, so the variation among the groups are same and we would use first row that is *equal variances assumed* to see t test results.

- **Novelty**
  The significance (p-value) of Novelty in the levene test is 0.910 which is greater than 0.05, so the variation among the groups are same and we would use first row that is *equal variances assumed* to see t test results.

  The levene test results are shown below:

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Attractiveness	Equal variances assumed	.193	.664	2.713	28	.011	1.04333	.38459	.25553	1.83114
	Equal variances not assumed			2.713	27.992	.011	1.04333	.38459	.25552	1.83115
Perspecuity	Equal variances assumed	.431	.517	2.365	28	.025	1.01667	.42989	.13609	1.89725
	Equal variances not assumed			2.365	28.000	.025	1.01667	.42989	.13609	1.89725
Efficiency	Equal variances assumed	.064	.803	2.649	28	.013	1.00000	.37749	.22674	1.77326
	Equal variances not assumed			2.649	27.648	.013	1.00000	.37749	.22630	1.77370
Dependability	Equal variances assumed	.083	.775	1.791	28	.084	.73333	.40946	-.10541	1.57208
	Equal variances not assumed			1.791	27.797	.084	.73333	.40946	-.10569	1.57235
Stimulation	Equal variances assumed	.018	.893	1.695	28	.101	.75000	.44235	-.15612	1.65612
	Equal variances not assumed			1.695	27.886	.101	.75000	.44235	-.15628	1.65628
Novelty	Equal variances assumed	.013	.910	2.232	28	.034	.91667	.41062	.07554	1.75779
	Equal variances not assumed			2.232	27.976	.034	.91667	.41062	.07551	1.75782

Table 11: Levene test of equality of variance

2. Independent sample t test results

Independent sample t test results would reveal that whether the means of both groups namely web data entry forms designed using usability heuristic set 1 and web data entry forms designed using usability heuristic set 2 are statistically different(i.e. significantly different) or are same .Therefore in order to determine the significant difference(P-value) among the two groups with respect to the six usability scales namely attractiveness, perspicuity, efficiency, dependability, stimulation and novelty, the sig(2 tailed column) is considered ,

If the sig value is less than 0.05 than the statistical findings can be considered as significant and it can be assumed that there lies a significant difference among the two groups. But if sig value is greater than 0.05 than it can be assumed that there lies no significant difference among the two groups. The output of independent sample test is shown below:

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Attractiveness	Equal variances assumed	.193	.664	2.713	28	.011	1.04333	.38459	.25553	1.83114
	Equal variances not assumed			2.713	27.992	.011	1.04333	.38459	.25552	1.83115
Perspecuity	Equal variances assumed	.431	.517	2.365	28	.025	1.01667	.42989	.13609	1.89725
	Equal variances not assumed			2.365	28.000	.025	1.01667	.42989	.13609	1.89725
Efficiency	Equal variances assumed	.064	.803	2.649	28	.013	1.00000	.37749	.22674	1.77326
	Equal variances not assumed			2.649	27.648	.013	1.00000	.37749	.22630	1.77370
Dependability	Equal variances assumed	.083	.775	1.791	28	.084	.73333	.40946	-.10541	1.57208
	Equal variances not assumed			1.791	27.797	.084	.73333	.40946	-.10569	1.57235
Stimulation	Equal variances assumed	.018	.893	1.695	28	.101	.75000	.44235	-.15612	1.65612
	Equal variances not assumed			1.695	27.886	.101	.75000	.44235	-.15628	1.65628
Novelty	Equal variances assumed	.013	.910	2.232	28	.034	.91667	.41062	.07554	1.75779
	Equal variances not assumed			2.232	27.976	.034	.91667	.41062	.07551	1.75782

Table 12: Independent sample test results:

The statistical findings for six usability scales namely attractiveness, perspicuity, efficiency, dependability, stimulation and novelty from table 12 are described in detail below

2.1. Attractiveness:

The statistical findings of table 12 reveals that a significant difference is observed $(t(28)=2.713, p=0.011)$ between the two groups namely Web data entry forms designed using usability heuristics set 1 and web data entry forms designed using usability heuristic set 2 in terms of attractiveness . Therefore the null hypothesis H_0 is rejected and alternative hypothesis H_1 is accepted which is shown below and is also discussed in detail in chapter 4(experiment design and implementation)

H_1: There is a significant difference between the usability of web data entry forms designed with usability heuristic set 1 and usability heuristic set 2

2.2 Perspicuity:

The statistical findings of table 12 reveals that a significant difference is observed $(t(28)=2.365, p=0.025)$ between the two groups namely Web data entry forms designed using usability heuristics set 1 and web data entry forms designed using usability heuristic set 2 in terms of perspicuity. Therefore the null hypothesis H_0 is rejected and alternative hypothesis H_1 is accepted which is shown below and is also discussed in chapter 4(experiment design and implementation)

H_1: There is a significant difference between the usability of web data entry forms designed with usability heuristic set 1 and usability heuristic set 2

2.3. Efficiency

The statistical findings of table 12 reveals that a significant difference is observed $(t(28)=2.649, p=0.013)$ between the two groups namely Web data entry forms designed using usability heuristics set 1 and web data entry forms designed using usability heuristic set 2 in terms of efficiency. Therefore the null hypothesis H_0 is rejected and alternative hypothesis H_1 is accepted which is shown below and is also discussed in chapter 4(experiment design and implementation)

H_1: There is a significant difference between the usability of web data entry forms designed with usability heuristic set 1 and usability heuristic set 2

2.4. Dependability

The statistical findings of table 12 reveals that no significant difference is observed $(t(28)=1.791, p=0.084)$ between the two groups namely Web data entry forms designed using usability heuristics set 1 and web data entry forms designed using usability heuristic set 2 in terms of dependability. Therefore the null hypothesis H_0 is accepted and alternative hypothesis H_1 is rejected which is shown below and is also discussed in chapter 4(experiment design and implementation)

H_0: There is no significant difference between the usability of web data entry forms designed with usability heuristic set 1 and usability heuristic set 2

2.5. Stimulation

The statistical findings of table 12 reveals that no significant difference is observed (t (28) =1.695, p=0.101) between the two groups namely Web data entry forms designed using usability heuristics set 1 and web data entry forms designed using usability heuristic set 2 in terms of stimulation. Therefore the null hypothesis H_0 is accepted and alternative hypothesis H_1 is rejected which is shown below and is also discussed in chapter 4(experimental design)

H_0: There is no significant difference between the usability of web data entry forms designed with usability heuristic set 1 and usability heuristic set 2

2.6. Novelty

The statistical findings of table 12 reveals that a significant difference is observed (t (28) =2.232, p=0.034) between the two groups namely Web data entry forms designed using usability heuristics set 1 and web data entry forms designed using usability heuristic set 2 in terms of novelty. Therefore the null hypothesis H_0 is rejected and alternative hypothesis H_A is accepted which is shown below and is also discussed in chapter 4(experimental design)

H_1: There is a significant difference between the usability of web data entry forms designed with usability heuristic set 1 and usability heuristic set 2

The above results are shown in the form of bar chart shown below
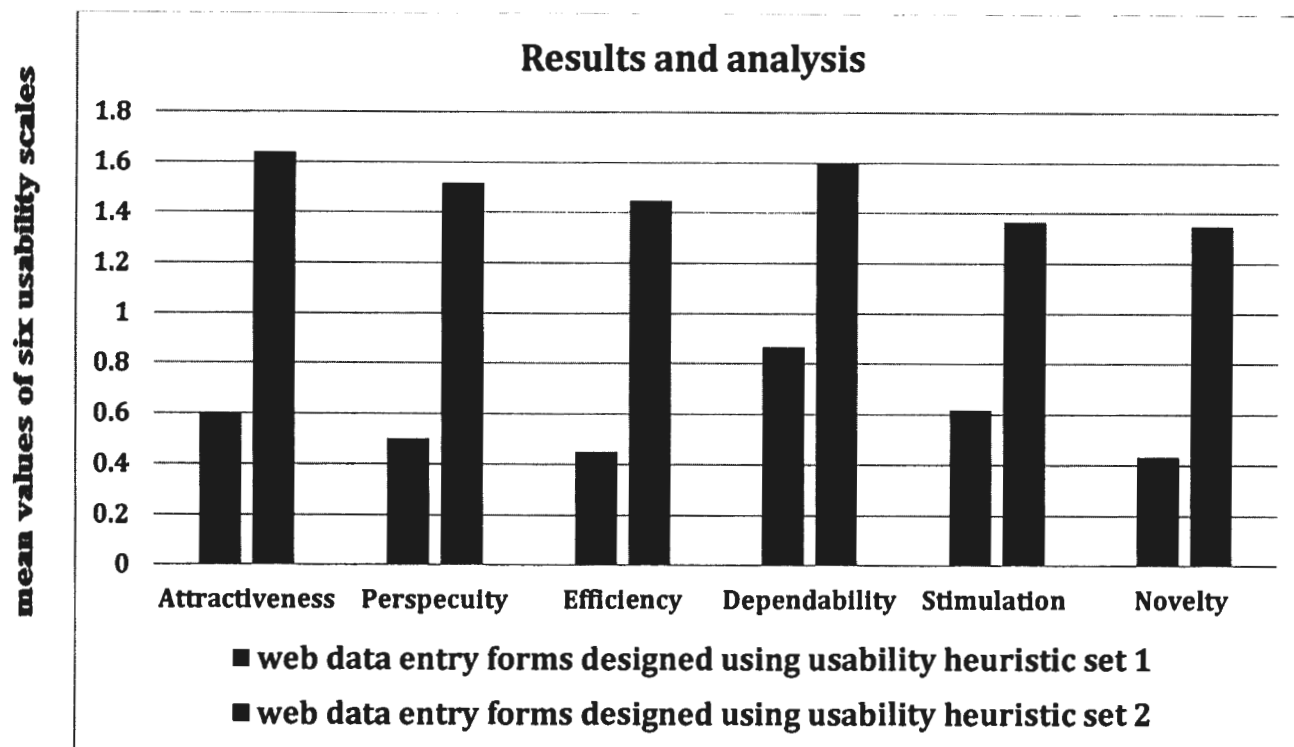
Figure 35: Comparison of six usability scales in web data entry forms designed using usability heuristic set 1 and usability heuristic set 2:

1.3. Validity threats and limitations

1.3.1.Internal and External validity

Internal validity assesses that whether the observed outcome was due to treatment or due to other factors. External validity also known as generalization is related to population that we have sampled and how well we can justify our results to a broader sample. To minimize or remove threats of selection biasness or learning effects of participants which can influence the internal and external validity we strictly followed random selection methods for the selection of subjects, random assignment of treatment to subjects. Another validity problem is that if the experience and knowledge of subjects within a group is not same than it may change the results. Therefore this threat can be minimized as we selecting subjects of same experience, skills, and understanding and of same degree and sessions for both implementation and usability testing.

Similarly to avoid content biasness all the subjects were provided with same relevant material regarding polio information system containing sample manual forms. The total time given to subjects for usability testing was same i.e. 1 hour for each subject and no

time pressure was imposed on subjects to complete tasks.so we may claim that the findings are not influence by content biasness or time pressure

6.4.2 Limitation

We used usability testing for usability evaluation of web data entry forms designed with usability heuristic set 1 and set 2 as we wanted to capture user experience, attitude and emotional response of users while using the system that is whether they like system or not .However other usability measurement methods such as usability inspection methods, cognitive walkthrough and web design perspective can be used to measure task completion time, response time etc .

Chapter 7

Conclusion and future work

7.1. Conclusion

Web Data Entry Forms are used by majority websites as a communication medium between users and website owner to facilitate and customize online transactions [14] and to improve data entry accuracy and efficiency. Usability plays a very important role in an online web data entry form so that the users can fill the form easily and quickly. From the study of literature it was observed it was observed that various sets of heuristics have been proposed by different researchers. However the proposed heuristics have not been validated and consists of limitations .Moreover there is no consensus as to which set of heuristics are most suitable and effective in addressing most of the usability problems related to web data entry forms. Therefore it was concluded that the current heuristics does not covers all the aspects. So there is a need to compose an optimal set of usability heuristics for designing web data entry forms which are suitable in addressing most of the usability problems related to web data entry forms as well as effective in designing web data entry forms.

In this study we composed an optimal set of heuristics from literature as well as the industry based heuristics that exists for designing web data entry forms .These industry based heuristics are collected from online repositories such as msdn, online help manuals and articles related to heuristics or guidelines for designing web data entry forms, websites such as www.usability.gov and books published on google scholar. These industry based heuristics are derived on the basis of experience and best practices of usability experts or practitioners. It helps in making the tacit knowledge practiced by practitioners and usability experts available in research. This also helps in obtaining heuristics which are effective in designing web data entry forms and addresses majority of the usability problems related to web data entry forms.

Therefore in this regard an experiment was conducted to implement web data entry forms for polio information web application on the basis of composed usability heuristic set 1 (Common Heuristics) and composed usability heuristic set 2(Common plus Others Heuristics).Besides that we evaluated usability of implemented web data entry forms by performing usability testing .The feedback of participants of usability testing was taken through semantic differential scale questionnaire.

We used six usability scales or dimensions i.e. attractiveness, perspicuity, efficiency, dependability, stimulation and novelty to assess the usability of web data entry forms designed with two set of

usability heuristics. Statistical findings shows that a significant difference is observed among the web data entry forms designed with usability heuristic set 1 and usability heuristic set 2 in terms of four usability scales that is attractiveness, perspicuity ,efficiency and novelty .while no significant difference is observed in two usability scales that is dependability and stimulation.

From the analysis of results it was concluded that the web data entry forms designed with usability heuristic set 2(Common plus Others Heuristics) are better in terms of usability than the web data entry form deigned with usability heuristic set 1(Common Heuristics).The heuristics which belong to Common Heuristics are commonly used by most of studies for designing web data entry forms and for addressing most of the usability problems related to web data entry forms. Therefore these heuristics are considered as important for designing web data entry forms. Others heuristics contains majority of industry based heuristics that are derived on the basis of best practices and experience of usability experts and practitioner. It allows tacit knowledge to be available in research. Therefore if we consider Others Heuristics set along with Common Heuristics set that is usability heuristic set 2 for designing web data entry than the design of web data entry forms can be better, usable, intuitive, would lead to better user experience as well as improve ease of use by facilitating users while filling web data entry forms

7.2. Discussion

In the web data entry forms designed using usability heuristic set 2 (Common Plus Others Heuristics) all the form content is organized and grouped into relevant and meaningful sections with headings. It helps user to comprehend well and easily fill the web data entry form in comparison with web data entry forms designed using Usability Heuristic set 1(Common Heuristics).Web data entry forms designed using usability heuristic set 2 uses sentence case labels and an optimal position of labels i.e. the labels and all the related information are placed close enough to data entry fields .It allows user to easily relate the required entries and the labels and user can read the web data entry form with less eye movements which can result in faster user entry as compared to web data entry forms designed with usability heuristic set 1.

Web data entry forms designed with usability heuristics set 2 uses large size of data entry fields for longer entries that is monitor name data entry field in order to provide large amount of space Therefore the user can enter multiple names of monitors and could easily view all the entries without scrolling in comparison with usability heuristic set 1.In web data entry forms designed

with usability heuristic set 2 the focus and attention of user is maintained on the desired entry locations by making the currently active or focused field visually distinct, so that it becomes apparent that on which form field the user is right now or on that point of time. Similarly it consists of multiple sections and shows only user focused sections i.e relevant sections to allow easier navigation in longer forms because scrolling in long web data entry forms leads to complicated data entry in comparison with web data entry form designed with usability heuristic set 2.

The layout of web data entry forms designed with usability heuristic set 2 uses the right size of input fields for entering date and time i.e length of date, month and year matches the actual length of date ,month and year with 2 digits for date & month field and 4 digits for year field. Similarly for time 2 digits for hours and 2 digits for minutes hence preventing user to enter date and time in incorrect format. Whereas in web data entry form designed with usability heuristic set 1 form field length does not match expected length of input. In the web data entry forms designed with usability heuristic set 2 uses likelihood based ordering for tehsil name field in which the tehsil name used most likely and frequently appears at the top of the drop down menu

The object implemented in our experiment i.e. Web data entry forms designed for polio information web application domain is representative of population. Therefore if the results (i.e. usability heuristic set 1 or set 2) are applicable on this application domain than the results can also be generalized for other types of web application also. But we need future multiple trials of an experiment also to generalize our results

7.3. Future work

We used usability testing for usability evaluation of web data entry forms designed with usability heuristic set 1 and set 2 as we wanted to capture user experience, attitude and emotional response of users while using the system that is whether they like system or not .However other usability measurement methods such as usability inspection methods, cognitive walkthrough and web design perspective can be used to measure task completion time, response time etc .The experiment can consist of more than one trail. The intellectual abilities of subjects can also be assessed

REFERENCES

[1] Fourcan Karim Mazumder, Utpal Kanti Das," Usability guidelines for usable user interface" published in, International Journal of Research in Engineering and Technology (IJRET), Volume: 03 Issue: 09, September 2014,

[2] Goals of HCI retrieved from http://facweb.cs.depaul.edu/cmiller/hci440/goals.html

[3] https://en.wikipedia.org/wiki/Usability

[4] Jakob Nielsen (2012, January 4) Usability 101: Introduction to Usability retrieved from https://www.nngroup.com/articles/usability-101-introduction-to-usability/

[5] Adrian Fernandez, Emilio Insfran, Silvia Abrahao, Usability evaluation methods for the web: A systematic mapping study, Information and Software Technology, Volume 53, Issue 8, August 2011, Pages 789-817, ISSN 0950-5849, Elsevier

[6] A. Fernandez, S. Abrahão and E. Insfran, "A systematic review on the effectiveness of web usability evaluation methods," *Evaluation & Assessment in Software Engineering (EASE 2012), 16th International Conference on*, Ciudad Real, 2012, pp. 52-56.

[7] F. Paz and J. A. Pow-Sang, "Usability Evaluation Methods for Software Development: A Systematic Mapping Review," *2015 8th International Conference on Advanced Software Engineering & Its Applications (ASEA)*, Jeju, 2015, pp. 1-4.

[8] Usability evaluation methods: Mind the gaps

[9] Tasha Hollingsed and David G. Novick." Usability inspection methods after 15 years of research and practice", Published In *Proceedings of the 25th annual ACM international conference on Design of communication (SIGDOC '07)*, pp. 249-255, 2007

[10] M. Al-Saleh, A. Al-Wabil, E. Al-Attas, A. Al-Abdulkarim, M. Chaurasia and R. Alfaifi, "Inline immediate feedback in Arabic web forms: An eye tracking study of transactional tasks", *Innovations in, Information Technology (IIT), 2012 International Conference on*, Abu Dhabi, 2012, pp. 333-338,IEEE

[11] Wroblewski, L., "Web Form Design: filling in the blanks", book published in Rosenfeld Media, Brooklyn, New York, 2008,ACM

[12] Javier A. Bargas-Avila, Olivia Brenzikofer, Alexandre N. Tuch, Sandra P. Roth, and Klaus Opwis. "Working towards usable forms on the World Wide Web: optimizing date entry input fields", published in Advances *in Human.-Computer Interaction.* 2011, pages 8, January 2011, ACM

[13] Bargas-Avila, J., Brenzikofer, O., Roth, S., Tuch, A., Orsini, S., Opwis, K., "Simple but crucial user interfaces in the World Wide Web: introducing 20 guidelines for usable web form design," published in "User Interfaces (INTECH '10)", book entitled by Rita Matrai (Ed.) pp. 1–10,, 2010,.ISBN: 978-953-307-084-1.ACM

[14] Mirjam Seckler, Silvia Heinz, Javier A. Bargas-Avila, Klaus Opwis, and Alexandre N. Tuch." Designing usable web forms: empirical evaluation of web form improvement guidelines", published in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '14), pp. 1275-1284 ,2014,ACM, New York, NY, USA.

[15] Mirjam Seckler, Silvia Heinz, Javier A. Bargas-Avila, Klaus Opwis, and Alexandre N. Tuch. 2013."Empirical evaluation of 20 web form optimization guidelines", Published In proceeding CHI '13 Extended Abstracts on Human Factors in Computing Systems (CHI EA '13), pp. 1893-1898, 2013, ACM, New York, NY, USA

[16] M. Levis, M. Brady and M. Helfert, "Website Design Quality and Form Input Validation: An Empirical Study on Irish Corporate Websites", published in *Journal of Service Science and Management*, Vol. 1 issue 1, , pp. 91-100 ,2008, scientific research publishing (SciRes)

[17] Javier A. Bargas-Avila, Sebastien Orsini, Hannah Piosczyk, Dominic Urwyler, Klaus Opwis, "Enhancing online forms: Use format specifications for fields with format restrictions to help respondents", published in journal of Interacting with Computers, Volume 23, Issue 1, January 2011, Pages 33-39, ISSN 0953-5438,Elsevier

[18] Mirjam Seckler, Alexandre N. Tuch, Klaus Opwis, and Javier A. Bargas-Avila. "User-friendly locations of error messages in web forms: Put them on the right side of the erroneous input field" Published in *Interacting with Computers,* vol 24, issue 3, pp.107-118, May 2012, Elsevier.

[19] Salve, S.; Yammiyavar, P., "Influence of local 'language' in data entry errors: A pilot study in the rural Indian setting", published in *Human Computer Interactions (ICHCI), 2013 International Conference* , pp.1,4, 23-24 Aug. 2013,IEEE

[20] Y. Ling, Y. An, M. Liu and X. Hu, "An error detecting and tagging framework for reducing data entry errors in electronic medical records (EMR) system," *Bioinformatics and Biomedicine (BIBM), 2013 IEEE International Conference on*, Shanghai, 2013, pp. 249-254.

[21] Kuang Chen, Joseph M. Hellerstein, and Tapan S. Parikh, "Designing adaptive feedback for improving data entry accuracy", published in *Proceedings of the 23nd annual ACM symposium on User interface software and technology* (UIST '10), pp.239-248, 2010, ACM, New York, NY, USA,

[22] K. Chen, H. Chen, N. Conway, J. M. Hellerstein and T. S. Parikh, "Usher: Improving Data Quality with Dynamic Forms," in *IEEE Transactions on Knowledge and Data Engineering*, vol. 23, no. 8, pp. 1138-1153, Aug. 2011

[23] C. Alarcon, F. Medina and R. Villarroel, "Finding Usability and Communicability Problems for Transactional Web Applications," in *IEEE Latin America Transactions*, vol. 12, no. 1, pp. 23-28, Jan. 2014.

[24] Harms, Johannes." Research Goals for Evolving the 'Form' User Interface Metaphor towards more Interactivity", published in *Human Factors in Computing and Informatics*, volume 7946 of Lecture Notes in Computer Science, pages 819–822, 2013, Springer Berlin Heidelberg.

[25] Harms, Johannes , Wimmer, C., Kappel, K., Grechenig, T."Design Space for Focus+Context Navigation in Web Forms" published In Proceedings of the EICS '14 ACM Symposium on Engineering Interactive Computing Systems, 2014, ACM.

[26] Marco Winckler, Vicent Gaits, Dong-Bach Vo, Firmenich Sergio, and Gustavo Rossi."An approach and tool support for assisting users to fill-in web forms with personal information", published In *Proceedings of the 29th ACM international conference on Design of communication (SIGDOC '11)*, pp. 195-202, ACM, New York, NY, USA,

[27] Shaohua Wang; Ying Zou; Upadhyaya, B.; Ng, J. "An Intelligent Framework for Auto-filling Web Forms from Different Web Applications", Published in *Services (SERVICES), 2013 IEEE Ninth World Congress on* , pp.175,179, June 28 2013-July 3 2013,

[28] Bargas-Avila, J., Oberholzer, G., Schmutz, P., de Vito, M., Opwis, K.,"Usable error message presentation in the World Wide Web: do not show errors right away" published in journal of Interacting with Computers 19 (3), 330–341, 2007, Elsevier

[29] Pauwels, S., Hubscher, C., Leuthold, S., Bargas-Avila, J., Opwis, K,"Error prevention in online forms: use color instead of asterisks to mark required fields", published in journal of Interacting with Computers 21 (4), 257–262, 2009, Elsevier

[30] Tullis, T.S., Pons, A.," Designating required vs. optional input fields" published In: CHI '97: CHI '97 Extended Abstracts on Human Factors in Computing Systems.1997, ACM, New York, NY, USA, pp. 259–260,

[31] Subhrajit Das, Tom McEwan, and Donna Douglas. "Using eye-tracking to evaluate label alignment in online forms." published In Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges (NordiCHI '08), pp. 451-454,2008, ACM, New York, NY, USA,

[32] Bargas-Avila, J., Brenzikofer, O., Tuch, A., Roth, S., Opwis, K., 2011b."Working towards usable forms on the world wide web: optimizing multiple selection interface elements", published in Advances in Human–Computer Interaction, Volume 2011, Article ID 347171, 6 pages, ACM.

[33] Nielsen, J." Enhancing the explanatory power of usability heuristics" Published in CHI '94 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems Pages 152-158 ACM New York, NY, USA ©1994

[34] Shneiderman's "Eight Golden Rules of Interface Design (2013, 12th September) retrieved from

[35] Sherry Y. Chen and Robert D. Macredie," The assessment of usability of electronic shopping: A heuristic evaluation.", published in *international journal of Information Management*, volume 25,issue 6,pp.516-532,December 2005,ACM

[36] Raphael Caixeta.(2011,January 7) .10 Tips for Optimizing Web Form Submission Usability Retrieved from http://sixrevisions.com/user-interface/10-tips-for-optimizing-web-form submission-usability/

[37] How to improve the usability (and conversion rate) of your forms (2011,may 17) retrieved from http://www.uxforthemasses.com/forms-usability/

[38]Design pattern 1 retrieved from http://webuserinterface.blogspot.com/p/design-patterns-i.html

[39] S. Miller and C. Jarret, "Should I use a drop-down? Four steps for choosing form elements on the web," 2001,http://www.formsthatwork.com/files/Articles/dropdown.pdf.

[40] "Research-Based Web Design & Usability Guidelines. "Book published in U.S. Dept. of Health and Human Services, 2006, ACM, http:// http://guidelines.usability.gov/

[41] Dr. David Travis. 23 forms and data entry usability guidelines retrieved from http://www.userfocus.co.uk/resources/formschecklist.html

[42] Zhijun Zhang, Victor Basili, and Ben Shneiderman," Perspective-based Usability Inspection: An Empirical Validation of Efficacy "published in. Empirical Software Engineering, volume 4, issue 1, pp. 43-69, March 1999, ACM

[43] Sidney L. Smith and Jane N. Mosier Guidelines for designing user interface software retrieved from http://hcibib.org/sam/1.html

[44] Jakob Nielsen (2001,june 24)Error Message Guidelines retrieved from https://www.nngroup.com/articles/error-message-guidelines/

[45] Dr. David Travis. 23 forms and data entry usability guidelines retrieved from http://www.userfocus.co.uk/resources/helpchecklist.html

[46] User interface elements retrieved fromhttp://www.usability.gov/how-to-and-tools/methods/user-interface-elements.html

[47] Justin Misfud (2011, 8th November) An Extensive Guide To Web Form Usability Retrieved from https://www.smashingmagazine.com/2011/11/extensive-guide-web-form-usability/

[48] "Form Design Quick Fix: Group Form Elements Effectively Using White Space "by Nielsen Norman Group on November 3, 2013, from https://www.nngroup.com/articles/form-design-white-space/

[49] Caroline Jarrett and Gerry Gaffney," Forms that Work Designing Web Forms for Usability" published in a volume in Interactive Technologies 2009, Elsevier

[50]Mads Soegaard affordances retrieved from https://www.interaction design.org/literature/book/the-glossary-of-human-computer-interaction/affordances

[51] Jakob Nielsen (2004, 27 September) Checkboxes vs. Radio Buttons, retrieved from https://www.nngroup.com/articles/checkboxes-vs-radio-buttons/

[52] Luke Wroblewski (2008,21 September) Previous and Next Actions in Web Forms retrieved fromhttp://www.lukew.com/ff/entry.asp?730

[53] Guidelines for form layouts 18th may 2016 retrieved from https://msdn.microsoft.com/en-us/library/windows/apps/jj839734.aspx

[54] C. Jarrett, "Label placement in forms: what's best?" published in Proceedings of the 22nd British HCI Group Annual Conference on People and Computers: Culture, Creativity, Interaction-Volume 2, pp.229–230, British Computer Society, 2008. ACM,

[55] Claes Wohlin, Per Runeson, Martin Host, Magnus C. Ohlsson" Experimentation in software engineering "book published in Kluwer Academic Publishers Norwell, MA, USA ©2000 ISBN:0-7923-8682-5,ACM

[56] https://en.wikipedia.org/wiki/Questionnaire

[57] User experience questionnaire retrieved from http://www.ueq-online.org/

[58] Rauschenberger M, Schrepp M, Pérez Cota M, Olschner S, Thomaschewski J (2013) Efficient Measurement of the User Experience of Interactive Products. How to use the User Experience

Questionnaire (UEQ). Example: Spanish Language Version. International Journal of Interactive Multimedia and Artificial Intelligence 2(1):39–45. doi: 10.9781/ijimai.2013.215

[59] Laugwitz B, Held T, Schrepp M (2008) Construction and Evaluation of a User Experience Questionnaire. In: Holzinger A. HCI and Usability for Education and Work. Berlin, Heidelberg: Springer. pp.63–76.

8.1. APPENDIX A

8.1.1. Semantic differential scale questionnaire

Please make your evaluation now.

For the assessment of the product, please fill out the following questionnaire. The questionnaire consists of pairs of contrasting attributes that may apply to the product. The circles between the attributes represent gradations between the opposites. You can express your agreement with the attributes by ticking the circle that most closely reflects your impression.

Example:

| Attractive | O | ⊗ | O | O | O | O | O | unattractive |

This response would mean that you rate the application as more attractive than unattractive.

Please decide spontaneously. Don't think too long about your decision to make sure that you convey your original impression.

Sometimes you may not be completely sure about your agreement with a particular attribute or you may find that the attribute does not apply completely to the particular product. Nevertheless, please tick a circle in every line.

It is your personal opinion that counts. Please remember: there is no wrong or right answer!

Please assess the product now by ticking one circle per line.

	1	2	3	4	5	6	7		
annoying	O	O	O	O	O	O	O	Enjoyable	1
not understandable	O	O	O	O	O	O	O	understandable	2
creative	O	O	O	O	O	O	O	Dull	3
easy to learn	O	O	O	O	O	O	O	difficult to learn	4
valuable	O	O	O	O	O	O	O	Inferior	5
boring	O	O	O	O	O	O	O	Exciting	6
not interesting	O	O	O	O	O	O	O	interesting	7
unpredictable	O	O	O	O	O	O	O	predictable	8
fast	O	O	O	O	O	O	O	Slow	9
inventive	O	O	O	O	O	O	O	conventional	10
obstructive	O	O	O	O	O	O	O	supportive	11
good	O	O	O	O	O	O	O	Bad	12
complicated	O	O	O	O	O	O	O	Easy	13
unlikable	O	O	O	O	O	O	O	pleasing	14
usual	O	O	O	O	O	O	O	leading edge	15
unpleasant	O	O	O	O	O	O	O	pleasant	16
secure	O	O	O	O	O	O	O	not secure	17
motivating	O	O	O	O	O	O	O	demotivating	18
meets expectations	O	O	O	O	O	O	O	does not meet expectations	19
inefficient	O	O	O	O	O	O	O	efficient	20
clear	O	O	O	O	O	O	O	confusing	21
impractical	O	O	O	O	O	O	O	practical	22
organized	O	O	O	O	O	O	O	cluttered	23
attractive	O	O	O	O	O	O	O	unattractive	24
friendly	O	O	O	O	O	O	O	unfriendly	25
conservative	O	O	O	O	O	O	O	innovative	26

8.2. APPENDIX B

8.2.1. Sample polio information forms for implementation

Poorly Covered Area:(if 3 or more children are missed due to NA / if a single child missed due to no team)   Yes [ ] No [✓]
Missed Area: (if 3 or more houses missed due to no team Yes [ ] No [✓]

Area/Household Monitoring Checklist

Name of TPM: Saqib Bashir
District/Town/Agency: Buner
Tehsil: Buner   UC/Area: Ward 9   Village/Mohallah/St.: Qadria Mohallah/colony
Team No. n/a   Date of work: 19-5-15   *is this a mobile population? NO

H. No	Name of head of house	Children <5 years		Children 0 - 11 months		Vaccinated but not finger marked	No Team	Not available (NA)	Refusal	Correct Door chalking (Y/N)	Comments
		Number of Children Seen	Number of Children Seen Finger Marked	Number of Children Seen	Number of Children Seen Finger Marked						
43	Noman	1	1	—	—	—	—	—	—	Y	
46	Suleman	1	1	—	—	—	—	—	—	Y	
48	Shahid	2	2	—	—	—	—	—	—	Y	
49	Sohail	1	1	—	—	—	—	—	—	Y	
49	Faroon	1	1	—	—	—	—	—	—	Y	
50	Anwar	2	2	—	—	—	—	—	—	Y	
51	Shafiq	2	2	—	—	—	—	—	—	Y	
	Total:	**10**	**10**								

Poorly Covered Area:(if 3 or more children are missed due to NA / if a single child missed due to no team)   Yes [ ] No [✓]
Missed Area: (if 3 or more houses missed due to no team Yes [ ] No [✓]

Name of Province: Punjab
Name of Tehsil: Buner
Name of Village/ Area: Qadria colony
Date of Visit: 19-5-15
Name & Designation of UPEC Chairman: Waqas
Name of UCPW: Asmatullah

Name of District: Buner
Name of UC: Ward 9
Name of Monitors: Saqib Bashir
Time of Visit:
Name of UCO: Fazl-ur-Rehman
Name of SM: Awais

		Yes	No	If No (Team No, AIC Name, Area Name and any other comment)
	Vaccine carrier/cold chain			
1	Is vaccine carried in a proper vaccine carrier?	✓		
2	Are ice packs used for maintaining cold chain?	✓		
3	Is VVM of the vaccine is valid (Stage 1 ad 2)?	✓		
	Vaccination team recording missed children			
1	Is the team recording the name and father name of the missed child	✓		
2	Is the team recording the complete address of the missed child	✓		
3	Is the team recording the reason of missed children (Refusal & NA)	✓		
4	Is the team recording the expected date of return of the missed child	✓		
	Vaccination team demonstrating skill in the household			
1	Is the team going inside the house for vaccination?	✓		
2	Is the team asking all the 7-9 (IPC specific) questions from mother?	✓		
3	Is the team asking about zero routine dose < 1 year children in all houses?	✓		
4	Is the team vaccinating the child as per SOPs (not vaccinating in sunlight, 45)?	✓		
	Household cluster checklist (meetings)			
	Evening Meeting at UC level	Yes	No	If No (reason)
1	Is evening meeting held at UC level daily during campaign days under the chairmanship of UPEC?	✓		
2	Is evening meeting held at UC level daily during campaign days attended by all stakeholders (govt., UNICEF and WHO)?	✓		
3	Is data analysis done in the evening meeting held at UC level?		✓	
	Evening Meeting at District level	Yes	No	If No (reason)
1	Is evening meeting held at district level during campaign days?			
2	Is evening meeting held at district level daily during campaign days attended by all stakeholders (govt., UNICEF and WHO)?			
3	Is data analysis done in the evening meeting held at district level?			

Monitoring visit form (vaccination)

Name of Province:	Punjab		Name of District:	Rwp
Name of Tehsil:	Rwp		Name of UC:	
Name of Village/ Area:			Name of Monitors:	
Date of Visit:	19-5-15		Time of Visit:	12:00
Name & Designation of UPEC Chairman	seed		Name of UCO:	rashid
Name of UCPW	Asmatullah		Name of SM:	Awais

	Vaccination carried in vaccine carrier	YES	NO	Remarks
1	Is vaccine carried in a proper vaccine carrier?		✓	no
2	Are ice packs used for maintaining cold chain?		✓	Ice packs are not used
3	Is VVM of the vaccine is valid (Stage 1 ad 2)?		✓	

	Vaccination team recording missed children	YES	NO	Remarks
1	Is the team recording the name and father name of the missed child	✓		
2	Is the team recording the complete address of the missed child	✓		
3	Is the team recording the reason of missed children (Refusal & NA)	✓		
4	Is the team recording the expected date of return of the missed child	✓		

	Vaccination team communication and awareness	YES	NO	Remarks
1	Is the team going inside the house for vacination?			
2	Is the team asking all the 7-9 (IPC specific) questions from mother?	·		
3	Is the team asking about zero routine dose < 1 year children in all houses?	·		
4	Is the team vaccinating the child as per SOPs (not vaccineting in sunlight, 45O?	·		

	Evening meeting at UC level	YES	NO	Remarks
1	Is evening meeting held at UC level daily during campaign days under the chairmanship of UPEC?	✓		
2	Is evening meeting held at UC level daily during campaign days attended by all stakeholders (govt., UNICEF and WHO)?	✓		
3	Is data analysis done in the evening meeting held at UC level?		✓	

	Evening meeting at district level	YES	NO	Remarks
1	Is evening meeting held at district level during campaign days?			
2	Is evening meeting held at district level daily during campaign days attended by all stakeholders (govt., UNICEF and WHO?			
3	Is data analysis done in the evening meeting held at district level?			

Monitoring visit form (SM/FCM)

Name of Province:	Punjab		Name of District:	Rwp
Name of Tehsil:	Rwp		Name of UC:	wand.3
Name of village			Name of Monitors: Saqib Bashir
Date of Visit:	20-4-15		Time of Visit:	9:30 Am
Name & Designation of UPEC Chairman	Aslam		Name of UCO:	Sajid Hussain
Name of UCPW	NA		Name of SM:	Naima Iqbal

	SM/FCM	YES	NO	Total	Found
1	Number of under one year children checked in the field for routine vaccination from log book				
2	Number of under one year children checked in the field during refusal and NA verification for routine vaccination and cross check in the log book				
3	Has SM shared the Zero dose children list with UCMO/UCPW/UCO				

	Log book/SM	YES	NO	Remarks
1	Is the SM updated total refusal children in the logbook according to the refusals reported in last campaign	✓		
2	Is the SM updated total NA children in the logbook as per guidelines from the back of tally sheet	✓		
3	Is the SM having updated list of refusal with reasons (Refusal Log book) after last campaign held in the UC	✓		
4	Is the SM having updated list of NA with reasons (NA Log book/Missed Children form) after last campaign held in the UC	✓		
5	Is the UCO having updated list of refusal with reasons (Refusal Log book) after last campaign held in the UC	✓		

	Registration book/FCM	YES	NO	Remarks
1	Is the FCM having registered children in the assigned area			
2	Is the FCM having registered pregnant women in the assigned area			
3	Is the FCM having registered routine vaccination status of all the registered children			

	Converted refusals/TPFM	YES	NO	Total	Found
1	Number of converted refusals children checked by TPFM	✓		7	
2	Number of converted refusal children found vaccinated by TPFM	✓		7	

	Covered NA/TPFM	YES	NO	Total	Found
1	Number of covered NA children checked by TPFM	✓		12	
2	Number of covered NA children found vaccinated by TPFM	✓		12	

	Still refusals/SM	YES	NO	Total	Found
1	Is SM sharing list of covered refusals against still refusals with with UCO on daily basis	✓			
2	Total number of still refusals covered by UCOs	✓		2	

	Still NA/SM	YES	NO	Total	Found
1	Is SM sharing list of covered NA against still NA with UCO on daily basis	✓			
2	Total number of still NAs covered by UCOs	✓		3	

				Name of District:	Rawalpindi
Name of Province:	Punjab				
Name of Tehsil:	Rawalpindi			Name of UC: ward 9#	
Name of Village/ Area:	Merryal Road ward #9			Name of Monitors: yasir, mahwish	
Date of Visit: 19-05-2015				Time of Visit:	
Name & Designation of UPEC Chairman				Name of UCO: Faiz ur Rehman	
Name of UCPW Asmatullah , Xoor Pahan				Name of SM:	

A. Microplan

		Yes	No	Comments
1	Clear boundaries between two Union Councils			
2	Clear Boundaries between two Area in charges			
3	High risk/nomadic population/settlement mentioned in plan exist on the ground			
4	High risk/nomadic population/settlement identified in the field included in the plan			
5	Major landmark like mosques/pre primary-schools mentioned in plan exist on the ground			
6	Major landmark like mosques/pre primary schools identified in the field included in the plan			
7	Randomly select first and last house of any team in an Area in charge plan and cross check it with field			

B. Training of vaccination team

		Yes	No	Comments
1	Training Venue was comfortable and right spacing avaialbie for the participants			
2	Is the number of participants attending training were as per plan/microplan?			
3	Is the training facilitated by UNICEF, WHO, Government etc jointly?			
4	Availability of training material like agenda, training manual, board, charts, marker, tally sheet			
5	Training agenda was followed			
6	Any recommended methodologies(Role Play, demonstration on all the basic IPC questions etc.) were used to deliver the sessions / Topics used			

C. Status of UPEC

		Yes	No	Comments
1	Is UPEC held 15 days before campaign?		✓	
2	Is UPEC chaired by UCMO/senior health staff and co-chaired by UC secretary?		✓	
3	Are all the members in addition to Chair and co-chair of UPEC like SHO, AICs, LHS, Community Members & representatives, UCO, UCPW, School principles and Religious influentials are part of the UPEC		✓	
4	Are all the AICs submitted the updated and field validated microplans to the UPEC	.	✓	
5	Is UPEC discussed the security plan in the presence of SHO		✓	

D. Status of DPEC

		Yes	No	Comments
1	DPEC held 10 days before campaign			
2	DPEC chaired by DCO/DC/PA and co-chaired by EDO-H			
3	All the members in addition to Chair and co-chair of DPEC like DPO, EDO-Revenue, EDO-Edu, District Coordinator of LHWs Program, District Head of PPHI, District Heads of Govt. NGOs and Local representatives of partner organizations UNICEF (DHCSO), WHO (PEO), N-STOP, and Rotary International are part of the DPEC			
4	Is there a meeting minutes of UPEC of HRUCs discussed in the DPEC?			
5	Is the DPEC meeting discussed and formulated the district security plan with special focus on HR Ucs/areas of concern?			

Name of Province:	Punjab			Name of District:	Rawalpindi
Name of Tehsil:	Rawalpindi			Name of UC: Sarai kala 8246	
name of village:				Name of Monitors:	
Date of Visit: 23-4-15				Time of Visit:	
Name & Designation of UPEC Chairman Haji Akhtar Zaman				Name of UCO: kuzia faraz	
Name of UCPW Nadeem				Name of SM:	

		Yes	No	Total	Comments
1	Number of under one year children checked in the field for routine vaccination from log book	✓			
2	Number of under one year children checked in the field during refusal and NA verification for routine vaccination and cross check in the log book				
3	Has SM shared the Zero dose children list with UCMO/UCPW/UCO	✓	7		not

Updated data

		Yes	No	Total	Comments
1	Is the SM updated total refusal children in the log book according to refusals reported in the last campaign	✓			still are not entered on log book
2	Is the SM updated total NA children in the logbook as per guidelines from the back of tally sheet		✓		
3	Is the Sm having updated list of refusal with reasons after last campaign held in UC	✓			
4	Is the SM having updated list of NA with reasons (NA Log book/Missed Children form) after last campaign held in the UC	✓			
5	Is the UCO having updated list of refusal with reasons after last campaign held in UC				82 NA (1 covered)

Registered children (FCM)

		Yes	No	Total	Comments
1	Is the FCM having registered children in the assigned area				
2	Is the FCM having registered pregnant women in the assigned area				
3	Is the FCM having registered routine vaccination status of all the registered children				

Converted refusals

		Yes	No	Total	Comments
1	Number of converted refusals children checked by TPFM	✓		11	
2	Number of converted refusal children found vaccinated by TPFM				

Covered NA

		Yes	No	Total	Comments
1	Number of covered NA children checked by TPFM				
2	Number of covered NA children found vaccinated by TPFM				

Still refusals

		Yes	No	Total	Comments
1	Is SM sharing list of covered refusals against still refusals with UCO on daily basis				
2	Total number of still refusals covered by UCOs	✓		31 6	

Still NA

		Yes	No	Total	Comments
1	Is SM sharing list of covered NA against still NA with UCO on daily basis				
2	Total number of still NAs covered by UCOs		✓		SM are not available

Area/Household Monitoring Checklist

Name of TPM: Saqib Bashir Khan   District/Town/Agency: RwP

Tehsil: RwP   UC/Area: Ward-9   Village/Mohallah/St.: Naseer plaza

Team No.: 02   Date of work: 19-5-15   *Is this a mobile population?* No

H. No	Name of head of house	Children <5 years Number of Children Seen	Children <5 years Number of Children Seen Finger Marked	Children 0-11 Number of Children Seen	Children 0-11 Number of Children Seen Finger Marked	Vaccinated but not finger marked	No Team	Not available (NA)	Refusal	Correct Door Chalking (Y/N)	Comments
8	Khighat	2	2	—	—	—	—	—	—	Y	
19	Adil Rai	1	1	—	—	—	—	—	—	Y	
20	Aulx	2	1	—	—	—	—	1	—	Y	
25	Shahzad	3	3	1	1	—	—	—	—	Y	
27	Quis	1	1	—	—	—	—	—	—	Y	
29	Gilal khan	1	1	—	—	—	—	—	—	Y	
30	Irfan	1	1	—	—	—	—	1	—	Y	
	Total:	11	10	1	1	—	—	1	—	Y	

Poorly Covered Area:(If 3 or more children are missed due to NA / If a single child missed due to no team)   Yes [ ] No [✓]

Missed Area: (If 3 or more houses missed due to no team Yes [ ] No [✓]

Area/Household Monitoring Checklist

Name of TPM: Saqib Bashir Khan

District/Town/Agency: RwP

Tehsil: RwP   UC/Area: Ward-9   Village/Mohallah/St.: Dhoke Mustaqeem

Team No.: 03   Date of work: 20-5-15   *Is this a mobile population?* No

H. No	Name of head of house	Children <5 years Number of Children Seen	Children <5 years Number of Children Seen Finger Marked	Children 0-11 Number of Children Seen	Children 0-11 Number of Children Seen Finger Marked	Vaccinated but not finger marked	No Team	Not available (NA)	Refusal	Correct Door Chalking (Y/N)	Comments
74	Alamzeb	2	2	—	—	—	—	—	—	Y	
77	Yasin	1	1	—	—	—	—	—	—	Y	
78	Naveed	3	3	1	1	—	—	—	—	Y	
80	Ali	2	2	—	—	—	—	—	—	Y	
81	Khurram	1	1	—	—	—	—	—	—	Y	
82	Nawaz	6	6	2	2	—	—	—	—	Y	
83	Hashid	1	1	—	—	—	—	—	—	Y	
	Total:	16	16	3	3	—	—	—	—	Y	

Name of Province: Punjab   Name of District: RwP

Name of Tehsil: taxila   Name of UC: UC 34

Name of Village/ Area: Qadria colony   Name of Monitors: hammad, mohsin

Date of Visit: Time of Visit:

Name & Designation of UPEC Chairman   Name of UCO:

Name of UCPW   Name of SM:

		Yes	No	Comments
1	Is vaccine carried in a proper vaccine carrier?	✓		
2	Are ice packs used for maintaining cold chain?	✓		
3	Is VVM of the vaccine is valid (Stage 1 ad 2)?	✓		
1	Is the team recording the name and father name of the missed child			
2	Is the team recording the complete address of the missed child			
3	Is the team recording the reason of missed children (Refusal & NA)			
4	Is the team recording the expected date of return of the missed child			
1	Is the team going inside the House for vaccination?			
2	Is the team asking all the 7-9 (IPC specific) questions from mother?			
3	Is the team asking about zero routine dose < 1 year children in all houses?			
4	Is the team vaccinating the child as per SOPs (not vaccinating in sunlight, etc)?			
1	Is evening meeting held at UC level daily during campaign days under the chairmanship of UPEC?	✓		
2	Is evening meeting held at UC level daily during campaign days attended by all stakeholders (govt , UNICEF and WHO)?	✓		
3	Is data analysis done in the evening meeting held at UC level?	✓		
1	Is evening meeting held at district level during campaign days?		✓	
2	Is evening meeting held at district level daily during campaign days attended by all stakeholders (govt , UNICEF and WHO?		✓	
3	Is data analysis done in the evening meeting held at district level?		✓	