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Usability engineering process model

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Abstract
Usability is most often defined as the ease of use and acceptability of a system for a particular class of users, carrying out specific tasks in a specific environment. For improving user interface different usability engineering methods were suggested by different usability engineers. These Methods /Techniques assist the process of user interface development; included as Heuristic Evaluation, Participatory Design, Cognitive Walk Through, Task Analysis and Rapid Prototyping. These techniques vary considerably in the extent of user involvement that they require. However in recent age not much concentration is given to usability engineering issue during testing. Evaluator mostly have not the complete knowledge, tools and time to tackle usability as complete engineering.
Usability engineering term has been widely used but rarely adopted as complete engineering. It is in most confused with some part as usability evaluation, testing and analysis. This research will list down all the activities of usability engineering and proposed a complete process model of usability engineering. The mentioned activities can be requirement, scope, design, and development of user interface, in addition to usability evaluation.
Many studies had revealed that a usability problem causes quality problems in software product. Potential problems lying in interface design, operating process or product structure also contributes to usability problems which resulted in lower effectiveness, efficiency and difficulty of use for end users.
The purpose of this study is to discuss about all available methods of usability engineering at one platform and also do comparison between these methods by different aspects and major topic is to define a usability engineering process model. Different engineering approaches (like model –based, prototyping, ontology driven,) will be studied to design a complete process model for usability engineering. This research also has a case study of a telecommunication organization which presents the results of empirical study of usability evaluation which was based on Usability Engineering process model in addition to usability evaluation.
In this research paper we also included a survey result of different visual formats of web application by applying usability engineering methods and process model. A comparison of two web based projects PTCL and Mirchi Masala is also included. More ever a comparative statement of various characteristics of newly designed web application (after applying UEPM) is also included.

Keywords: User Interface, Usability Engineering Process Model, Usability Engineering, Software Engineering.

1. Overview

The Procedure of a Usability Engineering is started from specifying the usability features before software is developed and then these features are measured throughout the life cycle of a development process. The importance of joining clients/users in the development procedure of a software development has been recognized. In addition because users are considered more intellectual than a computer, it is only a man who accepts computers for interaction it. However, it is not better to compel a user to accept and operate a software or web application which has usability so poor, because this can become the negative impression of software and it reduces the efficiency, effectiveness, and customer satisfaction. Due to poor usability the interest of user with computer interaction gradually reduces.

2. Introduction

Usability engineering is concerned the area which generally related to interact with computer and designing such an interface that occupy a user friendly atmosphere. Actually, an interface that is friendly for user is that which allows users to efficiently and effectively perform the tasks for which it was designed and the rate user's opinion was positive on emotional scales. Evaluating the usability about an interface and then giving recommendations in such a ways to improve it, is the responsibility of the Usability Engineer [6].
Mostly it is a tradition or need of user towards taking usability technique as important objects of a study in itself so that to improve our ability to choose the correct method for at hand task. It does clearly explain that people know better to find out usability problems that exist in an interface, they know more about the principals of usability. This may not be a surprise, but this kind of precise for understanding the tradeoffs in using various personnel types for usability work is necessary for professional usability engineering [4].
There are five main features of usability including learning ability, efficiency, effectiveness in use which the system has been learned, ability to frequently users to use the software without learning it completely, volume and number of user errors, and satisfaction of a user from his subjective point of

view. Certainly the above five parameters do not give equal preference to any single design, clear priorities, which are based on initial analysis a user has done and their job [3].

A process of usability engineering is to ensure that a good user interfaces should have the elements to be considered before it might be design, during the design, and after filed installation of a software or web application [3].

A High usability remained always the desire of a user, but it is not possible to be appearing magically as we wish. To ensure that the usability of an interactive computer program, we should actively include usability rules completely though out the development life cycle of a program. Surely, nobody intentionally wants to design an interface with poor usability, but only systematic usability struggle established such methods that have usability engineering. Only good intentions may not enough [3].

Several research about usability have been shown that usability inspection techniques have the ability to find many usability issues that are ignore by user testing methods whereas some user testing techniques can also finds few problems that might be overlooked by using inspections technique, it also means that by combining some methods effective results can often be obtained [9, 10, 11].

Many possible ways are there of combining the different kinds of usability methods and each new project is needed different combination; it depends on its exact features. Mostly it has been observed that a collection of heuristic method and thinking aloud method is mostly useful [7].

A man who uses a UEM to estimate usability of a user interface or design is named as an evaluator. More distinctively, a person who is using a usability inspection technique (use only one technique) is called an inspector [5].

Usability requirements usually are as gathered as other non-functional requirements suppose as security or reliability, yet the objectives are not the same of these non-functional requirements, as the objectives of usability. This issue is declared at the time when we try to take account of the usability needs confine in a Model Driven Development (MDD) life cycle, where an efficient capture method with an unmistakable notation is required to show these requirements [11].

Many research and studies had discovered that usability issues are occurred because of quality problems reside in the software product. Many Potential problems remain in the design of interface, process to operate, and the structure of a product may also contributes problems of usability which has result as lower effectiveness, difficulty and efficiency more ever it is used by end users [15].

The Human-Computer Interaction (HCI) rules studies those constraints that are related to the interaction between the computer and human more ever the main objective is to develop or improve the quality of interactive computer based software with attribute of usability safety, effectiveness. Existing material available in the textbooks provide sufficient knowledge of HCI concepts and methods but limitation is to offer few rules of guidance for a large project activities [16].

Two different Phrases as “User’s Friendly” and “Ease to Use” are considered enshrine now a days, and are known best in the marketing brochures for computer products. These phrases do not explain or provide sufficient knowledge which is helpful for end user to determine whether the software product will fulfill their requirements. Ease to use gives a concept about subjective and is relevant to a definitive path to characterize end users and also specify a product uses.

Ease of Use is defined as a way that makes it useful when it is designed and when a system is choose. Our objective to use the phrase “easy to use” is explicit language term that is used in the market and keep it in the field of engineering, where it is used for quality control measures which are for a product design or it life cycle.

The below given dictionary definition explain the meaning of these two terms when it applied for a system:

- Effortless - It requires few mental practice little training.
- Obvious – The software is clear in understanding and is without ambiguous
- Simplicity- So simple to use by any user ;
- Not Difficult. in system there is not hidden instruction;

The second term “Use” it has again a lot of possible meaning.

- to make presentation;
- to comprehend;
- to create output;
- to describe others ;
- learnability;
- to search;

In the past experience we propose the following five factors which are helpful for setting criteria:

Productivity – It is a measure that shows how extent a work can be completed within a specific time period.

Learn-ability – It is a measure that show how much training is needed before reaching a specific state of proficiency

User Satisfaction - A usability measure that users occupy to response the system; of the subjective responses a user has to the system

Memorability – it is a measure shows how much a user learn by heart a system give performance (it is important for a new/irregular users)

Errors detection Rates – It is a measure that shows the accuracy of the completed task that is carried out.

2.1 Importance of Usability Engineering Methods for Software Developers

In our past experience we have learnt that in the field of HCI or for designing user interface the software developer must considered usability before taking place a prototyping. Various techniques as Usability context analysis that are used before development process offered by (Thomas and Bevan 1996). When the different approaches of assessment and evaluation like inspection and testing method are applied at the end of design process a lot alteration, errors are detected and some it is impossible to go back because of cost factor. So it is necessary the software developer must use usability engineering process model or methods early of development cycle. Mostly software developers ignores the phrase “We have not a usability issue” at the initially, different drawbacks are detected, mostly it a chance to be corrected. So it is important that more focus should be given, while designing a User interface. For developing a User interface the participation of user must be in every phase of Waterfall mode or particularly when prototyping is design. In next chapter we have design a process mode which guide the

developer in what important phases in which the involvement of User for Usability pint is necessary.
To show that the above features of usability are included in a software product then we should use certain usability engineering method as inspection method, testing method and evaluation method designed by different authors of usability engineering. These methods are given below.

2.2. Inspection Methods

Heuristic Evaluation

It is taken from a Greek word which mean "to discover" is considered the most familiar usability method. In this method different usability experts work as judge to analyze whether in each dialogue component has follow the principals of usability. (Nielsen and Mack1994) [7]. by using this approach every judge or evaluator observe the User interface individually. This proves of evaluation is done a lot of time repeatedly. When all completed their evaluation then all evaluator communicate collectively and share their ideas about interface.
In this approach minimum 3 and maximum 5 evaluator participated to observe whether usability principles has followed or not carefully. Various versions of (HE) inspection method are prevailing in the market. They reflect the particular system that is inspected and share their comments about any software product or web base application where additionally the importance of Heuristics approach shows increasingly. If the evaluator is not experience then result will be declared accurate.

(a) Advantages

- To analyze whether the usability principles are applied or not perceptive ;
- In the early development process usability is focused ;
- Major and minor issues are early detected. rapidity;
- HE could be used throughout the life cycle of software development;

(b) Disadvantages

- Disconnection occurs to end users;
- Difficult to identify the desire of end users;
- Identification of domain problem remained unreliable;
- It not necessary the result may be correct because the evaluator might be give more focus on a single element of user interface;

2.3. Cognitive Walkthrough

The cognitive Walkthrough is 2nd inspection method also called task oriented technique. In this method the evaluator tries to explore the functions of a software product. He step by step observes the behavior of a user who performs a task give to him. Cognitive theory is used more amicably it also check the learnability of user, mental exercise and approach to observe the task.

(a) Advantages

- It is a fully functioning prototype and free from user;
- Identification of issues are more effective due to interaction with product and helpful to define the objective of user.

(b) Disadvantages

- User participation is not included.
- Focus is on low level description;

2.4. Action Analysis

This method is classified into two more elements as formal action and back of envelop action where the focus is give more on what the practitioners want to do and what they tell they perform. According to this method whole task is divided into separate actions for example click a mouse or move a mouse on a menu bar or compose with the help of keyboard.

(a) Advantages

- exact forecast of how long a task will take;
- A user behavior is observed deeply.

(b) Disadvantages

- A lot of time is required to observe user behavior
- It required high expertise.

2.5. Test Methods

Thinking Aloud

Think Aloud is a usability engineering test method introduced by Nielsen in 1994, considered as valuable method. In this method end user are invited to participate and asked to think out loud continuously during using software. His thoughts are verbally asked the evaluator tried to understand how the user views the product. The evaluator also monitors the difficulties of the users while the users use the system. It make is easy to recognize the major issue of user. The User interpretation of each element of a user interface is also observed.

(a) Advantages

- User is closely observed while thinking aloud.
- Comments of users are also entertained which is the major factor of this method.
- Preference is given to the comments of user.
- Very helpful to trace the source of issues and may avoid in future for reducing confusion later in design.

(b) Disadvantages

- In many type of measure some time it remains unsuccessful.
- Various styles of learning mostly perceived and proved unnatural
- Non-analytical and inexperienced learners some time feel inhabited.
- Wastage of time due to given briefing to end users which a compulsory part of this method.

2.6. Field Observation

The most easiest and simple testing method is observation. In this method more than one user are involved visited by observer at their job place. Notes should be obtained as unremarkably so that to avoid disturbance of the user work. If there is a noise and interference then it may affect the accuracy of the results. Sometime the observer use video cameras to observe the user and avoid interference in his work.

(a) Advantages

- Mostly used method in real life at different work places.

(b) Disadvantages

- It is only possible to apply in the final testing such as used in prototypes.
- It required many users needed (20 plus) with high expertise.

2.7. Questionnaires

Another method to check the usability is Questionnaire (ask question from users). For subjective user satisfaction it is considered the best method and it hard to analysis objective measures. Through this method it is verified how end user utilize the software and what are their preferred characteristics regarding system, but it requires some experience for designing system.

(a) Advantages

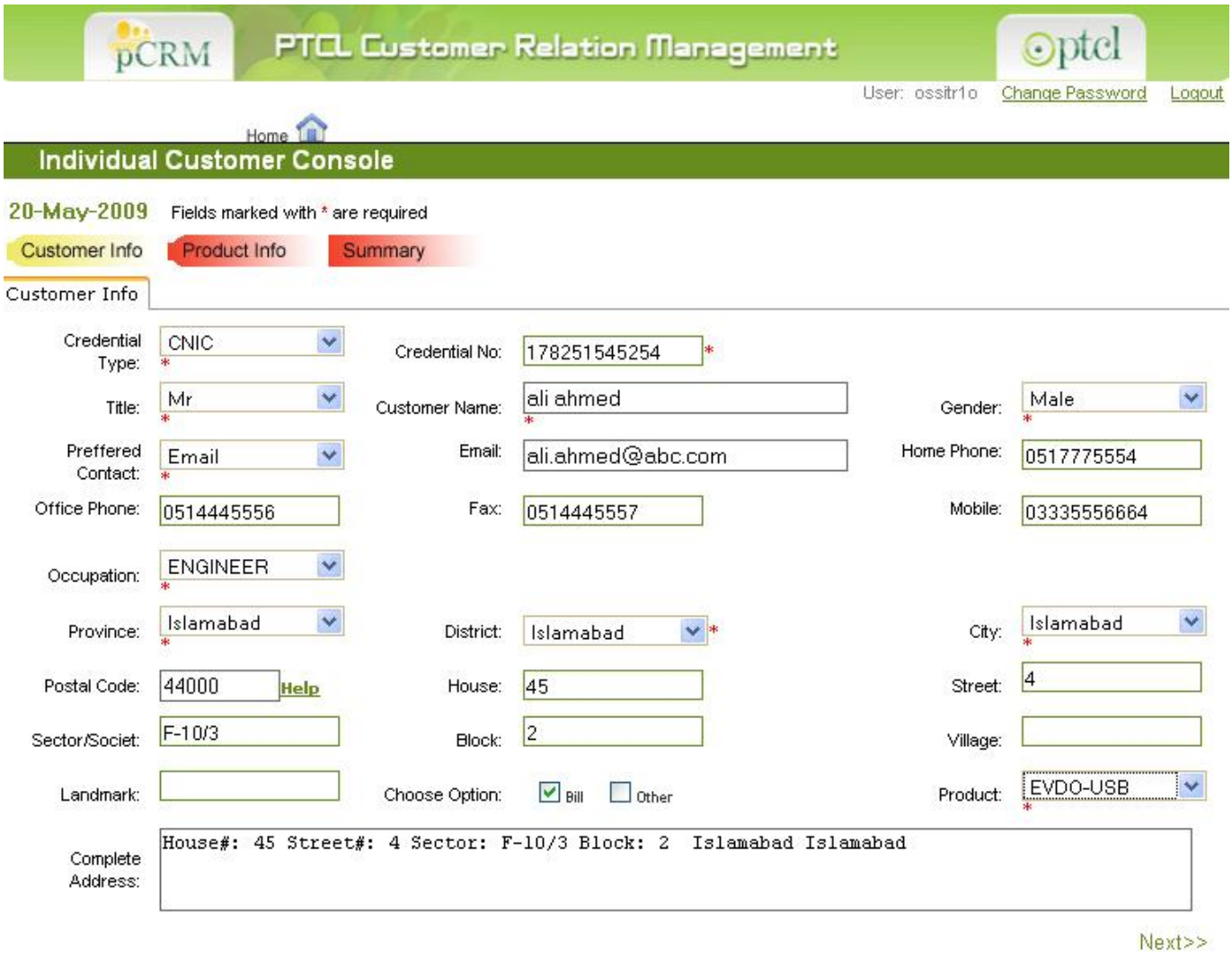
- Preference is given to subjective user.
- Easy and customer satisfaction approach;
- Statistical data can be obtained through this method.

(b) Disadvantages

- User data is not implemented directly for designing a user interface.
- The opinions of user may not face values
- Need sufficient data from sufficient number of users.
- It only identifies a little number of issues as compare to other methods.

3. Case Study (PTCL)

In research paper a case of PTCL web is include which based to design a new proposed model. PTCL web has poor usability. All linked page have a rush of information which required special training to enter data. User are compel to use poor and complicated web base application. It based a new proposed model which was implemented to develop a new web based application. The newly developed application has easy to operate from the user point. All interfaces has a lot characteristics as learn-ability, operability, memor-ability and user satisfaction.



4. Usability Engineering Process Model

The given below proposed usability engineering process model is helpful to the developer indirectly and directly beneficial for user. Instead of applying usability engineering method on the final stage of a system, at each phase in the development process cycle particularly in (Informational model, interaction model and look & feel) phases involvement of user should be compulsory. The reason is that

in final stage a lot changes/ modification in different phase make sometime it is impossible to go back due to cost. User involvement enables a system particularly in interface design more usable. The benefits of joining users included effectiveness, efficiency of the system and numbers of errors are reduced.

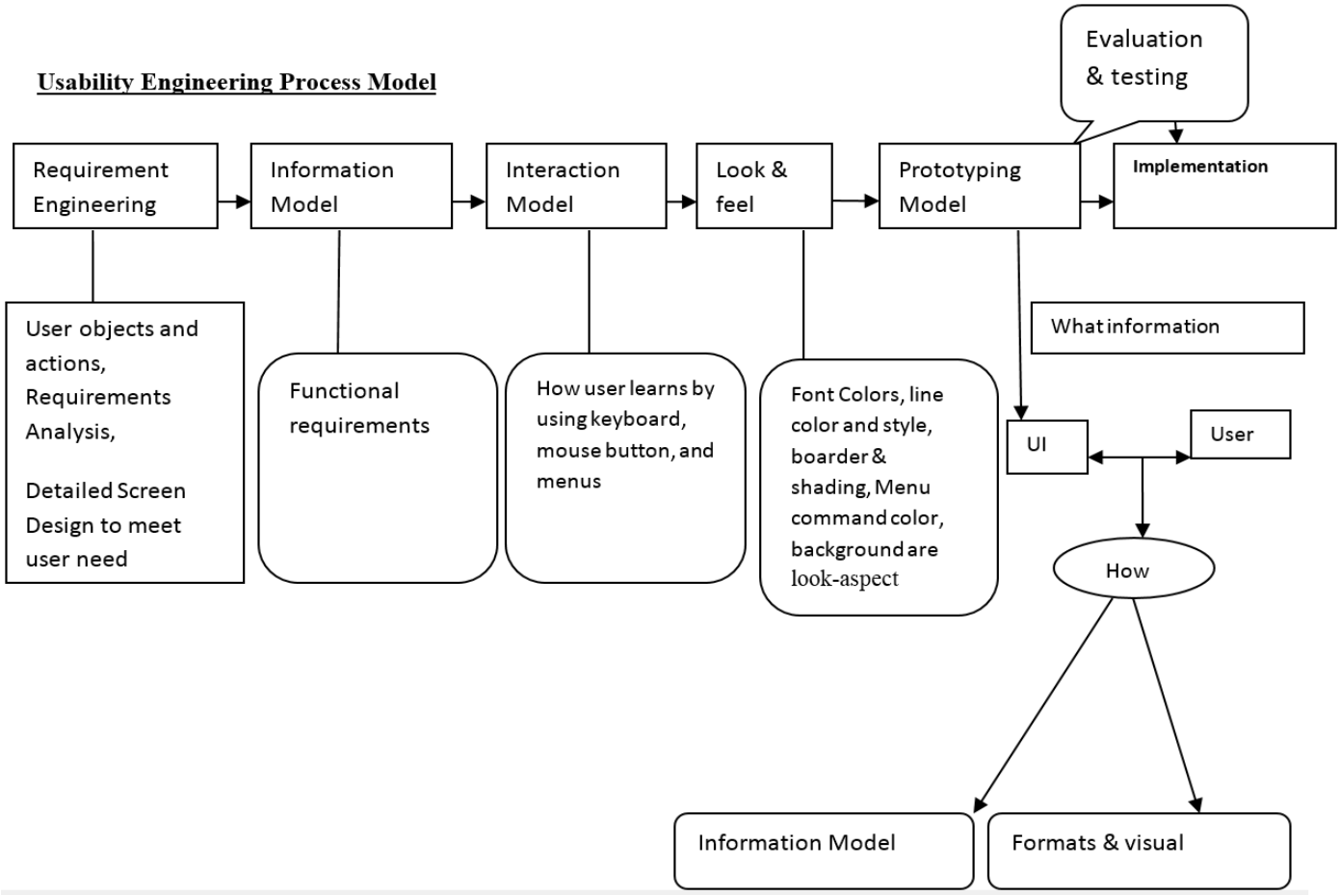


Fig 1: Usability Engineering Process model

4.1 Phases of usability engineering process model

The phases of usability engineering process model can be as follows.

- Requirement Engineering
- Information Model
- Interaction Model
- Look & Feel (visualization)
- Protyping Model
- Testing & Evaluation

Implementation of Different engineering approaches (like model –based, prototyping, ontology driven,) will be studied to design a complete process model for usability engineering.

4.2. Requirement Engineering

Requirement Engineering is concerned to investigate the goal, functions, and constraints of user interface. RE activities includes elicitation of information that is related to the problem domain, modeling of the problem area; Analysis costs, completeness, and consistency; and verification and validation. These tasks cover the way to generate complete, consistent, and unambiguous specification of system behavior that aid in the design and implementation activities. A major motivation for spending a lot time and struggles on requirements engineering and its improvement comes from the objective of doing The software development right from the beginning, instead of patchingat the end. Experiments show that the cost of detecting and repairing errors increases dramatically as the development process Proceeds (Davis, 1993; Nuseibeh and Easterbrook, 2000).

4.3. Informational model

This phase play a vital role to memorize the system by user. It contain certain types of information a user is required to enter in the text boxes, select check boxes, use command, select from define list. This model/phase increases the knowledge of the user by entering data and generating reports by using interface. While designing an informational model participation of the user must be compulsory.

The given below five elements objective, scope, skeleton, surface/visual and structure provide an intellectual skeleton for describing about user interface issues and different tool which we used for the solution of a user problem. The detail of these factors is given below.

4.4. Interaction Model

Interaction means the exchanging the information between the user and the computer system. It is very important to be remember that the interaction is not just consider when the visible parts of user interface is designed but also necessary

when designing the other parts of a software. In interaction model we define how the system behaves in response to the user [18].

During the development process it is impossible that a separate "Usability Team" must be available and make it convenient to be usable by designing an effective group of controls. In addition, adding the right mixture of color scheme and font. Developer must understand it clearly that user interaction from the initial stage of development must be considered. Final product's usability effect is depended on the understanding of users.

The main research area of Human computer interaction is given below:

- The analysis of a facial expression
- The body movement
- Recognition of gesture

(a) The Audio-Based HCI

Another important are of Human computer interaction between computer and man is audio base. It deals with that audio signal which required information such type. It clear that the natural audio signal can never be changed just like visual signal, the information collected from audio signal are more trustable and are helpful for providing related information.

- The following categories are included in the research:
- Recognition of Speech
- Recognition of Speaker
- Analysis of Auditory Emotion

(b) Sensor-Based HCI

This part included a collection of different kind of areas with a heavy range of applications. The combination of these different kinds of areas is consists of minimum one of the following physical input device which work as sensor base device. Pen drive, keyboard, Mouse, joystick, optical mark reader, scanner, bar code reader, haptic sensor, digital cameras etc.

(c) Look & Feel Model

According to the Jef. Raskin "The way that you accomplish tasks with a product – what you do and how It responds – that's the interface" In this section we will construct the complete puzzling display of expressions into the model. We classify the complete interface into components which take very closely view of all the parts that fit together create the complete user experience regarding interface.

(d) Font Style & Size

To differentiate each factor or user inter face the style is used like style of icons to make easier to recognize it and other element size of a text can also be used view or to declare the importance of text as the element will be larger it look will be more significant. Size also helps user who has weak eye side to read, click and control text easily. According to the ideas of Fittt's Law as the text will be large the user can control, click more quickly and efficiency will be automatically increased.

(e) Color

Color plays very significant role to give meaning many things. It attracts the users and increases its usability efficiency. Whereas different color has different meanings as green color is symbol of success and red is for danger. Color used in user interface as per the desires of user make a product more usable.

Color can also shows connection, such as coding color, things like different buttons, Tabs, links and toolbars to aid the user.

(f) Texture

It is a common concept in the field of interactive system named as affordance. It is usually considered the quality that communicates to the user that how something has meaning to be utilized. An example of a door which is opened on way has one side a handle and other plain plate shows whether push and pull to open a door. Similarly interface also communicates how it may use that is affords little technique of interaction and emphasize the user on the correct one.

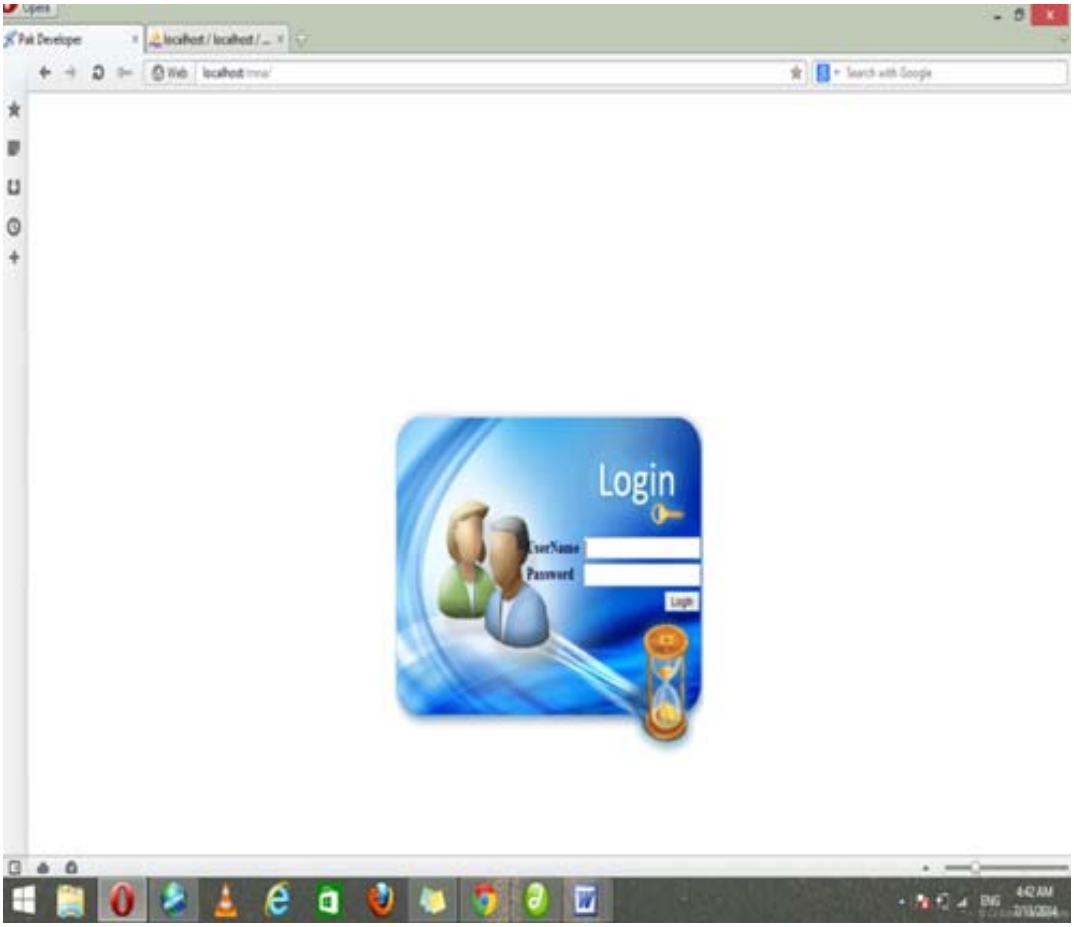
5. Prototyping

A functional limited representation of a program or web application in development process is called prototyping. By considering that a prototype with a realistic appearance is expected to have realistic behavior and thus can disappoint the user's expectations, especially with Mobile phone devices. Often it is better to make prototypes look like ones. A partial preliminary or possible implementation of a program used to explore and validate requirements and design approaches

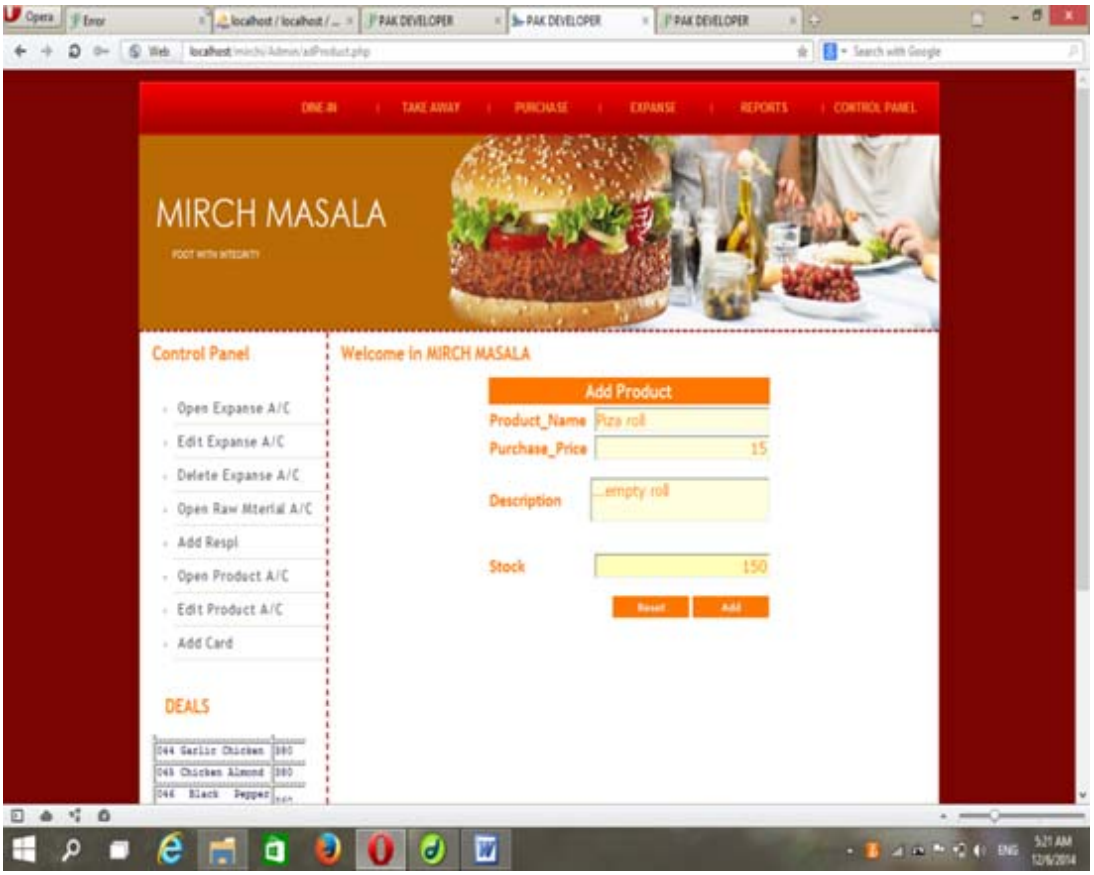
Some visual which were developed by applying UEPM are given below and comparison of the characteristics has also been given below.

6. Characteristics comparison of Usability Engineering Process of Projects A and B

	PHASES OF PROCESS MODEL						CHARACTERISTICS			
	RE	**Informa-tion model**	**Inter-action model**	**Look & feel**	**Pro-typing**	**Testing & evaluation**	**Learn-ability**	**Memor-ability**	**Produc-tivity**	**User Satis-faction**
Project (A) Mirchi Masala	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Project (B) PTCL	✓	✓			✓	✓				



Visual.1



Visual 2

7. Conclusion

Research on usability will never be complete, because no such things as a perfect user interface (Neilsen 2003). In spite of this, will still need to have "something" that indicate that how usable the developed system is?

In this paper we have described the importance of Usability engineering throughout the life cycle of software development process. Here we also proposed a usability engineering process model which will be helpful to user that he the user will feel easy to use system. The learn-ability, Memorability, and efficiency will be increase. By investing time, cost and resources in usability engineering activities we consider having return in term of less user training cost, less number of iteration and errors. More ever customer will also remain satisfied. Also, software with better usability is likely to decrease support cost (in term of hotlines, customer support service, and so forth).

Three major phases of my proposed model as informational model, interaction model and look and feel has the following benefits for users.

Productivity - a measure of how much work (in terms of actual tasks) can be accomplished in a given time. Involvement of usability engineering increase productivity.

Learn-ability - a measure of how much training is required before a specified level of proficiency is reached. Learn-ability of user is increased through usability.

User Satisfaction - a measure of the subjective responses a user has to the system is increased at maximum level.

Memorability - a measure of how robust the learning and performance are. (This can be particularly important for intermittent users)

Error Rates - a measure of the accuracy of the work carried out to complete tasks.

Number of iteration could also be reduced in much extent.

8. Future Work

In previous work, usability engineering was not adopted as complete engineering in the life cycle of software development. Mostly authors of usability focus on implementing usability engineering methods after completion of system or in testing phase. Due to which usability issues are discover late in the development process and result in, it is sometime impossible to go back. But the recent research focus that usability engineering should be used on every phase of waterfall model. In addition poor usability should not impose on user.

It is need of the time to give preference user by providing user friendly interface as per user desire. In this research paper usability engineering process model is applied on a web application and lot of problems related to informational mode, look & feel model, interaction were detected. This model should be applied before developing a system so that the usability problems might be reduced. In short motivation is given to increase the realization of usability engineering phases in all stages of software or web application adopted before development is completed. For this purpose the phases of proposed usability engineering model for effective usability will be very helpful.

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