Applying User-Centered Interface Design Methods to Improve the Usability of an Electronic Prescription System

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Despite the fact the human computer interface is the main facilitator of communication between the user and the computer system, its importance has been highly disregarded by system designers. This has resulted in many undesirable consequences, and in prescription and other healthcare systems, these problems are aggravated by the fact that not only are the users inconvenienced, but there are potential threats to the well-being of the patients under care as well. Many healthcare systems are often designed without considering the potential users of these systems. Consequently, the systems are created ad hoc, there is general dissatisfaction and eventually most of these systems are abandoned. This wastes human as well as economic resources while creating a stigma among the users towards the use of automated systems. In order to salvage one such system, different methods from the areas of usability engineering, human-computer interaction, psychology and cognitive science are considered, to systematically derive a framework to guide the redesign process.

The research undertaken in this project highlights the role and significance of the human-computer interface and puts an emphasis on the importance of user involvement in interface design in order to effectively satisfy their needs. Principles and guidelines for interface design are reviewed in order to obtain the guidance necessary for successful redesign. The research also reviews the different techniques involved in the design of user-centered interfaces and filters these to a reasonable set to be applied. Results from the research review, as well as from visits conducted to other healthcare facilities in Nairobi, are also used to pinpoint best practices for designing usable prescription system interfaces. Following the gathering of this information, a series of evaluations are conducted on the abandoned system to identify the flaws that could have caused its failure. Feedback from these evaluations, user suggestions and recommendations as well as best practices are used to iteratively develop an improved prototype system.

The redesigned system presents a successfully applied example of the user-centered design framework. A comparison between the original and redesigned system interfaces shows improvements in information quality, interface quality and system usability.

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Chapter 1: Introduction

1.1 Overview

Due to the rapidly advancing technology in computer systems hardware and software, hard-wired instrumentation and control systems have been replaced by modern computer-based information systems. Expert systems are now used to perform fault diagnosis and standby safety systems now allow users more response time while relieving them from routine and time-consuming tasks [Kontogiannis & Embrey, 1997]. However, increasing reliability, quality, maintainability and response speed has not always guaranteed increased usability. An estimate of 98% of software designed for the United States government was 'unusable as delivered' [Johnson et al, 2005] while a number of healthcare information systems have been reported to cost almost three times their original budget and get completed more than 3 years after their intended deadlines. A polling of managers regarding reasons for inaccurate cost estimates identified top four reasons relating to non-conformance to usability engineering practices, including request for changes by users, users misunderstanding of system requirements and overlooked tasks [Baker, 2000]. The result was often a non-performing system and dissatisfied users who either discarded an expensive system or demanded renovation immediately after system installation.

The human-computer interface is arguably the most significant element of a computer-based system or product [Pressman, 2000]. It is the "window" into the software and therefore directly molds the user's opinion regarding the quality of the information system. Information technology (IT) and the Internet offer many well-known benefits to healthcare, such as reminder systems, telemedicine applications and online prescribing, where IT has a significant impact on the quality and timeliness of healthcare delivery [Koppel et al, 2005]. But medical professionals must first adopt and utilize this technology if these benefits are to be realized. A poorly designed interface will severely hinder the user's capacity to tap the computation power of an application, generate anxiety and cause an otherwise well-designed and solidly implemented application to fail. However, practicing principles of good interface design early and throughout design often results in easy-to-learn interfaces, decreased user errors and training time and increased acceptance by users [Nicky, 2001; Talin, 1998].

A major goal during HCI design is to ensure system usability, which forms the basis for usability engineering. While poorly designed system interfaces may sometimes be a result of time and cost constraints, the reason is more often than not the lack of user involvement or the developer's limited knowledge in usability engineering techniques. Williams & Kennedy [1999] observe that only 61% of software meets user specification requirements. It is also estimated that almost 63% of projects over-blow their initial budgets due to lack of adequate initial user analysis [Lederer & Prasad, 1996]. Healthcare software developers often ignore users' tasks, preferences and characteristics as well as system usability issues. Poor information display in these systems frequently results in inefficient care in the form of redundant tests and missing vital information on patient diagnosis or prescriptions among other complications. The result is decreased productivity or systems that are simply unusable [Johnson et al, 2005]. Evidently, there is inadequate consideration to the basic design principles, especially during the project initiation phase. As development proceeds, the cost of correcting problems from previous phases multiplies. Fixing a problem with a system in the field can cost 100 times more that fixing the same problem during the design phase [Pressman, 2000]. This high cost often makes redesign of a failed information system impossible, rendering it a permanent catastrophe.

The secret to successful healthcare applications lies in careful design with consideration to the different backgrounds, tasks and environments of healthcare providers. According user-prominence to system design ensures that these applications adhere to the standards and models outlined by the profession while also being intuitive and easy-to-use.

1.2 Client's Background

The Jomo Kenyatta University of Agriculture and Technology (JKUAT) hospital is the department of the university that offers medical services to the students and staff, as well as to other private patients who subscribe to the hospital and pay a slightly higher rate than the staff and students. The pharmacy unit of the hospital is responsible for servicing the prescriptions made by the doctors and physicians. They also need to store and update records of drugs and other medical supplies that are received from the stores as well as those handed out to the patients. This enables the tallying of drugs and medical supplies circulated, as well as the monitoring of supplies in order to re-order from the stores in good time whenever there is a shortage. Following the huge amount of paperwork needed to be done to achieve this, the lack of storage space for the numerous paper files and the length of time and effort it took to manually compute paper data and retrieve records of previous transactions, there was need for automation to speed up the process and also make work easier. In September 2005 the pharmacy acquired an electronic prescription (EP) system to aid in this.

The EP system is a powerful automated system with a lot of functionality and capability for data storage and handling. It however has serious operational difficulties which caused the users to abandon the system after only a few months of use, reverting to the manual mode of operation. Initial analysis of the system with the users revealed the following possible reasons for abandonment;

- ***Delay in operations***: The pharmacy staff members are required to input data for new drugs and patients or search for existing data and make the electronic prescription based on a paper-based one from the doctor's consultation room before servicing the prescription. Due to limited manpower they are also required to perform the physical dispensing of drugs, causing delays in patient service.
- ***System complexity***: due to information clutter on the screens, locating specific items and functionalities is still problematic even after a period of familiarization with the system. Chunking together of unrelated functionalities also tends to confuse and frustrate the users.
- ***Information search:*** this functionality is case sensitive although the knowledge of this has not been made clear to the users. Hence the search does not often produce expected results, causing delays and aggravation.
- ***System inefficiency:*** some system functions such as date and report generation are unstable and when triggered, cause the system to hang or reboot. This also causes user frustration.

- ***Ineffective error-prevention***: the requirement for too much typed-data input as well as the limited provision of error prevention, warnings and error messages often prevents the users from realizing their mistakes until they are deep into the interaction. Reverting at this point results in delays and frustration.

These causes and other identified system limitations could be attributed to bad user interface design. The need to redesign the user interface of this system so that it can become more usable, efficient and acceptable is crucial and the major aim of this project work.

1.3 Scope of the Study

The research carried out in this project aimed to examine the significance and effectiveness of the human-computer interface (HCI) during system development and elicit the current principles and guidelines for user interface design, in order to derive a set of usability design criteria. There then followed an evaluation of the abandoned system, which employed user-centered activities such as heuristic evaluation, task analysis and user observation. This aimed to extract limitations at the user interface that could have caused the system to fail. As part of the research, visits were conducted to a number of hospitals with automated systems to investigate the current practices on HCI design of healthcare systems as a guide in the selection of a suitable design approach. The results from the research review and evaluation activities were used to systematically design prototypes of user interfaces, borrowing a few leaves from critically evaluated approaches, and integrating feedback from the users. Co-operation from my client and users of the EP system enabled the incorporation of research findings into the practical system development.

1.4 Dissertation Outline

The structure of the dissertation is as follows:

Chapter 2 discusses the user interface and its role in prescription-handling applications. The complexity of hardware systems and the increasing bulk of prescription data to be handled call for increased interactivity between the user and system. The quality of an interface therefore directly impacts on the quality of care. The dangers of bad design are mentioned, while the benefits that good HCI design offers are also presented. An approach to usability engineering is identified which will form a guide in redesign.

Chapter 3 examines proposals for increasing interface usability by practicing user-centered design. Several principles and guidelines for HCI design are investigated to derive ideas for redesigning the EP system. The findings presented are used to develop a set of usability design criteria to be used to evaluate the existing EP system. A methodology for user-centered interface evaluation and redesign is also proposed with the aim of eliciting a strategy for uncovering flaws and successfully redesigning the EP system.

Chapter 4 presents a methodology used to conduct design evaluation on the EP system with user participation. These findings extract weaknesses of the system and comments, suggestions and recommendations from the users form a basis for designing the prototype user interfaces which will culminate in an improved EP system.

Chapter 5 describes the redesigned EP system, which was developed as the practical aspect of this project. Unnecessary complexities with the interface have been removed and the grouping of features reviewed to make the system easier to navigate through and perform functions. A description of the various tasks involved is given, as well as how the various customized interfaces necessary to fulfill these processed were created using java, a powerful tool for interface design.

Chapter 6 describes a comparative evaluation of the redesigned system against the original system to determine the level of improvement, as well as an evaluation of the redesigned EP system against a set of usability design criteria to evaluate success in implementing good HCI design. High consideration is accorded to the degree with which the research findings have been effectively applied to the design and development of the practical objectives. It is evident that a good amount of effort was spent to ensure that the practical work was conducted around the research review findings.

Chapter 7 provides an assessment of the whole project as a whole, with deliberation accorded to the client and user participation, the project management methodologies, and the overall project success. This is measured by the level with which the deliverables satisfy the project objectives. A justification of the success of each objective is given during the examination of the project objectives and the limitations with the project are acknowledged in recommendation for future work.

Chapter 2: The Human Computer Interface

2.1 Introduction

An interface is something that exists between two parties with the major role of facilitating exchange between them [Lin et al, 2005]. When these parties are both humans the interface is quite simple, often consisting of natural language and intonation, facial expressions and sign language. It however becomes complex when one interacting party is replaced with a computer system since the underlying structure of the system becomes more opaque and less readily determined. This, coupled with the rapid development in computer hardware and increased information complexity, has created the necessity to increase the interactivity between computers and humans. It is not strange to find powerful and expensive information systems with full functionality getting discarded due to poor interface design. The system users, the JKUAT hospital pharmacy staff, were recently forced to abandon the use of an Electronic Prescription (EP) system due to many interface flaws, including complexity, system instability and user mental overload. This chapter aims to establish the importance of effective information communication between users and computers, while highlighting the dangers arising from limited interface usability, with constant reference to the EP system. Usability engineering activities are identified, which will be used to resolve the pharmacy problems with human-computer interaction. First is a description of what constitutes the user interface.

2.2 Modeling the User Interface

To effectively design the user interface, the designer needs to be armed with a comprehensive understanding not only of the technical components of the system but also of the human components and how these components are used during interaction. The human processing system is complex and often poorly understood. Although it cannot be fully or accurately represented in a model, figure 2.1 attempts to depict it.

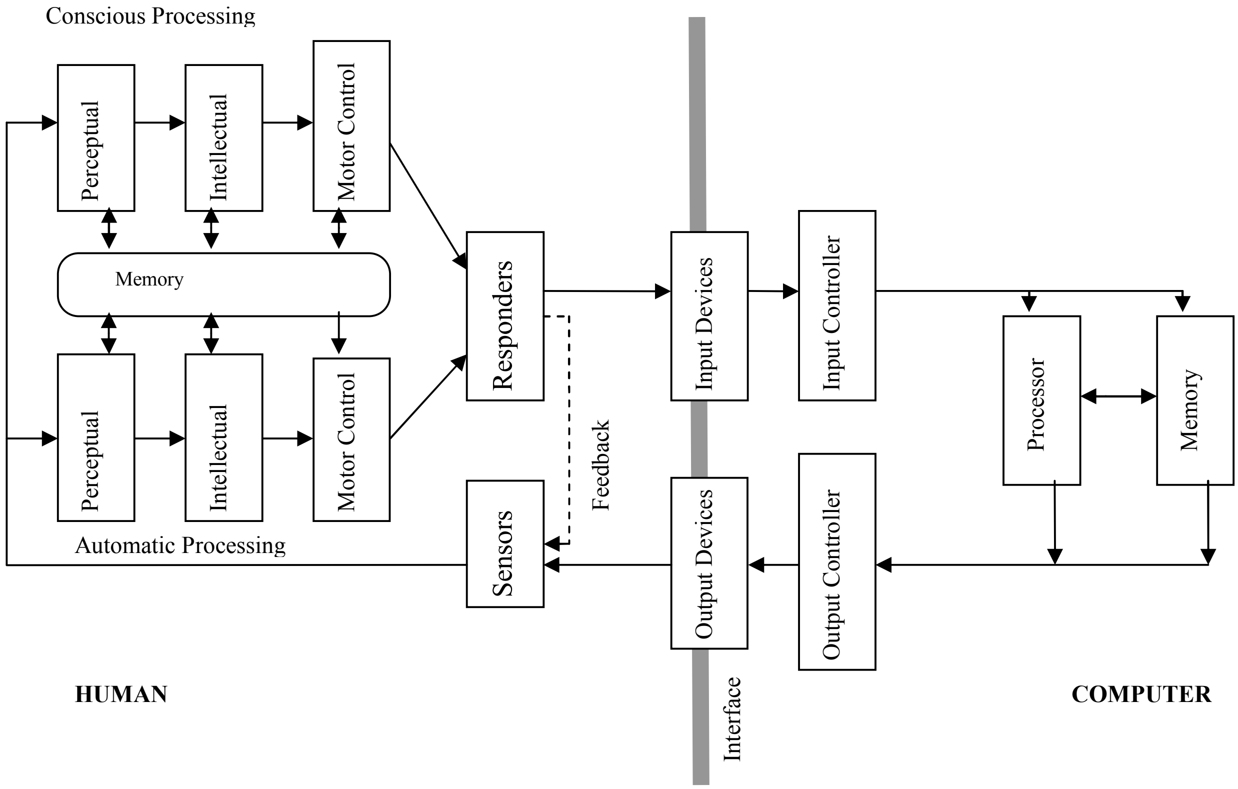

Figure 2.1: Model of the human-computer Interface [Downton,1999]

On the left of the interface is a simple model of a conventional human processing system consisting of three major parts;

- The perceptual processing provides the connection from the sensory organs (eyes, ears, etc.) to the brain. Information here is represented in an unprocessed and uncoded state and is temporarily stored in its physical form (rather than the corresponding symbolic form) to be used later during cognitive processing [Downton, 1999].
- Intellectual or cognitive processing is concerned with the processing of information received from perceptual processing and can be divided into short-term memory (STM) and long-term memory (LTM). Although no such practical demarcation exists in the brain, it is necessary to classify these as two separate and discrete elements.
- Motor control is concerned with response to information from cognitive processing. The main responders of the human operator consist of two hands, two

feet and one voice. Motor control is estimated to be at its best when none of these responders is impaired.

All of the above subsystems interact with the human memory and share a similarity with the conventional computers in terms of processors, memories and the interaction between them by paths akin to busses. The left of the interface models the computer system with input devices such as mouse and keyboard to allow data input by the user as well as output devices such as screen display, printer, etc. to allow the results from computer operations to be presented to the user. The computer output is monitored by the user's sensors (eyes and ears) through the interface and passed to the human cognitive processing system to generate an appropriate response from the human responders (e.g. fingers). This response is the input that dictates the next operation by the computer.

The three subsystems are split into two parts; conscious and automatic processing. Conscious processing occurs when all responses to incoming stimuli are taken into account and the intellectual part of the processing takes time to determine an appropriate response. Conscious processing occurs when performing new or infrequent actions and therefore produces slow and thought-over responses. Automatic processing spends very little time on intellectual decisions since all responses are of a reflex nature. This form of processing relates to frequent actions which become automatic due to practice and are therefore relatively fast. All actions start as consciously processed but over time and with practice and experience, they gradually become automatic/reflex actions with only occasional conscious observation. While automatic actions are quite inflexible and difficult to change, conscious actions can be easily changed.

Although STM, like in perceptual processing, stores information in a temporary memory buffer, the information is in a symbolically coded rather than physical form. Research shows that STM has a limited storage time of 20-30 seconds [Johnson & Turley, 2006] However, persistent rehearsal can increase this. STM is also essential for decision-making. This memory represents an impediment in human processing, and when interacting with computers there is always a danger of an overload, especially for new or occasional users [HFI, 2001]. To minimize this danger, interface design needs to be simple, meaningful and familiar. Information is transferred from STM to LTM consciously through learning effort or unconsciously through repeated exposure but transfer from LTM to STM is indirect, unconscious and asymmetric, and can occur very rapidly. No limits to the size of LTM have been discovered. Although it appears that once information is stored in LTM it is never forgotten, sometimes the acquisition of more information tends to interfere with, mask or overwrite existing information.

Aside from the variations in users' needs as a direct result of different factors e.g. difference in gender, age, language, skills, motivation, personal interests, cognitive styles, personality factors, goals, aptitudes and ability to adapt, users of the human-computer interface are divided into 3 basic groups; novice users are those new to the system and require a simple and easy-to-learn interface, occasional users use the system after prolonged periods of non-use, and expert users are more experienced with the system, interface and technology [Jean, 2000]. While expert users require little or no help with system interaction, occasional users need special attention since they may alternately behave like novice or expert users [Lohr, 2000]. This interface should therefore be designed to accommodate the needs and expectations of varied users. It should also be able to guide any user when interacting with the system, thus there is need to fully understand the users for effective interface design

The hardware and software used to run the system also play a critical role during interface design. The ever-growing technology has produced modern computers which are smaller in size and more powerful, with extremely high processing speed, higher memory capacities and high-resolution graphic screens. The use of the mouse, bitmapped displays, windows and point-and-click editors among other technological advances are the building blocks of the modern user interface [Hewett et al, 2004]. The use of Graphical User Interface (GUI) has continued to grow, narrowing the gap between the real environment and the virtual ones represented on an interface. The development of speech and gesture recognition devices is continually improving the HCI technology and design. But in the face of all this, consideration of appropriate hardware when designing HCIs is compulsory. An interface that uses a mouse, for example, may not be usable if a place for placing the mouse is not provided. Using an audio feedback would be inappropriate if speakers were absent or not configured to be used by the system. The type of computers hosting the application system should also be considered. Appropriate interface components also need to be made accessible to the intended user, for example, a blind person cannot read text on a graphic screen. The appropriate devices should be chosen to interact with the right human senses to optimize system usability [Galitz, 2000]. The concept of usability with regard to prescription systems will now be discussed.

2.3 Usability Engineering

The ISO 9241 standard for usability defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction" [ISO, 1998]. System usability is closely linked with error frequency, learnability and memorability (the ease of committing to memory) [Nielsen, 1993].

Effectiveness involves the accuracy and completeness by which users achieve a goal [Hornbæk, 2005] and deals with issues such as the percentage of users successfully completing a task, number of user errors and number of tasks completed in a given time, ratio of successful interactions to errors, and average accuracy of completed tasks.

Efficiency is concerned with the resources used in relation to the accuracy and completeness mentioned above, and represents the time to complete a task, number of times a user needs help, effort (cognitive workload), tasks completed per unit time, and time taken to learn the system [Park & Lim, 1999].

Satisfaction deals with user freedom from discomfort and his positive attitude towards the product. It measures issues such as frequency of complaints and the rating scale for user satisfaction.

These three aspects of usability directly affect the acceptance or rejection of a system by the user since the absence of one will impair a system's performance. The ease-of-use of an information system depends heavily on how its interface is designed and usability criteria form a foundation for interface design choices. To alleviate the serious usability problems that poorly designed HCIs pose to users, a lot of literature has emerged that give standards and guidelines for the design of usable interfaces. Scapin [1999] and Nielsen [1993] suggest usability heuristics such as consistency, efficiency, predictability, user control, responsiveness, recovery, forgiveness, simplicity, transparency, minimum user memory load and simple, natural dialog. Holcomb and Tharp [1997] present a merged model of usability identifying characteristics similar to Nielsen's heuristics. An analysis of these different sets of usability criteria results in a common set of heuristics which are described in appendix B. This set can be termed as representative since it covers, interprets and simplifies all major usability proposals identified from the researched literature. The usability engineering lifecycle is composed of three major activities, usability evaluation, iterative prototyping and usability testing. These activities will now be discussed.

2.3.1 Usability Evaluation

These methods are much similar to interface evaluation methods discussed in section 3.3, although the focus is on evaluating system usability [Park&Lim, 1999]. Many different computer interfaces are evaluated and compared using three criteria, usability, learnability and the degree of ease of use after system mastering. This is because lack of either of these three will automatically incapacitate the user and increase his cognitive load, destroying the purpose of automation. Usability evaluations are classified into four broad categories: analytic methods which analyze dialogue transactions such as keystrokes or cognitive analysis; empirical evaluation using formal experiments and informal user observation; user feedback from interviews and questionnaires and expert analysis where usability experts provide objective interface assessment [Johnson et al, 2005]. Stannely et al [1998] advise on the exploration of several alternatives to achieve sufficient evaluation. Park and Lim[1999] suggest an evaluation decision structure made of two major phases: the prescreening phase based on expert-judgment-based approach such as heuristic evaluation, and the evaluation phase, a user-based approach. This structure uses both subjective (qualitative) and objective (quantitative) criteria as shown in figure 2.2.

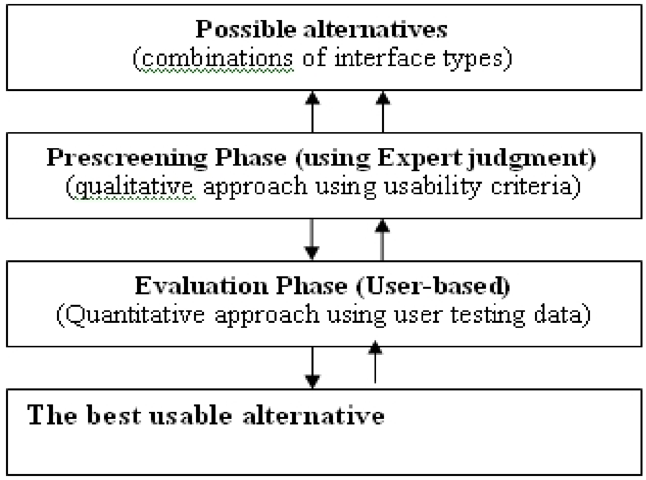

Figure 2.2: Evaluation procedure [Park & Lim, 1999]

Although qualitative usability studies such as observations and interviews may experience major set-backs such as busy, non-cooperative or resistant users, they have great potential to improve the design and usability of an interface through interaction with real users. They seek to identify and prioritize users' tasks and diagnose areas where usable design is absent

Quantitative data is difficult and tedious to collect and analyze, and may lead to ineffective evaluation when not properly done. But a well-conducted analysis has the unique advantage of efficiently satisfying usability needs across a great user population since the analysis generates a template to satisfy global needs of users.

2.3.2 Prototyping

The user-centered design process is the most iterative, often beginning with a simple key prototype and proceeding until all the critical design decisions have been made. Prototyping is based on the use of formal dialogue specification methods and software tools to translate from user specification to simulations or implementations of the user-interface components of a system. Prototyping explores the practical usefulness of a system to justify its viability before implementation is done.

2.3.3 Usability Testing

Usability testing concerns the evaluation of information systems through the analysis of typical end users interacting with the system [Kushniruk, 2002]. This practice has not been a routine part of designing prescription systems even though measuring the extent of ease-of-use of an application before shipping can assist in decision-making and greatly save efforts and costs of later redesign. Having evaluated various expert-based usability criteria and used these to aid in system re-design, it is important to test the redesigned system against these usability criteria in order to measure success.

2.4 Role of the HCI in Prescription Systems

Adverse drug events are the single leading cause of medical injuries and account for 19.4% of all adverse events identified in the Harvard Medical Practice Study [Lin et al, 2002]. Medical Human cognitive limitations, slips in knowledge as well as regular problems with the healthcare work flow have many times led to medical errors in Kenyan hospitals [GOK, 1997]. But with the emergence of information technology, many of these errors have been dramatically reduced through the streamlining of work processes, capability for online prescribing, telemedicine applications and provisions of features such as alerts and reminders. Electronic prescription systems have significantly reduced adverse events such as unnecessary lab testing, events involving drug-to-drug interaction and transcription errors, and hold a great promise of improving safety in healthcare [Kushniruk et al., 2005]. Experience has proven that practicing good interface design practices can improve system usability and generate systems that fully exploit the advantages offered by technology as is discussed below.

2.4.1 Effects of Good Interface Design

Following the steady increase in the number of users and software applications, HCIs have gained in importance [Bæker et al., 1997]. A good HCI is one that is efficient, pleasant, is easy to use and performs according to the user's expectation. Whether or not electronic medical records can be adopted or made to satisfy the user is largely dependent on the system's interface usability [Rose et al., 2004]. On the other hand, a well designed prescription system interface presents a number of benefits, such as:

- **Decreased User and Medical Errors**

Good interface design can greatly reduce user errors during system interaction especially by checking the requested prescriptions against the current medication being taken by the patient and alerting the physician of any adverse effects. Without this, the physicians would need to rely on their memory which is never absolute.

- **Increased User Productivity**

Increased navigation ability enables easier and faster information retrieval [Linder et al, 2005], enabling physicians and pharmacists to view patient history without the need to obtain physical paper charts. Treatments prescribed and patients' results can be easily referenced. Multiple referencing, access and update of information is also made possible. Users therefore accomplish much more tasks within a shorter time period.

- **User Confidence and Trust**

Despite the increase in information bulk, functionality and the complexity of healthcare Information systems today, well-designed interfaces that are less prone to errors tend to make the users more comfortable when working with the application [Ivory& Hearst, 2001]. An aesthetic presentation enhances personality while providing users with a sense of enjoyment, trust and professionalism.

- **Decreased Training Costs and User Support**

More user-friendly interfaces greatly reduce training costs and support effort as they are easily learnable, even by the new users. Time and resources used in train users is considerably cut down.

- **Savings Gained From Making Changes Earlier In Design Life Cycle**

While many project managers view interface usability costs as added effort and expense, studies have shown that the first 10% of the design process when key usability-design decisions are made can determine up to 90% of a system's cost and performance. Changes made earlier during design cost less effort and money [Pressman, 2000].

◆ **Increased Public Appeal and Satisfaction**

When users are able to easily learn, retrieve and manipulate information from computer systems, this increases their efficiency in serving the clients, in this case, the JKUAT hospital patients. Easy-to-use HCIs lead to better quality of care since by easily accessing patients' history, the suitability of procedures and orders recorded can be verified by the pharmacy without the need for physician consultation [Jimison et al, 1998]. The cost of healthcare to the patients is also reduced due to eradication of duplication, especially in the case of diagnostic procedures like blood work and x-rays.

The most challenging and important task faced by the information system designer is ensuring that the system remains in use and is accepted and appreciated by users. Ensuring that a system utilizes all the benefits associated with good interface design is a major goal in HCI design. The effects that come with bad interface design will now be discussed.

2.4.2 Dangers of Bad HCI Design

Despite the many benefits that technology offers in the automation of tedious manual operations and reduction of human errors, electronic medical records have not been widely adopted and accepted. This is not due to financial, organizational or technological problems but rather because of deficiencies of user-centered interfaces which render them unusable [Koppel et al., 2005]. Badly designed HCIs can have the following diverse effects.

◆ **Medical Errors**

There is risk of unintended increase in medical errors if the interface is badly designed. Studies in healthcare information have proven that poorly designed medical systems can introduce new classes of errors and sometimes even contribute to more errors overall [Kushniruk et al., 2005]. These errors are a result of the following design limitations:

✘ **Poor Readability**

This limitation can have the following effects;

- Names and details appearing in small font or on a minimized window make reading difficult [Jean, 2000]. This may lead to selection of the wrong patient or prescription of the wrong drug.

- In individual patient records, if the patient names don't appear on all the screens, there is the likelihood that users will not discover an error with a particular patient until they are deep into the interaction.

✘ Memory Overload

Dangers with this manifest themselves in the following ways:

- Sometimes users are made to review a lot of screens in order to get all of a patient's information and medication. Following man's short-term memory, memorizing every detail across that many screens is impossible. Nielsen [1998] mentions a study where 72% of pharmacy staff were uncertain of medication and dosage since reviewing a patient's total medications was difficult. This can easily lead to erratic performance by users.
- Interface complexity or too much detail on a screen can overtax the user's mind and cause confusion, leading to errors in prescription-handling.

✘ Complicated Workflow

This is when several aspects of the system require a user to perform numerous tasks on numerous screens which conflict with the hospital's workflow. The EP users, for example, are required to search for or enter both the patient and drugs details from the paper prescription before they can service a prescription. Normal manual operation requires the records office to be concerned about the patient details, the store to take care of the drugs details, and the physician to write the prescription. The pharmacist only needs to service these prescriptions. As a result, the system fails to attain its usefulness in reducing the workload. This increases the risk of errors by straining the user's cognitive load.

◆ Date Description Errors

Sometimes the interface lets users specify medications for ambiguous dates like "tomorrow". The danger with this is that when such a prescription is made right after midnight, it may result in a patient missing his medication for a whole day.