

IMPLEMENTING JAKOB NIELSEN'S 10
HEURISTICS OF USABILITY IN DEVELOPMENT
OF WEB BASED DENTAL SYSTEM (WEBDENT)

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ABSTRACT

The majority of work on computer use in the dental field has focused on non-clinical practice management information needs. Very few computer-based dental information systems provide management support of the clinical care process, particularly with respect to quality management. Traditional quality assurance methods rely on the paper record and provide only retrospective analysis. Today, proactive quality management initiatives are on the rise. Computer-based dental information systems are being integrated into the care environment, actively providing decision support as patient care is being delivered. These new systems emphasize assessment and improvement of patient care at the time of treatment, thus building internal quality management into the care giving process. The integration of real time quality management and patient care will be expedited by the introduction of an information system architecture that emulates the gathering and storage of clinical care data currently provided by the paper record. This paper proposes a methodology for developing web based dental system by implementing Jakob Nielsen's 10 heuristics of usability that help making WebDent more user friendly and efficient through interactive tooth chart. The goal is to develop web based dental system for dental clinic in Malaysia and to simplify patient follow up practicable information support. The findings reveal that Web Based Dental System was developed for dental clinics in Malaysia. The automated patient record system will replace the manual dental record system and the patient follow up appointment will be simplified.

Key Words : *Web based dental system, Jakon Nielsen's 10 heuristics, dental system, paper record*

ABSTRAK

Majoriti kerja yang melibatkan penggunaan komputer dalam bidang pergigian memberikan tumpuan kepada keperluan amalan pengurusan maklumat bukan klinikal. Sangat sedikit sistem maklumat pergigian berasaskan komputer menyediakan sokongan pengurusan proses penjagaan klinikal, terutamanya berkaitan dengan pengurusan kualiti. Kaedah jaminan kualiti tradisional bergantung pada rekod kertas dan hanya menyediakan analisis retrospektif. Hari ini, inisiatif pengurusan kualiti proaktif semakin meningkat. Sistem maklumat pergigian berasaskan komputer telah diintegrasikan ke dalam persekitaran penjagaan, dengan aktif menyediakan sokongan keputusan ketika penjagaan pesakit sedang disampaikan. Sistem baru ini menekankan penilaian dan peningkatan penjagaan pesakit ketika masa rawatan, sekali gus membina pengurusan kualiti dalaman ke dalam proses pemberian jagaan. Integrasi terhadap pengurusan masa nyata berkualiti dan penjagaan pesakit akan dipercepatkan dengan pengenalan seni bina sistem maklumat yang mengemulasi pengumpulan dan penyimpanan data penjagaan klinikal yang kini disediakan oleh rekod kertas. Kertas kerja ini mencadangkan satu kaedah bagi membangunkan sistem pergigian berasaskan web dengan melaksanakan 10 heuristik kebolegunaan Jakob Nielsen yang membantu menjadikan WebDent lebih mesra pengguna dan cekap melalui penggunaan carta gigi interaktif. Matlamatnya adalah untuk membangunkan sistem pergigian berasaskan web untuk klinik pergigian di Malaysia dan untuk memudahkan maklumat sokongan pesakit susulan dapat dilaksanakan. Kajian ini menunjukkan bahawa Sistem Pergigian Berasaskan Web telah dibangunkan untuk klinik pergigian di Malaysia. Sistem rekod pesakit automatik akan menggantikan sistem rekod pergigian manual dan temujanji pesakit susulan akan dipermudahkan.

Kata Kunci : *Sistem pergigian berasaskan web, Jakob Nielsen 10 heuristik, sistem pergigian, rekod kertas*

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Information technology is growing rapidly in both its capability and capacity to support the delivery of health care. However, most of the dental clinics in Malaysia still using the conventional manual system instead of using the web based management system. The aim of the project is to provide a solution by the development of web based information management system in field of dentistry. This system is Web-based Dental System or known as WebDent. It is hoped that the work of this project can be developed successfully to eventually produce an information systems which would have the potential to improve current dental care delivery for both patients and dentists.

WebDent is a system that functions to manage all the patients' dental information for dental clinics. According to Shepherdstown, approximately 90 percent of all dentists in the U.S. now use computers in their practice. Dental informatics, a subfield of health informatics, is focused on the application of computers, telecommunications, and information science to improve all aspects of dental practice, including management, clinical care, education, and research. According to Shepherdstown, the use of electronic dental record systems can help to improve a practice's bottom line, while it was benefiting patients.

They can help reduce the cost of operation, strategic workflow, also improve quality of care, and enhance patient safety (Shepherdstown, August 2010). The main purpose of this system is to automate methodology of work and business activities of a dentist and a dental practice.

This system is a web based application which can make it easier for the dentist, management staff and also for the patient to use this system where ever there is an internet connection. WebDent can helps in managing doctor's appointments, patient waiting list, patient health information and dental procedures. It is not only dental care management, administrative features in the system enables in audit patients information, messages that allow the staff and patients successfully interact in a virtual visit, and reminder message to let the dentist and patient alert about any appointment in which allowing dentist to focus on providing quality patient care and to work in an easy manner.

1.1 Problem Statement

The majority of work on computer use in the dental field has focused on non-clinical practice management information needs. Very few computer-based dental information systems provide management support of the clinical care process, particularly correspond to quality management. Traditional quality assurance methods rely on the paper record and provide only retrospective analysis. As the main purpose of this system is to automate methodology of work and business activities of a dentist and a dental practice, this project is the attempt to improve the traditional dental management system to control all the patients record and manage appointment systematically.

Generally, the number of dental clinic that using web based information and management system is still less in Malaysia compare to other country. Usually most of dental clinics in Malaysia take patient records by using patient card. However to use patient cards or book an appointment, patients have to go to the place that their treatment to be done, give information and take a reservation or take treatment if the condition is available. In this condition patients may lose too much time because of waiting or even patients may have to book a reservation for another day.

Even though there are existing computerized dental system, but it is too complicated to use and takes time for the staff to get used to it. Thus, WebDent will be developed by implementing human computer usability heuristics to make the system more usable for the users. Besides, there can be some difficulties in changing patient personal information if using paper based system. By using WebDent patient records can be transferred from papers into the computerized WebDent so that patients can make appointment requests instantly by online system. Patient treatment plans to be done on dental pictures visually to prevent possible treatment mistakes or misunderstandings between patients and doctors.

The WebDent also can simplify patient follow-up to practicable information support and to make process of institution easily accessed, limitless and productive. This way, both the doctors will be able to produce solutions reaching all the information of the patient with ease and health status of the patient will be fast traceable.

1.2 Objective

The objectives of this project are :

- i. To develop a web based dental system.
- ii. To implement Jakob Nielsen's 10 Heuristics of Usability in development of WebDent.
- iii. To enhance system usability for the end user.

1.3 Project Scope

The scope of this project are :

1. There are four type of user that can used this system
 - i. Admin
 - ii. Dentist of the dental clinic
 - iii. Management staff of the dental clinic (Nurse)
 - iv. Patient (Visitor)
2. This system is a web based application

WebDent is a web based application. The online application must be performed to run the system.

3. This system is developed for the use of dental clinic.
4. The design of the system must apply Jakob Nielsen's 10 Heuristics of Usability in order to enhance system usability and enable user to perform interactive tasks.

1.4 Thesis Organization

This chapter consists of the six chapters. All of this chapter will explain each part of the system development process.

Chapters 1 will be about the introduction of project. It is including the project overview, problem statement, objective of the project, and also the project scope.

Chapter 2 is to explain briefly about the chosen project. Study on the research that had been done by other researches and research on the existing system that related to the project in order to get complete information and also the suitable technique to be used for developing the system.

Chapter 3 is description of methodology used and overall work load to develop this system. The content include framework for the project that used in this system and description about the hardware and software necessary that will be use during development.

Chapter 4 is implementation. The purpose of this chapter is to explain briefly on implementation of process that is involved during development of this system.

Chapter 5 is about results and discussions. This chapter interprets and evaluates the finding that obtained from the implementation of the system.

Lastly, chapter 6 is about conclusion. This chapter describe summary on the overall system.

1.5 Conclusion

As a conclusion, it shows that there are many dental systems which are still using the traditional or manual system in managing the patients' record. Manual system has many drawbacks compare to computerized system and that is one of the reason for the development of WebDent. WebDent is a system that will help to automate patient record system and also make it easier for the patient to book for doctor appointment online. Besides that, this system can also help to improve dentist work by making it easier for them to update the patient record using computerised system.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter is about discussion of knowledge and understanding in project background. The system importance and functionality is also discusses in literature review. In addition, it also explains about the reviews that had been related with the existing system. Some research of the techniques used is also discussed in this chapter.

2.1 Background of Project

Currently the Malaysian healthcare sector is valued almost U.S. \$900 million and is expected to grow up to \$1.2 billion by the year of 2005. In general health, oral healthcare is being considered as an important part. Oral healthcare was given considerable importance in Malaysia during the last decade. As this scenario had become a demand in our lifestyle, a system called Web-Based Dental System is one of the solutions to fulfill the dentistry healthcare industry demand.

According to the Free Dictionary by Farlex, dental record was defined as a confidential document. The document content can be clinical and financial data of the dental patient, including the patient's identity, pertinent history, medical and dental conditions, services rendered, and charges and payments made (The Free Dictionary, n.d).

A detailed document of the history of the illness, physical examination, diagnosis, treatment, and management of a patient is known as the dental record.

Dental professionals are compelled by law to produce and maintain adequate patient records. With the increasing awareness among the general public of legal issues surrounding healthcare, and with the worrying rise in malpractice cases, a thorough knowledge of dental record issues is essential for any practitioner. The ability of clinical practitioners to produce and maintain accurate dental records is essential for good quality patient care as well as it being a legal obligation. The dental record provides for the continuity of care for the patient and is critical in the event of a malpractice insurance claim.

Comprehensive and accurate records are a vital part of dental practice. Good record keeping is fundamental for good clinical practice and is an essential skill for practitioners. The primary purpose of maintaining dental records is to deliver quality patient care and follow-up. Dental records can also be used for forensic purposes and have an important role in teaching and research, as well as in legal matters (Journal of Contemporary Dental Science, n.d).

The background information of the patient is also important to the dentist. According to the study on ‘How information systems should support the information needs of general dentists in clinical settings’, it is found that Dentists also inquired about issues beyond the medical or biological aspects of a dental problem. These information needs information such as medical history, dental health behaviors and dental insurance. To help assess the dental problem and decide on drug use dentist first need to looked for information such as chronic diseases, medications and allergic histories in the medical and health history. (Medical Informatics and Decision Making, 2010).

By using this kind of system, dentist can identify the last treatment that had been done by the patient from the system. This information will help dentist to keep track of the patient oral condition and can also do an analysis and also understand the patients' condition better. Dentist can also insert and save the new record regarding the new treatments that are done for the treatment session. The dentist can easily record all the information from the illustration of the patients tooth. Dentist can also record the next treatment that need to be done by the patient according to their oral health condition.

2.2 Dental and Health Record Management

Health record management is also known as health information management. Health information management (HIM) is the practice of maintenance and care of health records by traditional (paper-based) and electronic means in hospitals, physician's office clinics, health departments, health insurance companies, and other facilities that provide health care or maintenance of health records. (Wikipedia, n.d).

There are various types of health record management according to the specific health sectors. One of them is dental record management a subfield of health record management. Generally, dental records should provide an accurate picture of the patient's oral or dental status relative to the patient's concerns and requests, the proposed treatment plan, and the treatment performed, and should include all supporting documentation. Any result and information of the check up must be recorded on the patient chart during the time of service and patients should be advised of compromised results as soon as the dentist is sure of the facts. In these circumstances, all information presented to the patient must be documented (Dental Record Management.1996).

The primary function of a dental record is to document the management of a patient's dental disease and treatment. A record that is adequate in this regard will provide the presentation, differential diagnosis, treatment plan, and treatment in clear and understandable language. Anyone reading the document, including an individual totally unfamiliar with the case, should have no doubt as to what the patient's problem was and how the doctor alleviated the problem.

A secondary function of the dental record is that information contained in the record should serve as a means of communication between the treating dentist and other health-care providers, subsequent practitioners, consultants, and third-party carriers. It should be able to reasonably re-create the course of the patient's treatment from beginning to end. The dental record serves as an official document in medical or legal confrontations (malpractice suits) and should assist in protecting the legal interests of the doctor as well as the patient. The patient's records often become the pivotal point, not only in the decision to pursue a malpractice suit but also in the outcome. Maintaining accurate, complete records in today's environment is absolutely mandatory (The Dental Record, n.d).

Every practicing dentist has a legal duty to keep some sort of record of each of their patients for whom they provide dental care. Whilst this requirement might be met by simply recording the patient's name and address, it is widely accepted in the profession that there is an ethical duty to maintain patient records to ensure accurate and safe treatment. There are relatively few reports in the literature concerning the quality of clinical record keeping in primary dental care, it does appear that the standard of record keeping is inadequate. Although there have been no studies of clinical records kept by General Dental Practitioners (GDPs) in the UK, an observation made by two District Reference Officers (DROs) in Scotland does give rise to concern. On comparing National Health Service forms completed by GDPs (in which there is a charting of teeth present), only 48% of chartings were the same as the charting carried out by one of the DROs.

The DROs' charts commonly showed more teeth as present than actually were present, suggesting that records were made at the first visit of a course of treatment and not kept up-to-date (Research practice management, n.d).

There are four important reasons to keep good clinical records and always up to date. Firstly, it is in the dentists' best interests. It is known that good records facilitate good defense, poor records a poor defense and no records no defense. Secondly, good dental records can help in the process of forensic odontology and poor records hinder it. Thirdly, good records facilitate the process of dental audit. Fourthly, good records enable a monitoring of the patients' state of oral health. This information can then be used for the benefit of the patient, to aid motivation in preventive oral healthcare practices and to monitor the success of any treatment carried out. As patients become more aware of various treatment alternatives and as consumers (particularly where treatment is being provided on a private or private capitation basis) wish to be informed of the progress of treatment, this fourth aspect of record keeping is becoming increasingly important. (Research practice management, n.d) .

2.3 Studies on Technique Applied to Web-Based Dental System

This section is about the study on technique that is going to be applied in development of Web-based Dental System or known as WebDent. Computer-based patient records have been shown to provide significant benefits to patient care and outcomes. However, poor user interface design is a barrier to using clinical information systems effectively. Many problems can be traced to weaknesses in usability and human computer interactions (HCI) design. Usability and HCI methods are considered important components of the system development process outside of healthcare.

In medicine, several studies describe cognitive and HCI methods for evaluating and improving clinical systems. For example there are cognitive task analysis, heuristic evaluation, cognitive walkthroughs and usability tests, which are used to provide insights to developers about potential usability problems. These methods can also be used for the summative evaluation of clinical systems.

2.3.1 Comparison between the Jakob Nielsen's 10 Heuristic and Schneiderman's Eight Golden Rules.

Table below shows the rule of both heuristics and the description about the heuristics.

Type of Heuristics	Rules	Description
Jakob Nielsen's 10 Heuristic	<ol style="list-style-type: none"> 1. Visibility of system status 2. Match between system and the real world 3. User control and freedom 4. Consistency and standards 5. Error prevention 6. Recognition rather than recall 7. Flexibility and efficiency of use 8. Aesthetic and minimalist design 9. Errors: recognise, diagnose and recover 	<p>Jakob Nielsen is the founder of 10 Heuristics of Usability. This heuristic is more to enhancement of usability of a system. The Jakob Nielsen's 10 Heuristics of Usability is widely used for web based system.</p>

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	10. Help and documentation	
Schneiderman's Eight Golden Rules.	<ol style="list-style-type: none"> 1. Consistency 2. Shortcuts for frequent/trained users 3. Provide informative feedback 4. Design dialogues to yield "closure" 5. Error prevention and handling 6. Easy reversal 7. Internal locus of control 8. Reduce short-term memory load 	<p>Schneiderman's Eight Golden Rules is best known for interfaces. To improve the usability of an application it is important to have a well designed interface.</p> <p>Shneiderman's Eight Golden Rules of Interface Design are a guide to good interaction design.</p>

Table 2.1 : Comparison of the Two Best-Known Lists of Heuristics Guidelines

2.3.2 Jakob Nielsen's 10 Heuristics of Usability

Human factor or usability engineering is a discipline that investigates human or machine interface issues, using a wide array of methodologies (Lathan CE, Sebrechts MM, Newman DJ, Doarn CR, (n.d). These methodologies vary in terms of research design, complexity, cost, duration, and relevance to operational programs. The two approaches for evaluating the human-computer interaction (HCI) characteristics of a system include inspection methods or user evaluations.

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Inspection methods are based on reviews of a system, often by experts, which can be guided by usability heuristics, user tasks, or other information. User evaluations measure user task performance in a lab setting. Using these methods in system development has been recognized as an important way to ensure the usability of the end product (Kushniruk AW, Patel VL. Feb 2004).

Nielson defines heuristic evaluation as a measurement that utilizes heuristics in order to find usability problems (Nielson J,1993). Nielson's method uses a small set of principles, guidelines, or heuristics that are systematically assessed against a target system in order to identify problems and their severity, as well consequences for the user. His guideline is suitable for any web application or websites.

These are ten general principles for user interface design. They are called "heuristics" because they are more in the nature of rules of thumb than specific usability guidelines (Nielsen, J. and Molich, R. 1990).

1. Visibility of system status

A website should always keep users informed about what is going on through appropriate feedback within reasonable time.

2. Match between system and the real world

The webpage should speak the language that users can understand, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

3. User control and freedom

Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

4. Consistency and standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

5. Error prevention

Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

6. Recognition rather than recall

Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

7. Flexibility and efficiency of use

Accelerators unseen by the novice user may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

8. Aesthetic and minimalist design

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

9. Help users recognize, diagnose, and recover from errors

Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

10. Help and documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

2.3.3 Graphical User Interface Design

User interface (UI) software is often large, complex and difficult to implement, debug, and modify. Graphical user interface meets the Jakob Nielsen's 10 usability heuristic as its second heuristic is to match between the system and real world. As interfaces become easier to use, they become harder to create (Myers, 1994). Today, direct manipulation interfaces or also called "GUIs" for Graphical User Interfaces are almost universal.

A graphical user interface (GUI) is a graphical display in one or more windows containing controls, called components, that enable a user to perform interactive tasks. The user of the GUI does not have to create a script or type commands at the command line to accomplish the tasks. Unlike coding programs to accomplish tasks, the user of a GUI need not understand the details of how the tasks are performed. GUI components can include menus, toolbars, push buttons, radio buttons, list boxes, and sliders. (MathWorks, n.d). It is a program interface that takes advantage of the computer's graphics capabilities to make the program easier to use. Well-designed graphical user interfaces can free the user from learning complex command languages. On the other hand, many users find that they work more effectively with a command-driven interface, especially if they already know the command language.

Graphical user interfaces, such as Microsoft Windows and the one used by the Apple Macintosh, feature the following basic components:

- **Pointer** : A symbol that appears on the display screen and that you move to select objects and commands. Usually, the pointer appears as a small angled arrow. Text -processing applications, however, use an I-beam pointer that is shaped like a capital I.
- **pointing device** : A device, such as a mouse or trackball, that enables you to select objects on the display screen.
- **Icons** : Small pictures that represent commands, files, or windows. By moving the pointer to the icon and pressing a mouse button, you can execute a command or convert the icon into a window. You can also move the icons around the display screen as if they were real objects on your desk.
- **Desktop** : The area on the display screen where icons are grouped is often referred to as the desktop because the icons are intended to represent real objects on a real desktop.
- **Windows**: You can divide the screen into different areas. In each window, you can run a different program or display a different file. You can move windows around the display screen, and change their shape and size at will.
- **Menus** : Most graphical user interfaces let you execute commands by selecting a choice from a menu.

2.3.3.1 Advantages of GUIs

A major advantage of GUIs is that they make computer operation more intuitive, and thus easier to learn and use. For example, it is much easier for a new user to move a file from one directory to another by dragging its icon with the mouse than by having to remember and type seemingly arcane commands to accomplish the same task.

Adding to this intuitiveness of operation is the fact that GUIs generally provide users with immediate, visual feedback about the effect of each action. For example, when a user deletes an icon representing a file, the icon immediately disappears, confirming that the file has been deleted (or at least sent to the trash can). This contrast with the situation for a CLI (Command Line Interface), in which the user types a delete command (inclusive of the name of the file to be deleted) but receives no automatic feedback indicating that the file has actually been removed.

In addition, GUIs allow users to take full advantage of the powerful multitasking (the ability for multiple programs and/or multiple instances of single programs to run simultaneously) capabilities of modern operating systems by allowing such multiple programs and/or instances to be displayed simultaneously. The result is a large increase in the flexibility of computer use and a consequent rise in user productivity.

But the GUI has become much more than a mere convenience. It has also become the standard in human-computer interaction, and it has influenced the work of a generation of computer users. Moreover, it has led to the development of new types of applications and entire new industries. An example is desktop publishing, which has revolutionized and partly wiped out the traditional printing and typesetting industry.

In addition to their visual components, graphical user interfaces also make it easier to move data from one application to another. A true GUI includes standard formats for representing text and graphics. Because the formats are well-defined, different programs that run under a common GUI can share data. This makes it possible, for example, to copy a graph created by a spreadsheet program into a document created by a word processor.

2.3.3.2 Interactive Dental Charting

The ability to provide a complete and reliable patient dental record is considered as a vital factor in the continuing efforts towards a more effective, patient centered dental care. Current dental practices, which make use of pictographic symbols and codes, differ among practicing dentists and these may lead to miscommunication and visual interactivity. During a typical dental check-up, a dentist verbally conveys the patient's teeth condition to an assistant who in turn updates the patient's dental card. Both the dentist and the assistant use a common pictographic symbols and codes to facilitate the dental data updates. In spite of the convenience, this paper-based recording imposes several major drawbacks namely miscommunication between the dentist and the assistant and lack of visual interactivity. The system proposed here is an interactive, visual dental charting system intended as an alternative means to the commonly practiced paper-based dental data capturing local dental clinics.

The rationale behind the design of the charting system lies on the interactive mapping between the dental charts and the patient dental records. It does not only offer quick-to-comprehend, user-friendly interfaces, but also reduces miscommunication between dentists and dental assistants. It will affect positively the accessibility, reliability and consistency of the patient dental data through interactive manipulation and query by the dentists.

In the current local dental practice, a patient has to complete the patient details form during his/her visit to the dental clinic. The front desk staff will store the details in the system and the patient will be given a unique registration number. A patient need to wait before his or her number is called upon. The patient will be assigned to a dentist (not necessarily the same one) for each visit unless prior appointment is made.