Smart Clinic: Health Smart Card System

By:

Saiful Adli Adam

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Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Information Technology Programme
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BACHELOR OF TECHNOLOGY (Hons)
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Approved by,

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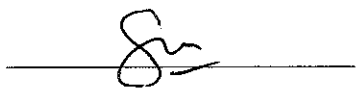
(Mr. Mohammad Noor Ibrahim)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
April 2004

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



SAIFUL ADLI ADAM

ABSTRACT

The project focuses on creating a new smart environment as an alternative to the current conventional health care system sign in and data access. The learning of current technology which is the smart card architecture is determined feasible to react with the difficulty stated as an answer. The current health care system is considered as inefficient as it consumes time and create annoying atmosphere especially in crowded health center. This could produce danger if there is an unexpected emergency case which requires immediate actions by both the patient and the doctors. The conventional health system requires the patient to fill in forms to be admitted in order to receive treatment and consulted by a doctor. The objective of this project is to conduct a study and find a solution to overcome this problem. Furthermore, the ease of usage for both the patients and the health system personnel must also be met. So, a smart card system implementation is proposed in order to overcome the problem stated and furthermore improve the situation in the current health care system. The project developed can reduce the admission time to a health care center, provide a better patient's information storing and data management coordination embedded with security features ensuring data safety and maintains its integrity. In order to develop the solutions proposed, a system engineering process is applied to get determined results. The Incremental Development model is chosen as its compatibility to the vital system discussed and strict processes that ensure the outcome produced is satisfying. Many attempts have been made to computerize the management of patient records using advanced computing and networking facilities across hospitals, clinics, and other health care center. Therefore, the author hopes that the system is a move towards realizing the smart environment health care system.

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The author admiration and gratification then goes to fellow coursemates supervised by Mr Mohammad Noor Ibrahim. Thank you also to Mr. Fairus Hariri and Mr Mohd Sofyan Arief Mahmud, for lending his thought, knowledge and experience regarding the smart card development.

To others who involve either direct or indirectly in this project, the author feels really grateful for everything. On the whole, a single page acknowledgement is absolutely not enough to show author's sincere gratefulness, love and respect to all of the people who has helped to accomplish the project.

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ABBREVIATIONS

GUI	– Graphical User Interface
HTML	– Hypertext Mark up Language
NSTP	– News Straits Times Publishing
eHealth	– electronic health
JCWS	– Java Card Web Servlet
eTrade	– electronic trade
OS	– Operating system
PIN	- Personal Identification Number
PC	- Personal Computer
MB	- Megabytes
RAM	- Random Access Memory
COM	- Communication
32k	- 32 kilobytes
SDK	- System Development Kit
IDE	- Integrated Development Environment
SQL	- Simple Query Language
OSS	- Open Source Software

CHAPTER 1
INTRODUCTION

1.0 INTRODUCTION

The current health system requires the patient to fill in paper forms before being consulted by the doctors or before receiving their treatment. This conventional protocol should be abolished and replaced by a better way of communication between both parties using the technology available to reduce transaction time between patients and the health care personnel for admission.

So, in order to create this smart environment we have to think of a system that could be applied to the current system without arising any complicated hassle. The smart card system which is now available worldwide is a wise solution to the problems faced by using computerized data exchange between the smart card holder and the online web based system proposed.

In addition, the system developed will create a better environment for us and a new image in providing services to both the patients and the health care system administrator in their everyday activities. This could be done as the proposed system is a computerized and uses electronic data exchange between both parties involved.

1.1 Background of Study

The project proposed consist in covering three main parts of study, which are the smart card architecture, database systems and web-based interface program. The graphical user interface (GUI) design is essential as well as programming skills to create a user-friendly application.

The smart card architecture is extracted from the System Development Kit used which is the Cyberflex Access Software Development Kit version 4.4 which comprises the smart card software, the smart card reader and the smart card itself. The tool used enables programming of the patient's smart card content and retrieving the information stored for further processing.

Meanwhile, the web-based interface program is developed using Macromedia Dreamweaver in creating the HTML (Hypertext Mark up Language) and the PHP server-side script. The usage of these programming languages allows the system to be available online for access throughout our country regardless of any location.

Finally, the database selected to power up the system is the MySQL database which is very suitable in online system and supporting communication of data transfer in large volume. Selection of this database is based on its impressive capability and ease of use that it offers.

1.2 Problem Statement

1.2.1 Problem Identification

Software systems are now practically used in everyday lives including hospitals and clinics which are frequented by most of us. The current problems identified are as follows;

i) The data entered and stored in the health system is inefficient in managing patients' information for reference and future usage. The process of entering the patient's file using papers and manually seeking for the file back is burdening the health care centre's personnel.

ii) Patients are required to fill in paper forms before submitted for receiving services and the information will be processed manually by the personnel. This requires a long information transaction time between both parties and mistakes and error rate is high.

iii) The data and information entered and stored to the current system are not secure enough in ensuring its security and integrity. This could harm the trust that the public gives towards the health care organizations.

1.2.2 Significant of the project

This project will serve as an intermediary between three parties, which are the smart card user, medical centre personnel, and computers interfacing with the web-based system. The application also can be assumed as an integration of the existing MyKad system where the usage of smart card can be seen as an effective way of confidential information communication.

Moreover, the system will be a tool in helping in producing efficient data management and also reducing data redundancy for easier data administration. Patient's information storage and retrieval for future reference became much easier using the computerized system. The elimination of paper usage also will create healthier and improved environment to our world. This reduces the data transaction time between the patient's and the health care personnel and furthermore reduces the risk of data entry error and basic human mistakes.

1.3 Objective and Scope of the Study

1.3.1 The relevancy of the project

The underlying principle in developing this project is to create an effective transaction system for the current health center rather that continuing with the current conventional system available. The system should be able to reduce the transaction period, create a paperless environment and provide efficient data management. Besides that the smart card architecture also will be learned as the project progressed towards completion. The objectives targeted for the system developed are as follows;

i) To identify and find solutions possible in problems faced in current health information system.

ii) To create an efficient data management system for the patients health information.

iii) To embed security features to health information access and storage to the system developed.

iv) To produce a system which are compatible to the current system and applicable throughout our health system.

1.3.2 Feasibility of the Project within the Scope and Time Frame

The project is done on going for 14 weeks which are approximately 3 months in this particular semester. The project Gantt chart draft is included as an attachment in the appendix section (Appendix A) showing the entire schedule from doing preliminary research up to presentation to the respective personnel.

The scope could be divided into 2 sub-scopes which are the research analysis phase and the system development phase. The research analysis phase includes doing observation, data gathering, problem definition and theoretical framework. This phase is more focused on study of the current health system, and investigating the problem faced and finding solutions to these problems.

Meanwhile, the second phase of the scope which is the system development phase is towards developing the solutions to the problems that concurrently occurred in the existing system. The objectives stated also must be achieved to ensure that the project is successful.

The area scope focused in this project is only on the interaction part between the client which is the user with the server which is the web based online system and the communication between the server with the storage database as shown in Figure 1.1.

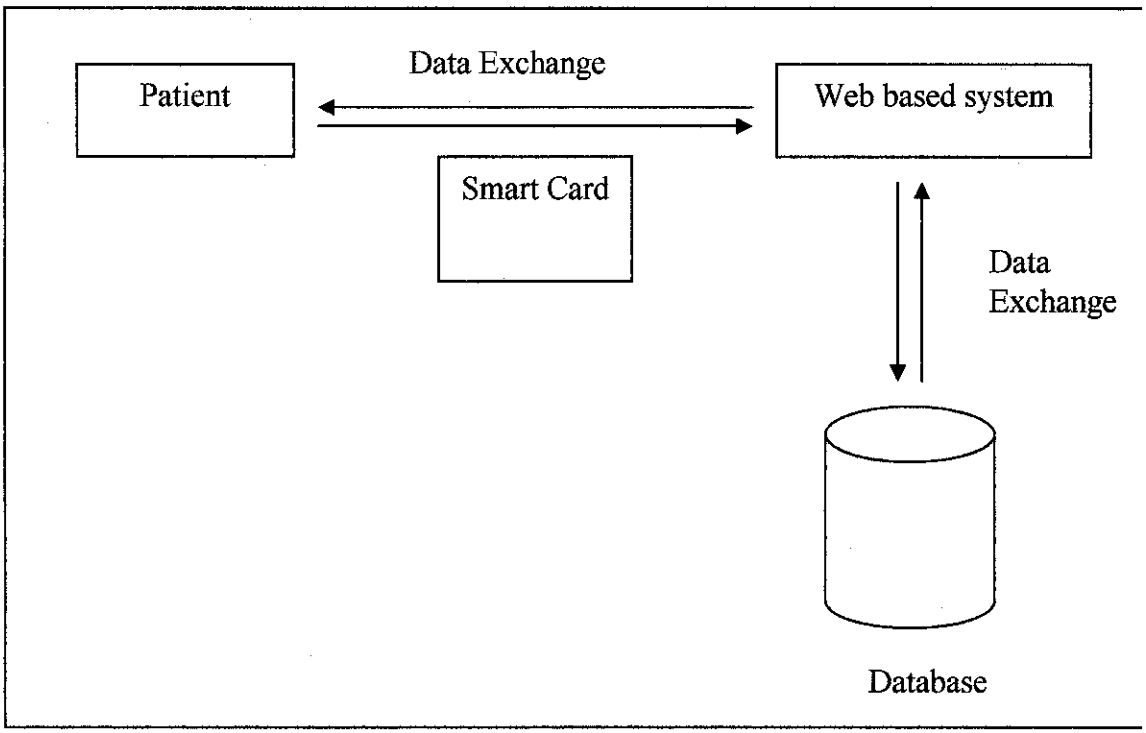

Figure 1.1 Fundamental layout of Smart Clinic system

CHAPTER 2
LITERATURE REVIEW AND THEORY

2.1 Current Health System Weakness

Patients' information is very essential in saving lives and mistakes should be avoided in ensuring their effectiveness. Liang (2004) stated that individuals entering the health delivery system endure significant risk of encountering medical error and, potentially, avoidable injury. Examining the systems nature of medical error can result in true improvements in health care delivery. Medicine and law should reflect this reality, so that no one will suffer the tragedy of harm that could have been avoided through previous error reporting, discussion, and correction.

According to American Medical Student Association's website (2004), erasing people's negative, and often inacurate, perceptions of a single-payer health care system may prove to be difficult. Long lines, inefficient bureaucracy, limited choice, and sub-standard health care are just a few of the erroneus beliefs hat would need to be changed. This statement clearly describes the weaknesses of the current health system generally.

Refering to the statistics given by EconEdLink (2004), stated that with over 40 million people in the United States without health care and many others dissatisfied with health care service. This shows that the current health system is not satisfying the needs of the global populatio as a whole.

Another statement that supports the fact that current health care system is failing; The health care delivery system is poorly organized to meet the challenges at hand,. The delivery of care often is overly complex and uncoordinated, requiring steps and patient "handoffs" that slow down care and de-crease rather than improve safety. These cumbersome processes waste re-sources; leave unaccountable voids in coverage; lead to loss of information.(Richardson, 2001)

The importance of a patient's health information management had been an issue for a long time ago. According to Health Data Management website; The inability to track a patient over time and across myriad providers and payers is a fundamental weakness of the industry. And the problem is growing more acute as the implementations of clinical information systems increase because most clinical systems have their own embedded master patient indexes.

An interconnected information system is in need to the current health data management. This statement shows that patients' information should be managed as it is an important issue. Although the problems and needs of critically ill neonates and their medical records are unique, most of their issues apply to other longitudinal care settings. Changes in patient status and in patient care must be recorded in an accurately and promptly. (Carroll, 2000)

2.2 Smart Card as a Solution

As Kohl (1995) observes, providing anywhere, anytime, anyplace access to patient medical records remains unrealized in this age of increasing mobility within the global economy. Envisaging a brave new (technological) world of eHealth brings with it consideration of privacy, confidentiality and security. The statement is very clear in promoting the usage of a smart card system in replacing the current conventional health system.

Even our very own leader had seen the future of the usage of smart card. According to NSTP e-media website (2004) our ex-Prime Minister Tun Dr Mahathir Mohamad, said all new-born babies will be provided with MyKad, a lifelong identification document and a personal database. He also added that this was being done in tandem with the Government's intention to widen the use of information and communications technology.

The statistics also supports the usage of smart card worldwide and the prospect of it. According to Howstuffworks website; Smart cards are much more popular in Europe than in the United States. In Europe, the health insurance and banking industries use smart cards extensively. Every German citizen has a smart card for health insurance. Even though smart cards have been around in their modern form for at least a decade, they are just starting to take off in the United States.

Smart card promotes mobility to the owner's information itself. Lambrinoudakis (2000) is very definite:" The evolving smart card technology can be utilized for the implementation of a secure portable electronic medical record, carried by the patient herself/himself".

The advantages of smart card usage in health system are very encouraging. "The emergence of smart card technology is recognized as a potential solution to manage a patient's medical records effectively and accurately. Medical records contained within the card can be augmented to include multimedia rich information such as scanned images and voice recordings, to facilitate rapid diagnosis of a patient's possible symptoms and problems. In short, a smart card provides the rich benefits of storing a comprehensive, accurate, and up-to-date medical history of a patient, while its pocket size offers easy mobility" (Chan, 2001a)

The usage of a smart card system provides cost reduction in long term duration and make ease for the health system personnel. Raghupathi (2002) points that smart card, besides granting ready access to data warehouses full of patient-care and

insurance records, as well as critical medical information, they help management cut costs and remote physicians work collaboratively. (Please refer Figure 2.1)

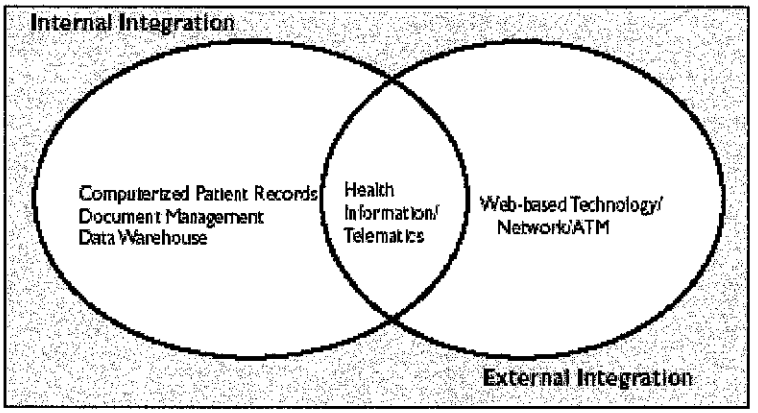

Figure 2.1 External and Internal Integration

"A smart card is a portable computer. Usually it has the shape and size of a credit card. A smart card can be made physically tamper-resistant. Therefore, it can be used as a highly secure storage for all kind of confidential information, such as secret keys. Security and portability are two reasons to use smart cards"(Hansmann, 2000) The statement shows that the portability of the smart card with security features embedded together promoting information security and integrity.

The applicability and acceptance of smart card is very clear. According to Fulcher (2002); In their coverage of smart card applications, Shelfer & Procaccion (2002) cover authentication, authorization and transaction processing. They discuss eHealth in the context of authorization, citing that over 80 million smart cards are currently within use in the German healthcare system. Shelfer & Procaccion advocate using smart cards to automate and standardize patient demographic information contained within medical records. The ability to store both text- and image-based medical records is seen as a further advantage to be gained from using smart cards.

For making the proposed online system a reality, the basic concepts have been developed. This statement supports it; While a smart card can leverage on the rich services available for online operation, the requirement for offline access and

management of medical records is vital in the event of an emergency or unavailability of network access. The JCWS (Java Card Web Servlet) framework is designed to support both offline and online operation of smart card information access. (Chan, 2001b) (Please refer Figure 2.2, Figure 2.3, Figure 2.4 and Figure 2.5)

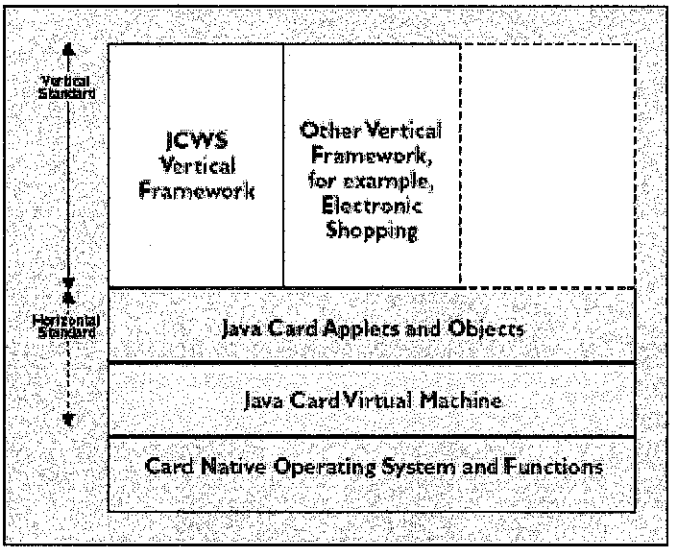

Figure 2.2 Horizontal and Vertical Standards

The Figure 2.2 shows the layer involved in a Java smart card architecture system and the wide overview that it covers.

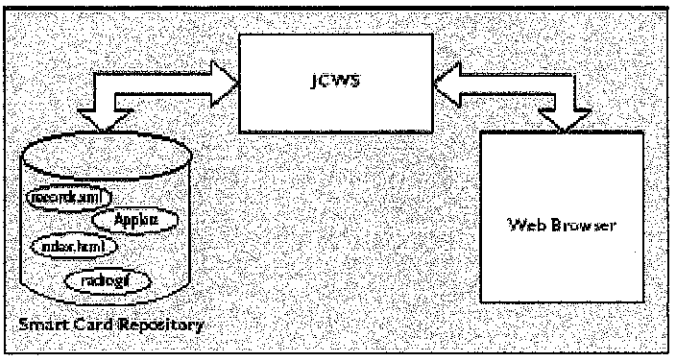

Figure 2.3 Interface between Smart Card and Web Browser

The proposed system will adopt this framework shown in Figure 2.3 which could be derived directly into realizing it in reality.

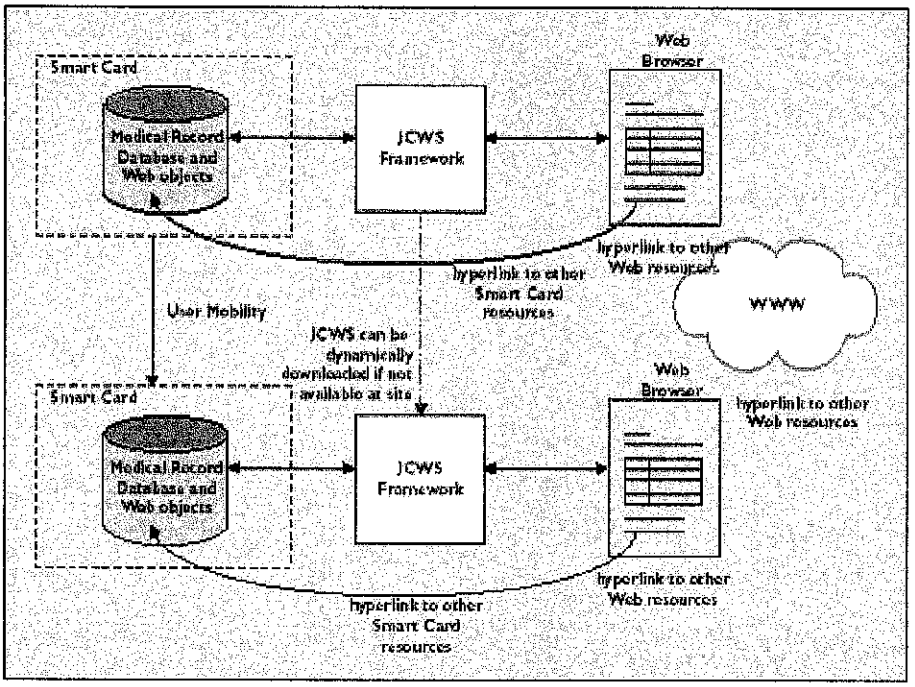

Figure 2.4 JCWS Concept

The concept diagram in Figure 2.4 shows the data flow and entities involved in the JCWS framewok.

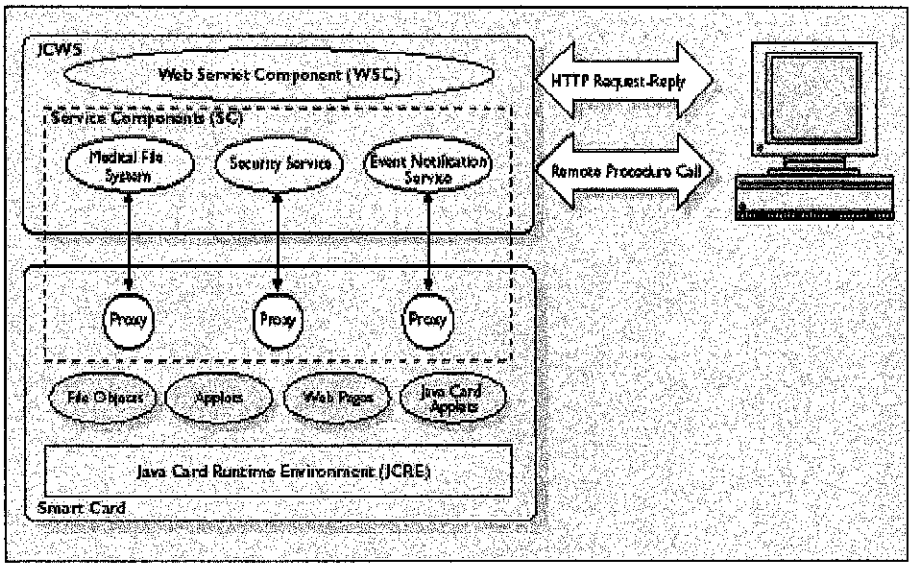

Figure 2.5 JCWS Architecture

The architecture of JCWS and the component involved beneath it is clearly shown in the Figure 2.5 above.

To implement an online system, security features are very important which are available in a smart card. From the Smartex website; The Internet, in particular, is focussing the need for online identification and authentication between parties who cannot otherwise know or trust each other, and smart cards - coupled with effective cardholder verification techniques - are believed to be the most efficient and portable way of enabling the new world of e-trade.

The technology needed to implement the proposed smart card system is already available in the market. According to Axalto Cyberflex Homepage (2003); Axalto provides leading-edge technology to enable innovative smart card and terminal applications that enhance the security and convenience of businesses and communities of all kinds. The company provides cards, terminals, development tools and support in open configurations for operators, developers, integrators and distributors worldwide.

From the statements stated above, assumption can be made that this project will be a succesful one. Initially, people might find it hard to use the system, this is where user-friendliness of the system plays it roles to make the smart card could be accepted by the society.

CHAPTER 3
METHODOLOGY

3.0 METHODOLOGY

In order to develop the proposed system, we have to have a guideline in ensuring that the project flows to the targeted objectives. Therefore a suitable system development life cycle for the designated project must be chosen. The compatibility of the methodology and the project should also be taken into consideration.

3.1 Procedure Identification

There are three main components that build the whole system which are the database, smart card selection and its interface need to be developed within the period of completing the project. So, the most suitable methodology in developing the system is using the Incremental Development model. (Please refer Figure 3.1)

The first step is the smart card architecture learning process. Basically, the smart card will have connection with the card reader, its driver and programming language. The compatibility of the smart card with different types of Operating system and other application programs also must be analyzed.

Next would be drafting and designing the Guided User Interface for the system which is the Internet Explorer web browser. In this case, the usage of Java Applet is necessary to integrate the smart card with the web browser as one system.

Finally is creating the database system. As the system will be web based, the setup of database on the server is essential. Verification of the smart card will also be done by the server to ensure data security and integrity.

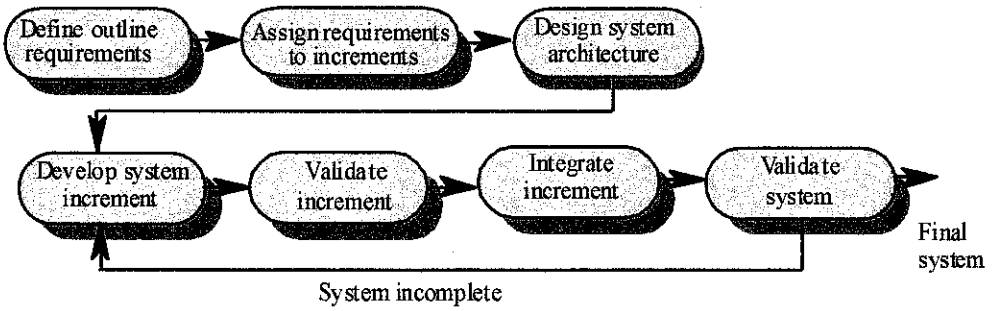

Figure 3.1 Incremental Development Model

3.1.1 Define Outline Requirements

This is where the requirements are specified after analyzing data gathered about the system. Possible alternatives of solution are listed out in order to fulfil the project objectives.

3.1.2 Assign Requirements to Increments

In this process, the requirements defined are assigned according to its parts of the system. This is because the system is actually consisted by several main vital parts as a whole.

3.1.3 Design System Architecture

This phase requires proper actions taken to ensure that the requirements and objectives are achieved. There could be several choices resulted form this process and the best selection is picked.

3.1.4 Develop System Increment

As the system consist of several essential parts, each of it should be developed individually first. For each part, the duration of development could differ from each other.

3.1.5 Validate Increment

The resulted increment products are validated whether it fulfils the targeted specification defined or not. Testing is the best way in order to confirm whether the increment is validated.

3.1.6 Integrate Increment

In this stage, the validated parts of the system are combined with each other in order to build the complete system. Compatibility of the different parts of the system are essential to achieve good integration.

3.1.7 Validate System

The parts of the system which are combined together is validated and its inter-operatibility are tested to ensure it is running according to the requirements and objectives defined.

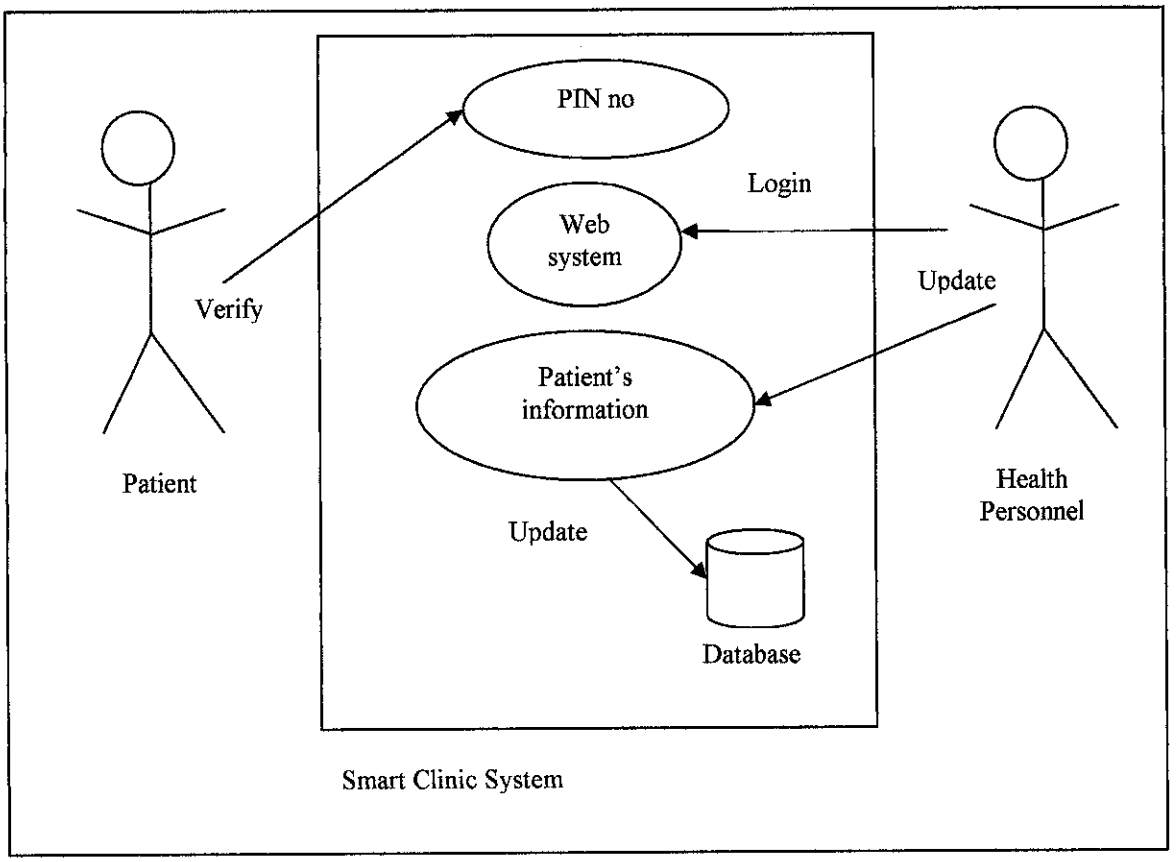

Figure 3.2 Use-Case Diagram for the system

The above Figure 3.2 shows the Use-Case Diagram for the Smart Clinic System project developed. The interaction involved is very simple and does not involved complex transaction between the actors concerned.

3.2 Tools Required

3.2.1 Hardware

a) Personal computer; An IBM-compatible personal computer (PC) that has a Pentium-class processor with at least 64 MB of RAM and approximately 75 MB of available hard drive space if all components will be installed (the exact amount of hard drive space needed varies somewhat by operating system).

b) Reflex Lite Java Smart card reader; RS-232 COM port and a PS/2 keyboard or mouse input port, which the reader shares with the host system's keyboard or mouse through a special connector included with the kit.

c) Cyberflex Access 32k Java Smart card; With Cyberflex Access cards functions available includes create card applets, download card applets to the card, and create an instance of an applet to interact with and test.

3.2.2 Software

a) Operating System supported;

- Microsoft Windows 98 (Second Edition)
- Windows Me
- Windows NT 4.0 (Service Pack 6)
- Windows 2000 (Service Pack 3)
- Windows XP Professional (Service Pack 1)

b) Macromedia Dreamweaver; the solution for professional Web site design and production by visually designing and managing Web sites and pages. Dreamweaver includes many coding tools and features: an HTML, CSS, and JavaScript reference, a JavaScript Debugger, and code editors (the Code view and Code inspector) that allow you to edit JavaScript, XML, and other text documents directly in Dreamweaver.

c) PHP supported Website Server; enables PHP which is a server-side scripting language that is embedded into HTML pages. The pages are preprocessed by the server and the script code executed before the server sends the HTML to the browser.

d) MySQL Database Server; Enabling add, access, and process data stored in a computer database, the author needs a database management system such as MySQL Server. Since computers are very good at handling large amounts of data, database

management systems play a central role in computing, as stand-alone utilities or as parts of other applications.

e) Cyberlex Access SDK 4.4 Java Smart Card Kit; enables building smart card-enabled PC applications for SchlumbergerSema's multi-function Java-progammable and cryptographic smart cards. The Cyberflex Access SDK's middleware implementation libraries and suite of tools offer support for:

- configuring cards for cryptographic services
- developing and dynamically loading Java applets
- integrating custom PC applications
- using smart card-enabled security applications—digital signature generation and verification, authentication, and encryption/decryption

CHAPTER 4
RESULTS AND DISCUSSIONS

4.0 RESULTS AND DISCUSSIONS

This is the most crucial part in the project where all research and the outcome are presented in this section. As the target is to solve the problem stated, the results must meet the requirement of the designated users to fulfil their expectation of the system. All methodology applied within the timeframe of this project should get accurate result.

4.1 Findings

4.1.1 Cyberflex Access Software Development Kit

Smart cards can serve as interactive databases for storing current account information, personal data, and monetary value. Smart cards are ideal for secure Internet access, purchases, portable digital telephones, benefit programs, and health care programs. These values make the smart card a perfect solution for our dilemma in the current health management system.

The solution will continue by implementing the prototype application using Cyberflex Access Software Development Kit. The kit comprises of the smart card, smart card reader and the development software. Cyberflex Access cards support card programs and card applets which are written in compliance with Java Card 2.1.1 standard.

The Cyberflex Access Software Development Kit enables user to build smart card-enabled PC applications for multi-function Java-programmable and cryptographic smart cards. It has the ability to perform various applications such as configuring cards for cryptographic services, developing and dynamically loading Java applets, integrating custom PC applications and enabling smart card security application by using digital signature generation and verification, authentication and encryption or decryption.

The author found that the SDK have been very helpful to develop the smart card system proposed as it provides the user with the tools needed and shows several samples for more clear view of the capability of the smart card. This security features for the smart card are embedded together in the SDK for example the application to set the PIN number.

4.1.2 Java and Cyberflex Access Cards

The Java environment offers these benefits for Cyberflex Access card program developers:

- A standard programming language - Anyone who knows how to write a Java program can write a smart card program and load it onto a card.
- Security - Java's inherent security features are well known
- Multiple programs and applet instances on a card - The Cyberflex Access SDK architecture and Java Card security features make it possible for multiple applets to coexist on a card, each one secure from interference from the others.
- Full integration with mainstream Java IDEs - Cyberflex Access SDK software integrates with most Java integration development environments to provide easy access to the tools you need.
- Benefits of object-oriented programming - Benefits from the code reuse, design patterns, and superior structure that are object-oriented programming features.

- Platform and vendor independence - Java Card programs are portable across different chip architectures, so card programs are cost-efficient to develop and maintain. Java Card 2.1.1 programs designed for Open Platform smart cards run on a wide range of cards and terminals, which are vendor-independent.

The usage of Java language in the project development by the author resulted in easier programming and debugging process as it is a high level language. Furthermore, the object oriented concept used by the language gives advantages especially in the security perspective.

4.1.3 Java Environment Integrity and Security

The integrity and security of the Java environment are widely recognized. The following features provide program and data integrity and protection from malicious programs:

- Java compilers provide extensive, stringent error checking when the program is compiled. All references to methods and variables are checked to make sure that the objects are of the same type. The compiler also checks to ensure that a program does not access any uninitialized variables.
- All access to methods and instance variables in a Java class file is through access modifiers. These modifiers define a level of access control for each method. Declaration of a method can be public, protected, or private. If no declaration is made, the default allows the method to be accessed by any class in the same package.
- Basic Java types and operations are well defined. All primitive types have a specific size, and all operations are performed in a designated order.
- Malicious programs cannot forge pointers to memory because no pointers are accessible to programmers or users.
- Java accesses variables only through references from the Java stack. Malicious programs are prevented from snooping around in the Java heap because the

values of the local variables are unavailable after every method invocation. A method has access only to the resources it should access.

Java programming language has provided security features stated briefly before this. This essential factor is a need in the system to ensure data and information security and integrity.

4.1.4 MySQL

The MySQL software delivers a very fast, multi-threaded, multi-user, and robust SQL (Structured Query Language) database server. MySQL Server is intended for mission-critical, heavy-load production systems as well as for embedding into mass-deployed software. The advantages of MySQL usage includes;

- Speed; In an Database Management System, speed which are the time it takes to execute a query and return the results to the caller are essential. Even MySQL's most ardent critics will admit that MySQL is zippy, sometimes orders of magnitude faster than its competition. Benchmarks available on the MySQL web site show that MySQL outperforms almost every other database currently available, including commercial counterparts like Microsoft SQL Server 2000 and IBM DB2.
- Reliability; Most of the time, high database performance comes at a price meaning low reliability but it is not true with MySQL. The system is designed to offer maximum reliability and uptime, and it has been tested and certified for use in high-volume, mission-critical applications. MySQL's large user base assists in rapidly locating and resolving bugs and in testing the software in a variety of environments; this proactive approach has resulted in software that is virtually bug-free. Further, every new release of MySQL has to pass both MySQL's in-house test suite, which tests each feature and also contains test cases for previously-fixed bugs, and MySQL's crash-me tool, whose primary goal is to evaluate the system's capabilities by pushing it up to and beyond its limits.

- Ease of Use; MySQL is so easy to use that even a novice can pick up the basics in a few hours, and the software is well-supported by a detailed manual, a large number of free online tutorials, a knowledgeable developer community, and a fair number of books. While most interaction with the MySQL server takes place through a command-line interface, a number of graphical tools, both browser-based and otherwise, are also available to simplify the task of managing and administering the MySQL database server. Finally, unlike its proprietary counterparts, which have literally hundreds of adjustable parameters, MySQL is fairly easy to tune and optimize for even the most demanding applications.
- Multi-User Support; MySQL is a full multi-user system, which means that multiple clients can access and use one (or more) MySQL database(s) simultaneously; this is of particular significance during development of web-based applications, which are required to support simultaneous connections by multiple remote clients. MySQL also includes a powerful and flexible privilege system that allows administrators to protect access to sensitive data using a combination of user- and host-based authentication schemes.
- Scalability; MySQL can handle extremely large and complex databases without excessive performance drop. Tables of several gigabytes containing hundreds of thousands of records are not uncommon, and the MySQL web site itself claims to use databases containing 50 million records. In eWEEK magazine benchmark cited on the MySQL web site, MySQL scaled efficiently at loads from 50 to 1000 simultaneous users, with performance dropping only marginally once the 600-user limit had been crossed.
- Portability; MySQL is available for both UNIX and non-UNIX operating systems, including Linux, Solaris, FreeBSD, OS/2, MacOS, and Windows 95, 98, Me, 2000, XP, and NT. It runs on a range of architectures, including Intel x86, Alpha, SPARC, PowerPC, and IA64, and it supports many hardware configurations, from low-end 386s to high-end Pentium machines and IBM zSeries mainframes.

- Compliance with Existing Standards; MySQL's development team has attempted to make MySQL as standards-compliant as possible. MySQL 4.0 supports most of the important features of the ANSI SQL-99 standard, with support expected to grow in future versions. Additionally, MySQL extends the ANSI standard with custom extensions, functions, and data types designed to improve portability and provide users with enhanced functionality.

The author found out that the usage of MySQL as the database for the system gives a lot of advantages. The database uses very simple but high level query message for sending and receiving data from the user. Nevertheless, the MySQL is recognized for its capability in serving online system and supports access of huge volume of data impressing the author completely.

4.1.5 PHP

PHP which stands for Personal Home Page is an OSS (Open Source Software), like Linux, and is available for Windows and UNIX. PHP is a server-side scripting language that is embedded into HTML (Hypertext Mark-up Language) pages. The pages are preprocessed by the server and the script code executed before the server sends the HTML to the browser. This is the same idea as Microsoft's ASP technology functionality, however PHP is probably more portable. PHP provides a very convenient way of handling forms. PHP also supports a massive number of databases, including MySQL, Informix, Oracle, Sybase, Solid, and PostgreSQL as well as the ODBC. PHP also supports XML, PNG and PDF file format. It enables user to access directories, read and write files on the server, send mail and even upload files to the server. (Please refer Figure 4.1)

The service provided by the usage of the server side script embedded in the system gives more secure data transaction for example for the login web page that requires the user to enter login name and password to enter the web portal.

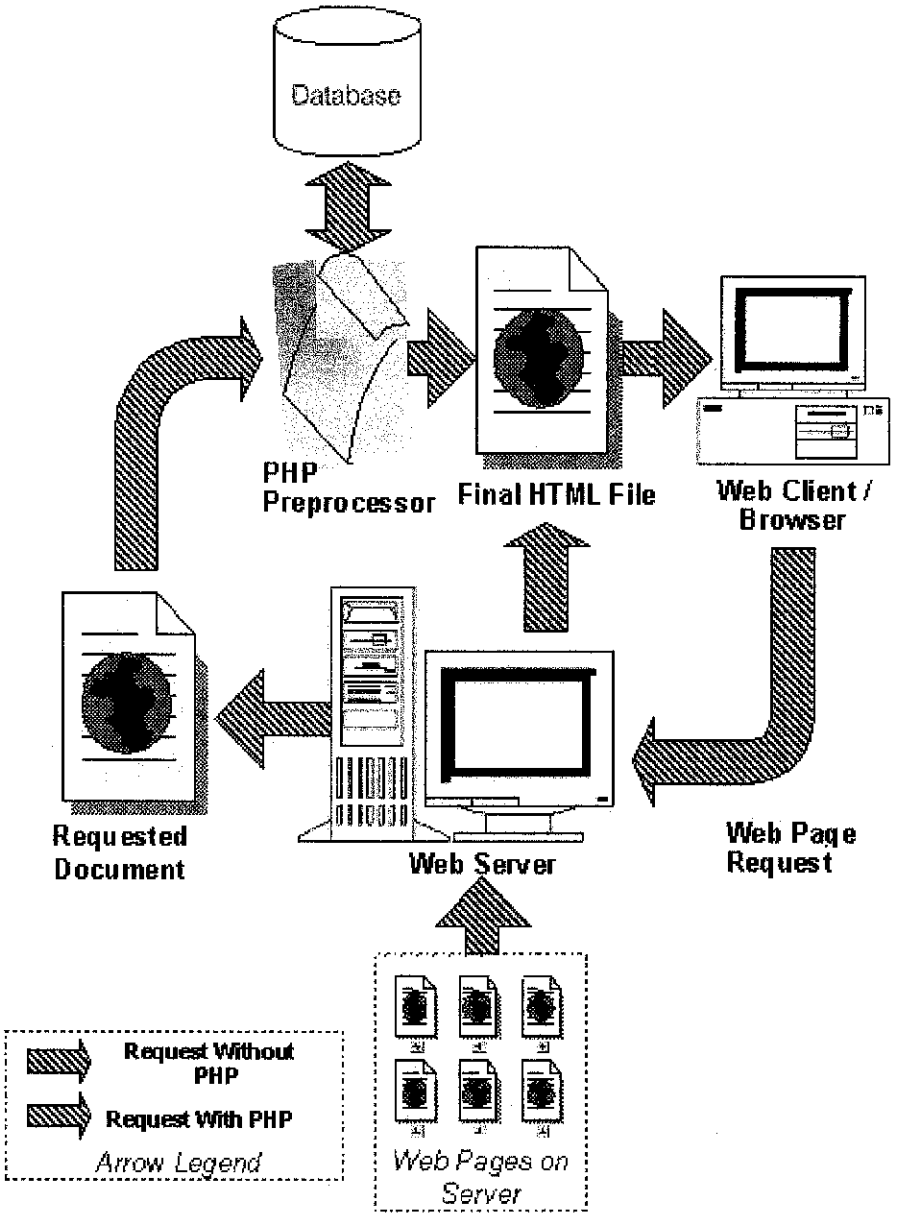

Figure 4.1 PHP data flow diagram

The figure 4.1 shown above illustrates on how the PHP server side script functions. The feature provides security on the data transferred from the server to the clients.

4.2 Discussion

4.2.1 Data Management

As a result from developing this system the data management for personal health file information became more organized and efficient. The web based system enable access without any complex hassle dealing and creating a paperless environment. Meanwhile, the centralized database system ensures data integrity and easy administration.

4.2.2 Security

For security purposes, the Patient Smart Card must be designed in a write-protected mode by assigning a Personal Identification Number known only by the patient. This is to ensure unauthorized persons would be unable to retrieve or write any information on the card. The patient's file also should not be given authority to access by any other personnel except the authorized doctors or people with exact qualifications by requiring login and password from the user to the web based system.

4.2.3 Accessibility

Regardless to any geographical factors, the web based system enables authorized users to access the system worldwide. It only requires the basic smart card reader with its kit and an Internet connection to create a new gateway for this online system.

4.2.4 MyKad Influence

To cope with our country's vision in creating a smart e-governance nation, the system is considered as an integration of the MyKad system. At the mean time, only the Personal Identity Card and the License part of the system have been implemented to our citizens. So, as an addition to this intelligent information storage the Smart Clinic system is possible to be applied in reality.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.0 CONCLUSIONS AND RECOMMENDATIONS

This project is considered a success since it achieves the objectives stated and solves the problems defined earlier. Furthermore, the system designed actually could give more advantages compared to the current health system. However, as the project developed is only a prototype there are more upgrades and enhancements possible to be conducted in the future.

5.1 Conclusion

The project developed is considered as a success as all the objectives targeted have been achieved and the problem stated earlier have been overcome with this solution implemented.

Firstly, the project is conducted to study and identify solutions possible to the present health system. The alternatives to this traditional system became very clear as the smart card implementation is a wise choice.

Then, data management became more versatile by implementing a centralized database interconnected by the World Wide Web using a web based interfacing system. This benefits both the patients and health centre personnel.

After that, security features applied ensures that only authorized person could access the smart card and the interfacing system which are connected to the database that contains vital information.

Lastly, the system proposed complies with reality as the technology required is already available and the necessary tools and software needed are at the minimum in terms of resource, cost and time.

5.2 Suggested Future Work for Expansion and Continuation

There are many possible enhanced upgrades for the system which could be done in order to refine the project developed. Encryption of data submitted throughout the system could be made to further secure the transaction between the users and the system itself.

The usage of middleware interfaces is also recommended to help in direct communication between the smart card programs with the web based interfacing system. This function is actually supported but it is not possible currently as the development kit used is for only development purposes only.

For the database part, the usage of a more stable one like Oracle is suggested as its capability to support large volume of data and more convenient information storage. It also could support distributed database system especially in mass data accumulation.

Finally, to wrap up the whole project, the author hopes that the project meets the objectives and successfully satisfying the requirements. The experience and knowledge received throughout conducting the project will be a tremendous foundation for future working atmosphere. Definitely, the understanding and skills gained will be applied in every day's life.

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APPENDIX A: PROJECT TIMELINE/ GANTT CHART

NAME : Ssiful Adli Adam
ID : 1418
TITLE : Smart Clinic: Health Smart Card System

NO	DETAIL/WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic	■													
			■	■											
2	Preliminary Research Work														
3	Submission of Preliminary Report			■											
4	Project Work				■	■	■	■							
5	Submission of Progress Report							■							
6	Project Work Continue								■	■	■	■			
7	Submission of Dissertation Final Draft												■		
8	Oral Presentation													■	