Conceptualizing Medical Application Software for Managing Electronic Health Records (EHR) and Cash Flow Management in Private Clinics

Azim Izzuddin Muhamad, Mohamad Rahimi Mohamad Rosman, Mohammad Ikram Ramzi, and Mohd Idzwan Mohd Salleh

***Abstract*— The growth of Information and Communication Technology (ICT) has certainly contribute to the better record management practice, especially in dealing with electronic record. Most major industry has shifted from paper record into electronic record as this kind of records were more reliable, accurate, cost-saving, and robust. This paper describe the development of medical software know as EHRIS (Electronic Health Record Information System). This system was develop using Microsoft Visual Studio 2008 as it main platform, with Microsoft Access as it database. Its include modules such as patient information, payment tracking, billing, medicine and supply, and QMS (Queuing Management System). It's suitable for small and large clinic, easy to installed and user-friendly. It's adopting the concept of EHR (Electronic Health Record) and refers to a systematic collection of electronic health information about individual patients or populations. This study undertakes the concept of System Development Life Cycle (SDLC) using the waterfall model.**

***Index Terms*—Electronic health record, electronic record, record management, cash flow reporting, and hybrid system.**

I. Introduction

Medical record management has evolved for centuries and the concepts of the electronic medical record and electronic recordkeeping are quickly becoming the major trends in any kind of information management. EHRIS which stands for Electronic Health Record Information System discussed about the conversion of a record system from manual recordkeeping into electronic recordkeeping through the development and implementation of Database Management System. EHRIS is intended to solve the problems of patient' registration and monitor a financial record (cash flow) in clinic so that the staff can manage the recordkeeping and the clinic can able to manage the activity of cash inflow and outflow. The system is developed because a poor recordkeeping in clinic. Through the research team observation, many clinics still use the traditional method in keeping the patient record such as paper card and diskette. These kinds of record storage practice are not practical because it needs a lot of spaces, and a lot of time in searching for a specific record. Moreover there is also probability for duplication and missing of patient record. Besides that, the systems also capable to record and monitor the cash flow so that the management can easily manage and monitor the cash inflow and outflow. Through this they can see the daily and monthly transaction performance of the clinic.

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II. Objectives

The objectives of this paper are:

1) To increase the profitability of clinic through cutting their costs and increase the quality and quantity of public services.
2) To achieve the best possible support of patient record and administration in clinic by electronic data processing.
3) To provide a green environment solutions by reducing less paper in a organization
4) EHRIS supports the major activities such as patient records, scheduling, administration, and billing.
5) The clinic can reduce the space through this system.
6) To see the performance of the clinic through the cash flow reporting.

III. Literature Review

Information system is a crucial aspect of human daily activities and slowly replacing the manual process. The conversion from manual recordkeeping to electronic recordkeeping through the development and implementation of Database Management System has improved the management of data and information. In January 2007, Sergio S. Furuie et al mentioned that the proper patient care should take into consideration that information in order to check for incompatibilities, avoid unnecessary exams, and get relevant clinical history. Their work describes the experience in the effort to develop a functional and comprehensive electronic patient record (EPR), which includes laboratory exams, images (static, dynamic, and three dimensional), clinical reports, documents, and even real-time vital signals [1].

MA Morales, S Dalmiani, C Carpeggiani [2] stated that a huge amount of information, administrative, clinical and instrumental, has to be handled every day for patient care. In their system a computerized method has been developed in their Institute able to track the patient from administrative admission up to discharge. The system use of JAVA language, with its multiplatform capabilities, allows extensive installation in the clinical environment and full integration with other subsystems. At present 4600 cardiological outpatients have been treated by their system with substantial clinical achievements, time saving, and a better follow up organization.

Title "Web-Based Medical Information Systems" discussed on architectures for delivering medical information on the Internet. Sub-second response times are crucial for the users to accept web-based medical information systems. For web-based medical information systems to be widely accepted, secure access to confidential medical data is a critical pre-requisite. Their paper provides an insight into security architecture for web-based medical information systems [3].

According to Andreas Holzinger et al [4], he emphasized the importance of computer-based methods in medical documentation and the automatization of clinical processes, including analyzing diagnoses. In their paper, they developed a methodology for text mining in medical text corpora and implemented a tool to evaluate their idea. The outcome of the calculations showed valuable results although based on a relatively low number of sentences. Observing all the diagnoses, generated in a hospital daily, will definitely improve the diagnostic value.

Zhelong Wang [5] invented a handheld wireless medical information system which uses PDAs and is based on Windows Mobile operating system. The paper firstly introduces a variety of wireless LAN technology, handheld devices and their operating systems. Then, it is described that the structure of the proposed wireless medical information system based on Windows Mobile, including its components and design methodology. The initial test of the wireless medical information system has been carried out in the laboratory environment and the test result shows that the system is reliable, efficient and secure.

Lastly, Axel Boldt And Michael Janich [6] on their research title "A Global Physician-Oriented Medical Information System" said that they propose an Internet-based, free, world-wide, centralized medical information system with two main target groups practicing physicians and medical researchers. After acquiring patients' consent, medical histories, physiological data and symptoms or disorders into the system an integrated expert system can then assist in diagnosis and statistical software provides a list of the most promising treatment options and medications, tailored to the patient.

Records management is referred as "the application of systematic and scientific control to all of the recorded information that an organization needs to do business" [7]. This definition is expanded by Ricks, Swafford and Gow [8] who stated that records management is "a function that provides for the systematic control of records from creation, or receipt, through their processing, distribution, organization, storage and retrieve to their ultimate disposition." Another definition highlighted by the Australian Standard is "the discipline and organizational function of managing records to meet operational business needs, accountability requirements and community expectations" [9].

IV. Methodology

The development of EHRIS is based on the traditional system development life cycle (SDLC) using Waterfall Model. This model describes 5 basic phases which involved planning, analyzing, design, implementation and maintenance phases. Fig 1 below shows the Waterfall model [10]

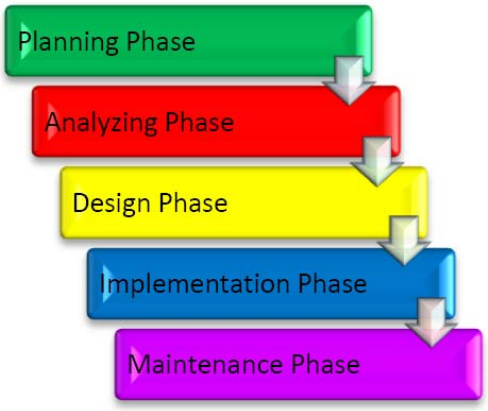

Fig. 1. System development life cycle of EHRIS using waterfall model. [10]

A. Development

The EHRIS system is developed using the integration of Microsoft Visual Studio 2008 and PHP: Hypertext PreProcessor programming language. Most of the system core modules is resides within the executable program while other additional modules is resides within the web based program.

B. System Infrastructure

System infrastructure is the basic, underlying framework or features of a system or organization. It can be divided into two categories, which are software and hardware. For the EHRIS project, there will be two layer of access, which are Ethernet (using Visual Studio 2008) and Online (using PHP programming).

The Fig 2 below shows the basic infrastructure for EHRIS. The process started from Front Desk staff who will register a new patient. The patient information will be retrieve using their respective MyKad. The data is automatically updated and display in doctor personal page. The patient will meet the doctor based on their registration number for that day. Then the process is carried out by the doctor who will diagnose the patient and update the patient record. The record will then move to pharmacy module whereby the front desk staff will issue a medicine based on doctor instructions and payment will be received from the patient. Moreover, patient can also check their medical record using web based module through Internet connection. The transaction record will be stored in EHRIS database and executed on an Apache Web server. EHRIS can be utilized through a web browser such as Internet Explorer or Mozilla Firefox.

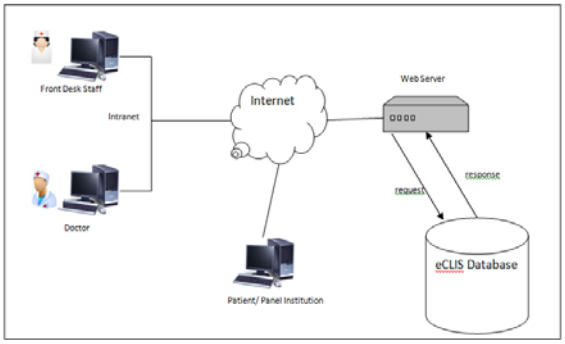

Fig. 2. The EHRIS system infrastructure system requirements.

C. System Infrastructure

The EHRIS can be run using Microsoft Windows operating system. There are two selection of web server that can be used, either Internet Information Services (IIS) or Apache Web server. The programming language that is used is Visual Studio 2008, PHP programming language and Java. The database is made up from Microsoft Access 2003. Table below describe the minimum and maximum requirement to run the EHRIS system. The advantages of the infrastructure are that it allows room for software improvement or modification while maintaining and retaining daily activities. Update to the server can be installing without disrupting business activities. Furthermore it could also reduce costs of supporting and providing services to the patients by using web technologies. Table 1 below shows the minimum and maximum requirements of EHRIS system.

TABLE I: MINIMUM AND MAXIMUM REQUIREMENT FOR EHRIS

Minimum Requirement	Maximum Requirement
Operating System: Windows XP Processor: Intel® Core™2 Extreme Processor 3.2 Ghz Memory: 2GB Storage: 20 GB Sata Hard drive Web Server: IIS/Apache	Operating System: Windows 7 Ultimate Processor: Intel® Core™ i7 processor 1.86 Ghz Memory: 4GB Storage: 120 GB Sata Hard drive Web Server: IIS/Apache

D. EHRIS Modules

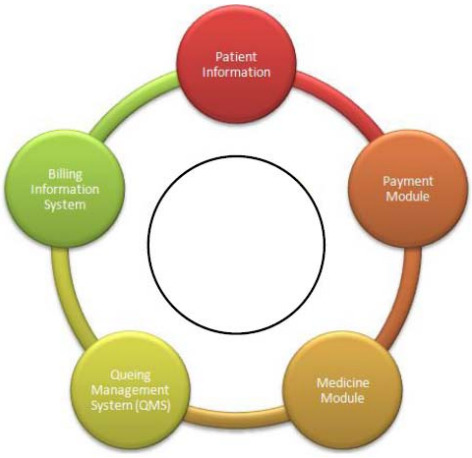

Fig. 3. List of modules of EHRIS.

Fig 3 above shows the lists of module available in EHRIS. Basically there are five (5) main modules, which are patient information, payment module, medicine module, queuing management system (QMS), and billing information system. Patient Information Module Patient information module in Fig 4 above is used to record and register patient information. This module will interface with MyKad Reader and patient information will be retrieved using the MyKad. This process speed up the information retrieval and at the same moment enhance the organization goodwill as customer will certainly satisfied with less waiting time. Moreover the module can automatically calculated number of patients and prevent favouritism as the principle of "first come, first serve".

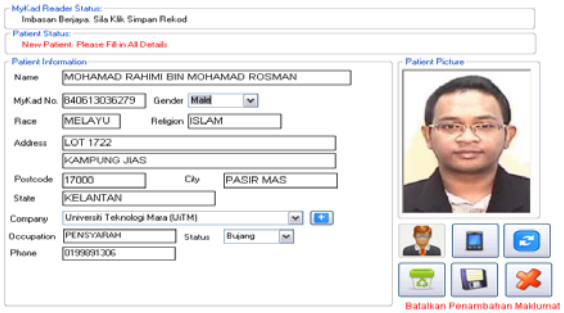

Fig. 4. Example of patient information module.

E. Payment Module

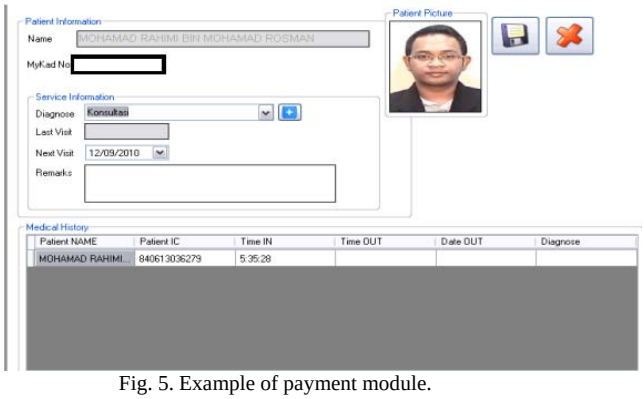

Fig. 5. Example of payment module.

Payment module in the Fig 5 is used to record payment received from patients. The record will be used to generate statistic on income and cash flow movement.

F. Medicine Module

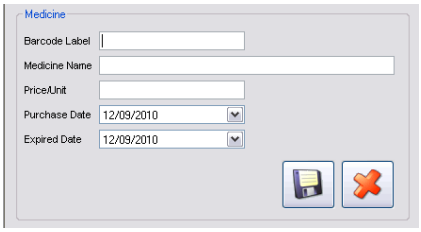

Fig. 6. Example of medicine module.

Medicine module in the Fig 6 above is used to enter new data regarding a medicine and as an inventory control mechanism whereby the front desk staff can monitor the stock.

G. Queuing Management System (QMS) Module

QMS module in the Fig 7 above is used to ensure that patient will be called based on their registration number and it can avoid misunderstanding and dissatisfaction among patient.

H. Billing Module

Billing information system module in the Fig 8 below is used to produce receipt to customer. Each medicine will be scanned using a barcode scanner and the price of the medicine will be automatically key-in into the system.

Black box testing approach is used to check user acceptance toward the information system. Black-box testing tests the functionality of an application as opposed to its internal structures or workings. In this type of testing no specific

knowledge of the application code and programming knowledge were required. The programmer only aware of what the software is supposed to do, but not how it does it. [11]

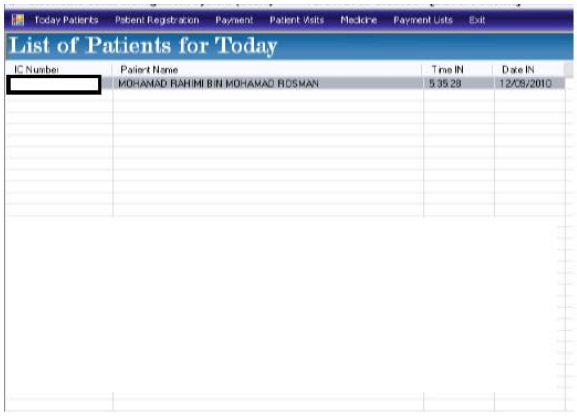

Fig. 7. Example of queuing management systen module.

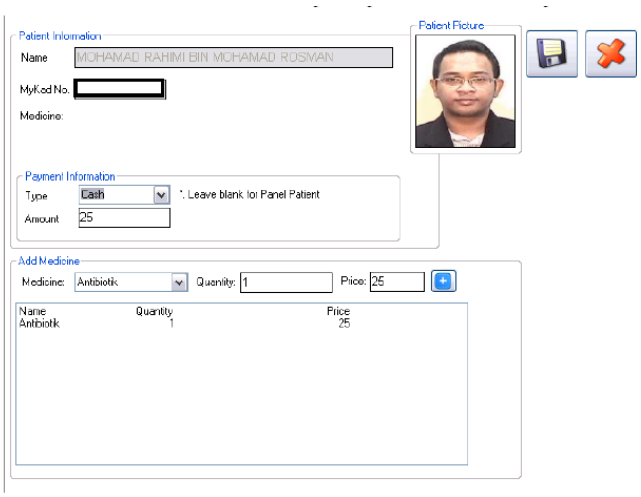

Fig. 8. Example of billing module.

V. Result

The outcome of the development process is the final product of EHRIS, in which the system can be accessed either by using executable file or web based information system. The system is capable to monitor and record patient information, queuing management, cash flow reporting, and inventory control.

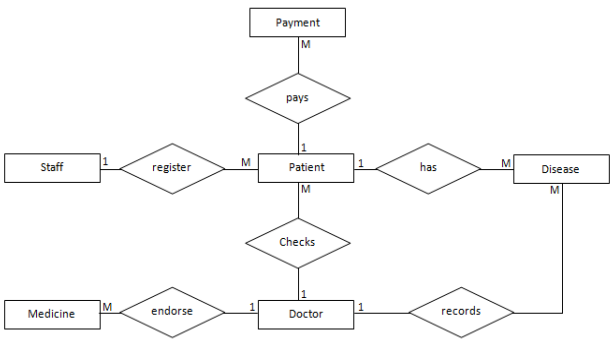

Fig. 9. Entity relationship diagram (ERD) for EHRIS.

Fig 9 show the ERD for EHRIS information system. Main entity consists of STAFF, MEDICINE, PATIENT, DOCTOR, DISEASE, and PAYMENT. STAFF can register many PATIENTS. PATIENT can have many DISEASES. DISEASE can be recorded by DOCTOR. DOCTOR can check many PATIENTS. One PATIENT can have many PAYMENT records as prove of transaction.

VI. Conclusion and Recommendation

Medical record is an essential part of our life and it's a wise decision to used the application of Information and Communication Technology (ICT) to record and monitor the medical record as long as proper mechanism is taken to protect those information from be steal. EHRIS is a project undertaken to solve the problem of improper medical record management practice and at the same time help the clinic to systematically manage their daily operation using an information system. It can't be denied that information system is a compulsory in record management practice. The main problem in managing medical record is that to create a centralized database which can be used by relevant partners. There are much issued that must be address because medical information is a sensitive information and it must be protected. There must be a mechanism and specific practice that can be implemented in creating a centralized medical record database. Moreover, in order to prevent unauthorized access to confidential information, a good security mechanism should be applied to protect those records.

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