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AN ASSESSMENT OF MEDICAL INFORMATICS IN FIJIAN PUBLIC HOSPITALS

by

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A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science

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February 2016
Statement of Originality

I, Swaran Sanadhika Ravindra, declare that this thesis titled, “An Assessment of Medical Informatics in Fijian Public Hospitals” and the work presented in it are my own. I confirm that:

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Dr. Dhenesh Subramanian Date

I, Dr. Dhenesh Subramanian, hereby certify that this thesis is the original work of the student.

Dr. Dhenesh Subramanian Date
Glossary of Terms

Australian Agency for International Development (AusAID) – is an Australian agency that manages development and assistance projects internationally. AusAID has recently been absorbed into the Australian Department of Foreign Affairs and Trade [1].

Biomedical Informatics – is the field of science that develops theories, techniques, methods pertaining to the use data, information and knowledge which support and improve biomedical research, human health, and the delivery of healthcare services [2].

Cloud Computing- refers to Information Technology services leased to a person or organization over internet network according to service level requirements. It requires minimal management effort or service provider interaction [3]

e-Health- an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered through the Internet and related technologies [4].

Electronic Medical Record (EMR)- An electronic medical record (EMR) is a digital version of a patient’s medical history [5]

Health Informatics - The field of information science pertaining to the management of healthcare data and information by the application of computer related technologies [2].

Open Source Software (OSS)- refers to software whose codes are available to be modified as per the users’ needs [6]

OpenEMR- is an open source medical practice management application which features a fully integrated EMR system with other features such as scheduling, electronic billing, free support, with the ability to work across different platforms [7].

World Health Organisation (WHO)- is a specialised United Nations agency whose primary role is to direct and coordinate international health within the United Nations’ system [8].
Abstract

Health Information Systems (HIS) have proven benefits in the areas of patient and hospital information management. However, the successful implementation and use of HIS continues to be a challenge in Fiji and other developing countries. The aim of this thesis is to study the current information systems in Fijian Government Hospitals and evaluate the proposed alternative open source solution which can be used in smartphones. In this study, the requirements for web based Electronic Medical Records (EMR) systems was assessed by studying the current state of HIS in Fijian government hospitals. The medical practitioners and general public were surveyed and interviewed to understand the current state of HIS in government hospitals in Fiji. Majority of the practitioners responded favourably to the introduction of web based EMR systems. They also want to use mobile applications for accessing their EMR system. The people of Fiji have responded favourably to the introduction of an online portal for their appointments and reports that can be accessed through smartphones.

The study has found that there are inconsistent information management practices and inadequate supply of computers in government hospitals throughout Fiji. A comparison made between the existing PATIS Plus EMR with an open source alternative suggests that open source options, can provide a more versatile, interoperable and free alternative to the Fijian Government. They can also be extended to hand held devices, however, successful implementation would require business process re-engineering, training and commitment at all levels.
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Chapter 1  

Introduction

1.1 Introduction

According to the last census report, the population in Fiji is currently 837,271 [9]. Fiji has 200 government health centers and hospitals which have 550 general practitioners all around Fiji. However, according to Fiji Medical Practitioners Association, the current Patient to Medical Practitioner rate is at an alarming 1:1522. The extreme shortage of medical professionals in Fiji [10] calls for the application of appropriate information technology solutions as an immediate need. One of the ways of solving this problem could be providing IT support since the automation of manual procedures can make work less cumbersome [11] by promoting better information management and less human errors, especially in the medical field [12]. With tedious work being automated by technology, the limited staff in a hospital can focus more on better diagnosis, decision making and patient care.

Out of the 200 government hospitals and health centers, only 36 are live with the current PATIS Plus system. However, it has been found that most health faculties follow manual information systems practices [13]. While there are a few computers in the main hospitals, the rural areas still have no infrastructure to have computerized information systems. Most computers are old and need upgrading in order to use any computerised Health Information Systems [10].

Patients who visit the emergency department of any hospital need to be treated as soon as possible. However, they lose precious time while waiting to be served [14], especially when procedures are all manual. Such delays can lead to deaths [15, 16]. While mortality rates in Fijian hospitals have decreased over the years[17, 18], it is possible that electronic medical records have the potential for better clinical decisions making which may assist in decreased wait time in hospitals [19]. An open source EMR has the potential to significantly improve quality of care particularly in developing nations such as Fiji.
Despite having a few health information systems in place, most government health centers and hospitals in Fiji operate manually [13]. The current HIS, PATIS Plus was donated to Ministry of Health by AusAID, however, the current maintenance, future development, and necessary human resource has not been funded by AusAID [20]. Most reports generated by the current HIS, PATIS Plus, may not reflect reliable statistics as this depends on the accuracy and timeliness of data entry which is a challenge due to shortage of staff and lack of computers in most centers [21]. According to a nationwide survey on government hospital systems, it was found that most health centers and hospitals in Fiji have been following inconsistent work methods in terms of information management [13]. Some patients use their National Health Card while some have never owned one. Nausori Health Center was used as a case study to observe current practices and then the results were later compared with practices in other government health centers in Fiji.

Open Source EMRs have benefited many developing countries in that it assists them in adapting with a much lower cost as compared to commercial solutions. Another success factor is the inclusion of all important stakeholders to design a viable system [22]. With the extension of such open source products on mobile tools on m-Health, such as Android based applications, home based care becomes easier in developing countries where it is difficult for patients to pay for costs of hospital bills [23]. Due to such benefits, government hospitals in particular benefit from adapting free and open source health information systems. One such country is Mexico where an open source solution, Veterans Health Information Systems and Technology Architecture (VistA)\(^1\) was successfully implemented across 40 large hospitals that served more than 30 million patients [24]. EMR systems have proven to be effective in clinical decision making especially in emergencies in countries where resources are scarce [25].

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\(^1\) Veterans Health Information Systems and Technology Architecture (VistA) is noncommercial health information software that was developed by the US Government’s Veterans Health Administration used in USA
There is scarcity of research in the area of cloud computing for paperless hospitals, particularly in developing countries. Many developing countries such as Malaysia have started to explore the use of EMRs to provide a complete paperless solution in their hospitals, however, a major contributing factor in the success of such systems depend on the careful adaption of the right framework for deployment [26]. In Taiwan, frameworks such as TOE (Technology-Organization-Environment) framework and HOT-fit (Human-Organization-Technology fit) were used to ascertain if cloud computing would be a viable solution for medical informatics in the country [27]. Cloud computing solutions has been successfully used to host main servers in a more developed country to control medical systems in an underdeveloped country such as Honduras [28]. Cloud based systems enable integration of smart phones applications which can assist patients by engaging them in self-care to manage chronic illnesses at home. Studies have proven m-Health is effective in proactively involving patients in preventative initiatives for non-communicable diseases with interventions such as weight management alerts [29] and smoking cessation [30]. The people of rural as well as developed areas in China have benefitted with healthcare provided through cloud computing [31]. According to a study in India, a major issue in successful diagnosis and treatment in the rural areas of developing countries, is the illiteracy of the patients [32]. A cloud based system provides a paperless, distributed platform that makes patient records accessible at any location, anytime. This assists physicians in making faster clinical decisions, without the need for patients to keep repeating their predicaments. This becomes particularly helpful where the patient may not be very literate as the information systems assists them with bio data and other records.

1.2 Motivation

In Fiji, some of the major limitations which impedes the progress of medical and health informatics is the lack of funding and studies in those areas, particularly in the government hospitals. Fiji’s 2015 health budget has seen some substantial improvement in allocation of funds for public health. In the previous years, it had been much lower as compared to developed countries [33]. The funding allocated to Ministry of Health in Fiji is distributed to many aspects of the ministry and its facilities
This includes investment in much needed areas such as improved pay for staff, upgrade of hospitals and health centers for specialised treatments. Therefore an EMR system could help hospitals in better managing resources with limited funds that could be allocated in the budget [25].

The motivation of this study is to find possible ways which can improve the management of information in the Fijian Government Hospitals, and potentially be a contributor to improved wait time amongst other contributors like better customer service. These are some common concerns in hospitals in developing countries [35]. Patients currently have to wait for weeks to get medical reports while practitioners have to go through tedious work procedures rather than concentrating on dealing with their patients more efficiently [36]. An online portal allows patients to easily make appointments and saves them from repeating their condition to all staff they meet. This is particularly helpful in cases where patients face stigma for their conditions, such as sufferers of sexually transmitted diseases, which is on the rise in the pacific [37]. We hope that after considering this study, strategies are developed and solutions are implemented that will assist citizens of Fiji in having better services in terms of information systems in government hospitals.

1.3 Research Goals

The aim of this thesis is to study the current information systems in Fijian Government Hospitals and evaluate the proposed alternative open source solutions which can be used in smartphones over a cloud infrastructure. The objectives are:

1. To study the current state of health information systems and EMR in various Fijian government hospitals, using Nausori Health Centre as a case study
2. To assess the requirements (health practitioners and general public) for web based electronic medical records system.
3. To find open source software alternatives for electronic medical records for Fijian government hospitals by comparing the exiting PATIS Plus system
1.4 Thesis Outline

The outline of this thesis is as follows:

- **Chapter 1** presents the main introduction, motivation, goals and overall outline of this thesis.
- **Chapter 2** provides background on the case study and literature review on EMRs, HIS, Mobile Healthcare on Cloud infrastructure for developing countries, Open Source for developing countries and Fiji, and Mobile applications for EMR in Fiji.
- **Chapter 3** describes the methodological approach used for this study. It discusses how qualitative research, grounded theory, surveys, random sampling, interviews and observational studies were used to do this study.
- **Chapter 4** presents the case study on Nausori Health Center, HIS and PATIS Plus in Fiji, modules of PATIS Plus, results from the surveys, feedback from interviews, and a comparison of PATIS Plus with a proposed open source solution (OpenEMR).
- **Chapter 5** discusses HIS in Fiji, web based EMR and OpenEMR on Cloud.
- **Chapter 6** provides conclusion, points known prior to the study, contributions of this study and future research directions.
Chapter 2   Background and Literature Review

This thesis explores various options in open source EMR software for government hospitals that can be used on a cloud based infrastructure with mobile application, in any part of Fiji. Firstly, it investigated use of information systems in Fijian government hospitals. Then it explored if the people of Fiji would think if it would benefit the health care system in Fiji. Surveys were done to determine if mobile applications would be useful for patients for improved healthcare in Fiji. The results showed that most of the survey participants (government health workers and patients) would like to use a mobile application on cloud infrastructure for accessing their EMR system.

Background

This chapter discusses the use of EMRs in developing nations. It also discusses points to consider to ensure successful implementation.

2.1 Electronic Medical Records in Developing Nations

Electronic medical record systems are known to provide significant benefits [38] [39] [40] to hospitals. It can reduce the provisions for errors that are found in manual operations [41]. It promotes a paperless, environmentally friendly organisation which improves the communication of information amongst medical professionals [42] [43]. In situations which call for critical decision making, EMRs help by allowing timely access to patient records for easier decision making [40] even if the expertise of overseas based specialists may be required [44]. EMRs can significantly reduce errors, eliminate ambiguities caused by illegibility [45] and make billing much easier while creating a data repository for future research and quality improvement [46]. Essentially, a good EMR system can ensure that continuity of care is maintained.
EMR systems subsequently assist the organisation [39] [40] by providing significant benefits to hospitals and health centers. However, the implementation and adaption of EMR has a higher possibility of success when the users of the EMR are directly involved in the discussion for its design and implementation [47]. Many developing countries such as Kenya, Haiti and India have benefited with the intervention of EMR systems which provides efficiency, accuracy, and overall cost benefits [48].

The benefits of an effective EMR system depends heavily in its successful implementation. For EMR implementation to be successful, developing countries need to be equipped with essential resources such as human resource, finance, computers, training, computer literacy, adequate infrastructure and careful tactical and strategic planning [49].

It is important to consider notable challenges of EMRs, such as investment into technology and its upkeep, transition time, privacy and security issues [40, 50]. Some practitioners find it far easier to scribble notes on a paper [51] and update the computer system later rather than doing real time data entry. They feel it is time consuming and it takes away the human factor while communicating with their patients [52-54]. However, one study suggests that the time a practitioner spends on entering data in the EMR can actually give time to their patient to think of any queries that they may have. This can be seen as a positive effect of EMRs [55].

2.2 Challenges in Implementation of EMRs

Since healthcare facilities are complex and interdependent [56], work flow and methods need to be carefully mapped to the EMR system or the implementation and success of the system can prove challenging [57]. It has been found that there is a lack of research in design strategies for EMR systems in developing countries [56]. Some notable challenges in developing countries, are the general lack of understanding and promotion of HIS, the lack of resources such as infrastructure, finance, technology, trained workforce and the resistance of technology seen in medical professionals [58].
2.3 Benefits of Electronic Medical Records

EMR systems, with inclusion of patients through access to individual personal health records, improves quality of health care given to individuals, reduce cost of health care in a country, and also engage individuals in their own health care [59], both in private practice as well as their adaption at a national level [60]. Benefits of computerized Information Systems for the information needs of the healthcare system are countless, particularly in developing countries [61]. Implementing e-Health in developing countries showed significant improvement in ability to track patients, monitor adherence of patients to the treatment regime, and keep track of those who do not follow up their treatments and appointments [48]. The time consumed in communication significantly drops due to use of e-Health. It is important to note the difference between e-Health and EMR. e-Health is the transfer of health resources and health care by electronic means [62] whereas an EMR contains the standard medical and clinical data gathered in one provider’s office [63]. Essentially, e-Health has the capability to extend the uses of an EMR system by sharing it electronically. EMR systems help developing countries by effectively facilitating data collection, data entry, information retrieval, report generation and research [61]. Real-time application of EMR contributes towards effective clinical decision support [19], process automation with the potential to improve the quality of patient care and significantly reduce costs [64]. The use of touch screen systems and hand held devices such as personal digital assistants integrated with EMR systems are quite helpful in a developing nation like Malawi, both in emergency medicine and field work such as collecting data for initiatives in proactive public health programs for such as Human Immunodeficiency Virus Awareness (HIV) programs [65]. The use of mobile applications and telecare in hospitals improves health status of patients, quality of care, reduces cost, and overall increased satisfaction of patients by allowing them to have access to knowledge about their health and their overall disease management [66, 67].
2.4 Health Informatics in Developing Nations

*Health Informatics*, used synonymously with the term *Biomedical Informatics*, is an emerging field of information science relating to management of general healthcare data and information by utilising computers and other technologies [2]. Health Informatics is a relatively new field that is currently being explored in the South Pacific region. In fact a major motivation for this study was the fact that there are very few studies done in this area in the developing nations of the South Pacific region. There is predominant evidence that HISs have significantly improved quality of care in developing nations [38]. Having a good health information system also assists developing nations by monitoring national outbreaks of diseases and better reporting of notifiable diseases for national statistics [68].

Health Information Systems in developing nations have the capability of improving quality and safety of healthcare at reduced costs, as long as the healthcare systems are developed with consideration of the local languages, training needs and knowledgeable workforce for deployment and maintenance of the systems [69].

While there are many of benefits for healthcare settings, the successful implementation of health information systems (HIS) continues to be a challenge in many developing countries. Some of these challenges include 1) human barriers such as belief systems, behaviors and attitudes, 2) professional barriers related to the nature of healthcare jobs, 3) technical barriers related to the use of computers, 4) organizational barriers such as the hospital management, 5) financial barriers related to funding, 6) and legal and regulatory barriers [58]. Political issues and conflict of interest amongst medical professionals are other barriers particularly in developing countries. The World Health Organization identifies financial constraints and lack of technical expertise as barriers to health information systems in developing countries [70].
2.5 Mobile Healthcare using Cloud Computing in Developing Nations

Cloud based Mobile technology has changed the face of healthcare all over the world, especially in the developing nations [71]. Non-communicable diseases are on the rise in the pacific. However with mobile technology available easily, it can be used by patients in self-management of chronic illnesses in the pacific and developed countries [28]. Technology giants such as IBM are already hosting cloud services in developing countries such as India, China, Vietnam, Brazil and South Korea. Therefore, healthcare on cloud seems promising in developing countries [72]. There has been studies based on the use of online health resources such as MEDLINE, CINAHL, (nursing & allied health), Evidence Based Medicine (EBM), POPLINE, BIOSIS, and Web of Science, AIDSearch (MEDLINE AIDS/HIV Subset, AIDSTRIALS & AIDSDRUGS) databases that are accessed through mobile phone. Results indicate that mobile healthcare can be promising in developing countries as it allows multidirectional communication platforms, however potential security issues needs to be addressed and protected by policies [73]. m-Health technologies have the potential to improve healthcare in developing countries where non-communicable diseases, chronic diseases and other notifiable diseases are on the rise as it allows a much economical platform. Such a platform allows patients to use their mobile phones for disease management through social networking, web surfing, electronic mailing list, web based learning and web based data entry [74]. Many such applications were found useful as interventions in management of HIV/AIDS in countries such as India, South Africa and Kenya [75].

2.6 Open Source EMRs for Developing Countries

While many software solutions come with expensive price tags, there are many options that are available as free and open source software. Open source software are those software whose codes are available freely to be modified, customized or enhanced by anyone who is interested in doing so [6]. One such software that been successfully implemented in developing countries is OpenEMR [76] [77]. According to Source
Forge, the world’s largest open source software repository, OpenEMR is the most commonly downloaded and used open source solution to Health Informatics today [78].

Open Source solutions have been successful in developing countries such as Africa in that it comes at no cost and can allow practitioners to work at up to double the efficiency as compared to working in a paper based environment [25]. OpenEMR² is being used actively in countries such as Pakistan [76], Malaysia, Kenya [79], Nepal, Indonesia, India [80] and also adopted by US Peace Corps in the nations where they are exist [81]. Open source software (OSS) solutions for EMR systems are being widely tested and adopted across the world since it provides users the liberty to customize the codes of the software freely, so as to provide hospitals and health care facilities the ability to efficiently reduce medical errors [82], improve quality of care and have less tedious work methods [83].

Open source products have both benefits and challenges. The key factors for success for OSS include users, the ability to change language settings and delegation of responsibilities [84] and adequate training [85]. Benefits of OSS in healthcare include reduced maintenance cost, support from OSS community, shared development cost, no risk of vendor failure or discontinuation of product [86].

The study evaluates the strengths and limitations of the current patient information systems software (PATIS Plus) in Fiji over a free open source software solution called OpenEMR. It also explores the possibility of using mobile application for the proposed system on cloud infrastructure.

### 2.7 Using Open Source for EMR in Fiji

*Free and Open Source Software* (FOSS) refers to software that is licensed to freely uses, copy, and change in any way by altering software code [87].

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Open source software has the potential to be highly cost effective and versatile solution for health information systems [86]. Governments, who play a major role in healthcare bills, have an interest in open source software adaption to transform their healthcare systems [88]. Open source software in health gives freedom from license restrictions and gives other benefits such as the flexibility and interoperability though openness where the users do not need to make “vendor specific choices” [89]. Open source software encourages innovation by making it easier for users to modify, customize and re-use the source code for enterprise use [88]. Open source software can be adapted to meet the specific needs of any HIS such as patient care, proactive management of disease outbreaks, learning, and research and administration tasks, such as inventory, human resource and operations.

OpenEMR is released and licensed under GNU General Public License³, and is ONC Complete Ambulatory EHR Certified⁴. It features a fully integrated EMR system, practice management, scheduling, electronic billing, internationalization and free support from a vibrant community of users. It can run on Windows, Linux, Mac OS X, and many other platforms [90].

Free open source software that is used to computerize any health center or hospital can be successful if they are rated high in matrices such as clarity, simplicity, extensibility and documentation [91]. The study reviewed five major free and open source software solutions, out of which OpenEMR has seen to have many benefits such as ease of use due to user friendly interface. It is also continuously developed by an active community of developers and has the prestigious HIPAA certification [86].

A significant benefit of OpenEMR is that not only can it be used in small clinics, but it is also adaptable to be used by medical officers as well as health centers and hospitals. It has most of the functionalities of health/hospital information systems, such as EMR systems, customer (patient) relationship management, human resource

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³ The **GNU General Public License** is the most widely used free software license, which guarantees end users (individuals, organizations, companies) the freedoms to use, study, share (copy), and modify the software.

⁴ The **Office of the National Coordinator** for Health Information Technology - a US based standards body that certifies that electronic medical record systems are complying with standards
management, medical billings, clinical decision rules and prescriptions in one simple user friendly solution. Moreover, it caters for the information needs of family medicine and primary care physicians, with a strong emphasis on having a proactive approach towards health, by including modules on social-economic variables such as education, housing and substance abuse. Therefore, its use is not only limited to the medical centers, primary care facilities and small hospitals, but it can also be used by nongovernmental organizations. Such flexibility allows a collaborative, nation-wide, holistic approach involving the government, non-government organisations, as well as private hospitals. Such benefits make Open source EMR a viable solution of Fiji.

2.8 Mobile Applications for EMR in Fiji

OpenEMR can be used in conjunction with state of the art hardware devices that can support tools for mobile health such as iPADs and Tablets. It can provide real time data for the hospital staff to access. For the patients, it has modules that will not only assist with treatment, but also with preventative health management. Popular open source EMR systems such as OpenEMR can also be extended to be used in smart phones and tablets for eHealth purposes, which can be used by medical practitioners at any site [36]. Due to such reasons, open source EMR systems are being widely adapted throughout the world. In the case of electronic medical records, OpenEMR is known to be popular and effective free and open source solution to support developing countries [92]. Such a solution can be very useful in Fiji, since a significant population live on outer islands, which have small health centers. The medical staff will find such mobility highly useful, especially in emergency cases.

5 iPADs are tablet computers made by Apple Inc.
2.9 The Use of Cloud Computing for Healthcare in Developing Countries

There are three major delivery modes of cloud computing, which are SaaS (Software as a Service- for lease of business-related computer programs), IaaS (Infrastructure as a Service- for lease of fast and almost unlimited processing capabilities and large and almost unlimited storage facilities) and PaaS(Platform as a Service- for lease of development tools and hosting options for clients preferring to create and manage their own Web applications) [93].

Cloud computing technology provides a scalable and effective solution to support EMR infrastructures with multiple platforms in hospitals [94]. Such platforms can allow common mobile operating systems such as android to work in multiple locations. Cloud technology is a viable solution for developing countries as hardware technology is relatively expensive to purchase and maintain in most developing countries [95]. Having EMR on cloud in Fiji will significantly reduce the cost of hardware resources and also allow physicians, patients and health researchers to collaborate from any location. A wireless approach would be particularly helpful in remote areas of Fiji where there are just small health centers instead of a fully serviced hospital [31] [96].
Chapter 3  Methodology

3.1 The Use of Qualitative Research

Qualitative research methods have been used in research for medical informatics [97] as it allows for greater understanding of behaviours and thoughts of people. This assists in gauging information needed to build better systems for use, where results may be more descriptive in nature [98]. It is mainly used in areas where there is little or no understanding of what can be found, therefore, discoveries may be novel [99]. Qualitative research consists of gathering relevant information through techniques such as analysing documents, taking interviews, observing, in natural settings, where the hypothesis is formed during the study [100]. Qualitative approaches are better suited to understand hospital environments and user acceptability of health information systems amongst the hospital staff [101] [102]. Similar studies done in hospitals have proven that qualitative studies are highly effective in understanding the use of EMRs in doctors’ practice, particularly in emergency situations [52]. Qualitative studies have also been used to understand patients perceptions regarding health information systems in hospitals for report and appointment purposes [97].

3.2 Application of Grounded Theory

Grounded theory is a methodology which involves construction of a theory based on empirical observations or data [98]. Grounded theory has been successfully used to do research on topics within social sciences as well as medical sciences where discovery of knowledge can be an inductive process. It has been used to study the effectiveness and use of EMRs for physicians [99] and to understand how an organisation can avoid the pitfalls of successful EMR implementation [100].

This study uses grounded theory with an exploratory approach [101] [102] [103]. It started by trying to understand the perceptions of the users towards the information management practices in Fijian hospitals, and to learn if they are currently using any
EMR. Qualitative study was conducted by using two primary methods of research, which are, surveys [39] and interviews [104] to understand user perspectives about information systems in Fijian hospitals. These surveys had questions pertaining to their experiences when they visit hospitals (patient/public survey) and the experiences of the staff of government hospitals when dealing with information within their facilities. The surveys were conducted both online (Sogo Survey) and through hard copies while interviews were done during visits to the health facilities including Ministry of Health, Fiji. All participants interviewed or surveyed remain anonymous as the research team had signed agreements for confidentiality and ethics for working with the staff of Ministry of Health. The conclusions were derived after analysis of the results in the data tables through Microsoft Excel files that were generated by Sogo Survey. The original grounded theory approach was used since the study has potential to reveal more results than what was initially anticipated [101]. Grounded Theory was used as the primary research methodology since details of the existing PATIS Plus system was not known prior to the research. Interviews and surveys were conducted to understand the system, after which it was compared to the features of the proposed, OpenEMR system. Grounded Theory seemed the most appropriate methodology in this case, with surveys and interviews to explore the existing system, as many developed countries have used similar methods to establish an understanding of their EMR systems, where it has been successfully utilized in studies about e-Health and personal health care management for a range of illnesses in developing nations [105]. It is also ideal for the study of Medical Informatics with particular focus on implementation of e-Health for better management of chronic illnesses and non-communicable diseases [106], which is a major concern in Fiji [107] as it is the largest contributor of mortalities in Fiji [17] [108]. Grounded Theory has also been successfully used in gauging attitudes toward health information systems of hospital staff [109] who would perhaps be the largest internal customer of health information systems in the hospitals.

This thesis presents a case study of the current status of electronic medical records and health information systems in Fijian hospitals and health centers. The study aims to find if the general population of Fiji who have access to Internet would prefer to have access to electronic record systems. We review the current EMR systems in Fijian hospitals and study its strengths and limitations. Nausori Health Center is used as a case study for this study. It also attempts to find out if the medical practitioners of Fiji
as well as the general public would be interested in a cloud based EMR system with a patient portal for online appointments and reports. Surveys were used to understand the current state of Health Informatics in Fiji, and to establish if Fiji has enough technology and resources to introduce a free and open source EMR system that can be accessed in any government hospital or through smartphones.

3.3 The Use of Surveys and Random Sampling

Surveys have been used for understanding medical information systems in many countries [110]. It has also been used in understanding the significance of using handheld devices for personal health management [111]. Web based surveys in particular are cheaper and easier to facilitate as it reaches out to wherever there is internet connectivity. It also ensures that the data falls into the back end database in real time [112], which makes it much easier to analyse in an electronic form. Surveys have also been used to measure internet readiness or literacy which helps gauge if patients are ready for online healthcare tools [113]. Studies similar to this thesis was conducted in United Kingdom [114] and USA [115] where junior doctors where surveyed on their usage of smartphones to assist their work and study.

Simple Random sampling technique was used in this study as it gives unbiased estimates of the survey results [116]. Many medical informatics based studies have used simple random sampling for surveys in regards to the use of information systems and its adaptability, particularly at state or national level [117]. It has also been widely used in hospitals in USA for understanding of application, use and adaption of health informatics and electronic medical records [118]. Qualitative research methods have been widely used to gauge behaviours of physicians pertaining to acceptance and use of medical information systems for clinical decision making purposes [119]. This study has taken a similar methodological approach to investigate the state of medical information systems in Fiji and to realise the potential of electronic medical records on smartphones using cloud computing.
There were two different types of surveys conducted:

a) **Patient/General Public Survey** - the data collection sheet was given to the general public and patients both in hard copy and as a link to an online version of the survey. 216 people had participated (n= 216 as these were the maximum number that consented to participate in this survey)

b) i) **Staff Survey** for *Nausori Health Centre* - this survey was given only to the workers of Nausori Health Centre (n= 23 as this was the total number of staff that had consented to participate) ii) **Staff Survey** for other government health centres/hospitals throughout Fiji - this survey was exactly like the survey for Nausori Health Centre; however this was done to compare the results of Nausori Health Centre to the feedback of staffs with rest of the government hospitals in Fiji. (n= 100 as these were the maximum number that consented to participate in this survey) The participants were from the main hospitals in Suva, Nadi, Lautoka, Labasa areas of Fiji.

### 3.4 Interviews

Interviews were carried out with the ICT team of Ministry of Health and UNAIDS\(^6\) information advisors in order to further understand the current systems in place. These interviews discussed the information systems that is currently being used in the health facilities in Fiji. Structured interview is known to be a popular method in gathering data for medical informatics [120]. It becomes a useful methodology particularly in developing countries where public hospitals are understaffed due to which gathering data may be challenging. Structured interviews have helped researchers realise the potential of new technology such as smart phones for medical informatics in developing African countries [121]. Together with observational study, semi

\[^6\text{UNAIDS- Joint United Nations Programmed on HIV/AIDS}\]
structured interviews have helped gauge viability and effectiveness of web based HIS in developing countries such as Ghana [122]. Such research methods have the potential to prepare Fiji for a similar study.

Nausori Health Centre was a case study for this research as it serves up to 300 patients per day. It is also the largest health centre in the Rewa Subdivision in Fiji. Since staff were always busy, it was easier to interview them using the surveys questions to which they had answered [123]. The staff of Ministry of Health answered a more structured and detailed questionnaire which helped gauge the history and use of the existing HIS in Fijian public hospitals.

3.5 Observational Study

An observational study provides unbiased data on a situation of study or research area [124]. Part of this study was done using observation as one of the methodologies. Non experiment observation assists with understanding information processes in medical setting [125] and to understand the information needs of individual physicians [126]. This was particularly useful because the staff of Nausori Health Center were always busy serving patients. Observational studies have been widely used in relation to health informatics [127] [128].

Ethics Approval

Ethics approval was sorted from both University of the South Pacific as well as Ministry of Health. Ministry of Health requires that a report be submitted to them after the completion of the study.
Chapter 4 Results

This chapter discusses the results of the surveys that were distributed to the staff of Nausori Health Center (case study), the workers of other government hospitals in Fiji and the general public. It also discusses the results of interviews conducted with the staff of the Information Technology Department Ministry of Health. It concludes by comparing modules of the current PATIS Plus system with the proposed OpenEMR system.

It further evaluates challenges that may be faced in implementation of EMR with an evaluation of Nausori Health Centre.

4.1 Case-Study: Nausori Health Centre

Nausori Health Center was chosen for this case study since it serves a large population, which includes two provinces of rural communities. This study also helps to gauge the information systems needs of an average government hospital in Fiji. Nausori Health Center serves as the major government hospital, in Rewa Subdivision in the Central area of Viti Levu, Fiji. It comprises of various departments such as dental, maternity, public health, general outpatient for accident and emergency, special outpatients for chronic diseases, integrated management of childhood illness, triage, pharmacy and administration. Every patient that is served at Nausori Health Center has a unique National Health Number (NHN) which is generated by a system called Patient Information System (PATIS Plus). This number is the national ID that is used in all hospitals. Currently, this system is used only to generate a NHN for a new patient, or to check the NHN of an existing patient. If the patient is an existing patient, then a search is done to merely know the NHN. Once the NHN is found, the staff manually locates a corresponding manila folder which has manual records of the patient’s medical history, prescriptions, history of previous visits and all other information pertaining to the patient. In case if it is the patient’s first visit, then PATIS is used to generate a new NHN, which is then printed out and physically pasted with adhesive paper glue on a new manila folder to follow the same practice as that of the existing patients. There is a huge room with all the manila folders that are labeled according to
the initial of the patient’s last name. It could take anywhere between 10 minutes to an hour to successfully locate the patient’s folder. Even in that case, it is highly unlikely that the folder may contain all accurate information about the patient, as most of the medical practitioners do not have time to do proper data entry, manually or electronically. In case a patient has to visit any other government medical center or hospital in Fiji, then they have to take their folders themselves. In the evenings, when the administration office is closed, Emergency patients are recorded in a thick book which only contains information of the current visit.

*Figure 1 Patients waiting to be seen at Nausori Health Center*

*Figure 2 One of the storage facilities for patient folders*
Such a practice is allowing room for anomalies at many levels. Firstly, the entire practice is clearly too time consuming and cumbersome for both the patients and the staffs of the health center. Not having access to timely, accurate and consistent data, subsequently delays diagnosis and treatment procedures for the patients. Secondly, due to such practices, the records are not accurate or up to date. Thirdly, according to the responses collected from interviews, the practice of patient’s having access to their own folders may raise concerns of security and data manipulation. Relying on an almost manual system makes it very difficult to deal with complaints as records are not entered well, therefore investigations can go on for up to a year. This was evident in a case in one of the hospitals where a patient is suing Ministry of Health for negligence [129]. The case is still under investigation for over one year. Having an EMR system would provide some evidence for the case to be solved in far less time compared to how complaints are dealt with now. It is clear that health information infrastructure in Fiji currently remains inadequate to meet the needs of Fiji’s population.

PATIS Plus, the current Health Information Systems used by Government hospitals in Fiji, is available mainly in the central/eastern, western and northern parts of the country. It is yet to be implemented in all government health centers across Fiji. The PATIS system was adapted based on a HIS in Samoa. It was jointly funded by Australian government and by the Fijian Government in 2001.

4.2 HIS and PATIS in Fiji

According to the interviews conducted with Ministry of Health, there is a total of 200 government hospitals and health centers in Fiji. Out of this, only 36 centers are linked with a Health Information System called Patient Information Systems (PATIS) Plus. The remaining centers still use paper based manual systems. PATIS Plus is the primary software used as an EMR. The Ministry of Health is currently in the process of upgrading to PATIS Plus, which is an improved version of the earlier PATIS software. PATIS Plus is intranet based, with the possibility of having remote access via Virtual Private Network tunnels. It has basic functionality of an EMR which includes patient administration, and details on medication, admissions and discharge. Apart from
PATIS/PATIS Plus, the hospitals are also using PHIS (Public Health Information System), a reporting tool used within the hospital for nursing stations (not at patient level), LabIMS for lab tests and RIS (Radiology Information System) for x-ray systems. Inventory and finance is managed by a software called Epicor. All these software have been provided by AusAID [9]. Even though there are 36 live sites equipped with PATIS Plus, it has been found that most of the centers do not use any software at all, as they are understaffed and have very few computers to work with.

Figure 3 Hospitals in Fiji (Source: http://www.health.gov.fj/hospitals.html)
Figure 4 Health Centres in Fiji (Source: http://health.gov.fj/health-centers.html)

Figure 5 Nursing Stations in Fiji (Source: http://health.gov.fj/nursing-stations.html)
4.3 Modules of PATIS Plus

These are the modules of PATIS Plus system:

- **Patient Master Index - PMI** - contains basic patient demographics and allows to search and view patients records. This is the first interface

- **General Outpatients Department - GOPD** - shows information about encounters from triage to diagnosis for general outpatients

- **Special Outpatient Department - SOPD** - specialty cases as accident and emergency, special clinics diabetics, eye clinic and family clinic

  **Admission and Treatments Department - ATD** - admission for patients

- **Pregnancy and Birth - P&B** - ante natal to birth cycle

- **Surgery** - all data pertaining to surgical procedures

- **Pharmacy** - medication inventory and dispensing

- **Radiology** - bookings for radiology (linked RIS)

- **Appointment** - appointments are decided for any module and booking are made

- **Reports** (PATIS Plus reports of any module) and External Systems (Lab IS, RIS, other software are interoperable with PATIS plus)

- **Site Administration** - create users, manage users, reset password

There are a total of 200 health centers and hospitals in Fiji. Out of that, 36 sites are now live with the new PATIS Plus.

Other stations with PATIS Plus include:

1. Ministry of Health - Head Quarters
2. Diabetes Hub Center – Central Division
3. Western Health Services Office
4. Northern Health Services Office

Figure 6 PATIS Plus Enquiry Screen

4.4 Results from Surveys

This section aims to study the current state of EMRs in Fiji. The study was done by conducting surveys on

(i) patients and general public, with 216 participants,

(ii) staff of Nausori Health Center, which is the case study, with 23 participants

(iii) staff of general health centers and hospitals in Fiji, with 100 participants from major hospitals and health centers in Suva, Nasinu, Lautoka, Nadi and Labasa. The sole purpose of the survey was to compare results of Nausori Health Center to the rest of the health workers in Fiji.
The surveys were launched online using Sogo Survey\(^7\). The link to the online survey was distributed through emails and social networking sites and was also available in printed copies for those who did not have access to internet. All participants of the survey were anonymous.

Below are the results from all 3 surveys.

4.4.1 Survey for General Public and Patients of Government Health Centers and Hospitals

This section shows results from the survey that was conducted for general public and patients of government hospitals in Fiji. They were surveyed on their experience in visiting government hospitals in terms of information systems and if they have smartphone/internet literacy, and if they would like to make bookings for their appointments online.

\(^7\) [http://www.sogosurvey.com/k/SsQWYWRsVsPsPsP](http://www.sogosurvey.com/k/SsQWYWRsVsPsPsP)
### Table 1 Survey Questions for General Public & Patients of Government Health Centres & Hospitals

<table>
<thead>
<tr>
<th>Q1. Do you own a smartphone?</th>
</tr>
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<tbody>
<tr>
<td>Q2. Do you have access to Internet/email (including social networking sites like Facebook)?</td>
</tr>
<tr>
<td>Q3. Do you use a nationally recognized government medical card (called National Health Card)?</td>
</tr>
<tr>
<td>Q4. How long does it take the staff to find your information (medical records) with the card?</td>
</tr>
<tr>
<td>Q5. How long does it take the hospital staff to find your information (medical records) without the card?</td>
</tr>
<tr>
<td>Q6. Would you like to make your appointments for check-up electronically (through Internet or smart phone)?</td>
</tr>
<tr>
<td>Q7. When transferred from your local government hospital to another government hospital (eg. Nausori Health Centre to Colonial War Memorial Hospital), did the second government hospital had your medical records prior to your visit</td>
</tr>
<tr>
<td>Q8. When transferred from your local government hospital to another government hospital, how was your information available prior to your visit?</td>
</tr>
<tr>
<td>Q9. Many countries in the world use a web based, free and open source health information system software, which can be accessed by medical practitioners(complete Electronic Medical Records system)as well as patients (to view their reports and make appointments) throughout the country. Would you like such a system in the government hospitals in Fiji?</td>
</tr>
</tbody>
</table>
### Figure 7: Results of the Survey for General Public and Patients of Government Health Centres and Hospitals Questions 1-4

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes (%)</th>
<th>No (%)</th>
<th>I don't know (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Did you have aHN?</td>
<td>60.18</td>
<td>25</td>
<td>11.37</td>
<td>214</td>
</tr>
<tr>
<td>Q2: Total</td>
<td>98.61</td>
<td>1.39</td>
<td></td>
<td>216</td>
</tr>
<tr>
<td>Q3: Total</td>
<td>81.94</td>
<td>18.06</td>
<td></td>
<td>217</td>
</tr>
<tr>
<td>Q4: Total</td>
<td></td>
<td></td>
<td></td>
<td>216</td>
</tr>
</tbody>
</table>
Figure 8 Results of the Survey for General Public and Patients of Government Health Centres and Hospitals Questions 5-9
According to the results in Figure 8, 81.97% of the survey participants have smartphones. 98.61% of the participants have access to Internet/email/social networking sites. 60.18% have National Health Cards. It is alarming that 35.19% patients responded that it takes the administration staff between 2-10 minutes to find their records if they have their National Health Cards, however, 46.76% patients have responded that it takes more than 20 minutes if they do not have the National Health Cards with them.

Another concern is that 10.19% of patients responded that when transferred from one hospital to another, the second hospital had their information prior to the transfer, but only 6.02% say that the second hospital had their information in electronic medical records. The survey results also show that 91.21% of the participants would like to make their appointments and access reports online (patient portal) or via their smartphones, while 92.13% of the participants are favorable of the idea of having a free and open source EMR system which can be accessed anywhere in Fiji, as a universal solution for Health Informatics in Fiji.

4.4.2 Survey for Staff of Government Hospitals

The following section shows results from the survey that was conducted at Nausori Health Center, which is in fact the case study for this study. They were surveyed on their current practices in dealing with information within their hospital such as patient information and internal information such patient medical records and transfer information, reporting) smartphone/internet literacy, and if they would like to make bookings for their appointments online.
a) Responses from Nausori Health Center (Case Study)

**Survey Questions Survey Participants = 23**

<table>
<thead>
<tr>
<th>Q1. Do you own a smartphone?</th>
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<tbody>
<tr>
<td>Q2. Do you have access to internet/email (including social networking sites like Facebook)?</td>
</tr>
<tr>
<td>Q3. Please explain why you do not use computers to do your work</td>
</tr>
<tr>
<td>Q4. Please describe how the information is entered/stored</td>
</tr>
<tr>
<td>Q5. What mechanisms do you currently use in order to complete your reports and disseminate information?</td>
</tr>
<tr>
<td>Q6. Do you think tablet computers will help you work more efficiently?</td>
</tr>
<tr>
<td>Q7. Would you like to be able to do electronic online/web based booking from any physical location in Fiji, for the patients you attend to?</td>
</tr>
<tr>
<td>Q8. While transferring a patient from your hospital to another hospital did the second government hospital have all information of the patient? How was the information available?</td>
</tr>
<tr>
<td>Q9. Many countries in the world use a web based, free and open source health information system software, which can be accessed by medical practitioners (complete Electronic Medical Records system) as well as patients (to view their reports and make appointments) throughout the county. Would you like such a system to be used in Fiji?</td>
</tr>
<tr>
<td>Q10. Do you have access to the PATIS Plus system</td>
</tr>
<tr>
<td>Q11. What are the problems you face with using PATIS Plus?</td>
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</tbody>
</table>
Q12. Many countries have integrated electronic medical record system that allows patient records to be shared between the practitioners of government hospitals as well as private practitioners. Such a practice allows faster, convenient access to patient records and more efficient reporting. Do you think such an integrated system will be good for Fiji?

Table 2 Survey Questions for Staff of Nausori Health Centre (Case Study)
Figure 9: Survey for Staff of Nausori Health Centre (Case Study) - Questions 1-6
Figure 10: Survey for Staff of Nausori Health Centre (Case Study) Q7-12
According to the results in Figure 9, 43.48% of the survey participants have smartphones. 73.91% of the participants have access to Internet/email/social networking sites. 52.7% say they do not have access to computers. 82.61% say that information is currently entered or stored by filling in manual forms and filing them in manila folders, while 86.96% say that they create reports manually. 95.66% think that Tablet computers will help them work more efficiently. 17.39% say that when transferring a patient from one hospital to another, the second hospital had electronic medical records of the patient prior to the patients visit. 73.91% of the participants would like to make their appointments for their patients online or via smart-phones using an EMR system which can be accessed anywhere in Fiji, as a universal solution for Health Informatics in Fiji. Furthermore, 34.78% have access to PATIS Plus, however, 73.91% of them responded that the screen freezes frequently, which is a major limitation of the software. 91.30% responded that they would like to have an integrated EMR that allows patient records to be shared between private and government practitioners.

Overall, the participants wanted changes such as more computers, trained staffs, user friendly systems for the disabled staffs, 24/7 access to systems, timely data entry and record keeping for better decision making and visibility into the medication that patients are taking.

b) Responses from Staff of other Government Hospitals (Generally)

The following section shows results from government hospitals throughout Fiji. Participants included staff of government hospitals and health centers from central, western and northern division. They were surveyed on their current practices in dealing with information within their hospital such as patient information and internal information such patient medical records and transfer information, reporting) smartphone/internet literacy, and if they would like to make bookings for their appointments online.
**Survey Questions**  
*Survey Participants = 23*

<table>
<thead>
<tr>
<th>Question</th>
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<tbody>
<tr>
<td>Q1. Do you own a smartphone?</td>
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<tr>
<td>Q3. Please explain why you do not use computers to do your work</td>
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<td>Q4. Please describe how the information is entered/stored</td>
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<tr>
<td>Q5. What mechanisms do you currently use in order to complete your reports and disseminate information?</td>
<td></td>
</tr>
<tr>
<td>Q6. Do you think tablet computers will help you work more efficiently?</td>
<td></td>
</tr>
<tr>
<td>Q7. Would you like to be able to do electronic online/web based booking from any physical location in Fiji, for the patients you attend to?</td>
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</tr>
<tr>
<td>Q8. While transferring a patient from your hospital to another hospital did the second government hospital have all information of the patient? How was the information available?</td>
<td></td>
</tr>
<tr>
<td>Q9. Many countries in the world use a web based, free and open source health information system software, which can be accessed by medical practitioners (complete Electronic Medical Records system) as well as patients (to view their reports and make appointments) throughout the county. Would you like such a system to be used in Fiji?</td>
<td></td>
</tr>
<tr>
<td>Q10. Do you have access to the PATIS Plus system</td>
<td></td>
</tr>
<tr>
<td>Q11. What are the problems you face with using PATIS Plus?</td>
<td></td>
</tr>
</tbody>
</table>
Q12. Many countries have integrated electronic medical record system that allows patient records to be shared between the practitioners of government hospitals as well as private practitioners. Such a practice allows faster, convenient access to patient records and more efficient reporting. Do you think such an integrated system will be good for Fiji?

Table 3 Survey Questions for Staff of other Government Hospitals in Fiji
Survey For Staff Of Government Hospitals (Generally) - Questions 1-6

Figure 11 Responses from Survey for Staff of Government Hospitals and Health Centres (Generally) Questions 1-6
Figure 12: Responses from Survey for Staff of Government Hospitals and Health Centres (Generally) Questions 7-12
According to the results above, 79% of the survey participants have smart-phones. 82% of the participants have access to Internet/email/social networking sites. 55% say they do not have access to computers. 69% of the hospital staff say that information is currently entered or stored by filling in manual forms and filing them in manila folders, while 95% responded that they create reports manually. 92% agree that Tablet computers will help them work more efficiently while a minor 11% say that when transferring a patient from one hospital to another, the second hospital had electronic medical records of the patient prior to the patients visit. 79% of the participants would like to make their appointments for their patients online or via smart-phones using an EMR system which can be accessed anywhere in Fiji, as a universal solution for Health Informatics in Fiji. 64% of those who participated in the survey have access to PATIS Plus however 66% say that the screen freezes frequently. A majority of 91% say that they would like to have an integrated EMR that allows patient records to be shared between private and government practitioners.

Overall, the participants wanted changes such as more computers, trained staff, user friendly systems, no downtime, better stock management, 24/7 access to systems, timely data entry and record keeping for better decision making and visibility into the medication that patients are taking. The results of all the surveys indicated that majority of the participants (patients, general public, staff of Nausori Health Center as well as staff of other hospitals around Fiji) want a Health Information Systems such as an Electronic Medical Records system to manage patient data at government hospitals in Fiji. Patients as well as medical practitioners were favorable of the idea of having access to health records available on a web based Electronic Medical Records system which can be accessed by any government hospital in Fiji. They also wished to make their appointments for checkup online using smart phones and mobile applications
4.5 Feedback from Interviews

Interview with Ministry of Health

1. What are the main software used in government hospitals as HIS/EMR solution
   1) PATIS Plus (Patient Information Systems)- as the main EMR which includes modules on patient administration, and details on medication, admissions and discharge, PATIS Plus is intranet based, with the possibility of having remote access via Virtual Private Network tunnels
   2) RIS (Radiology Information System)- for x-ray systems
   3) LabIMS- for lab tests
   4) Epicor- Inventory and finance is managed by a software called
   5) PHIS (Public Health Information System)- a reporting tool used within the hospital for nursing stations (not at patient level)

2. When was PATIS Plus it implemented and by who?
   The original PATIS was developed and donated by AusAID for Western Samoa in 1996. It was adopted by Ministry of Health, Fiji as part of AusAID’s support program.

3. Do we have technical as well as user documentation for PATIS Plus? Is it possible to sight these documents?
   Technical and User manuals are being made by the ICT staff of Ministry of Health. It is not accessible by anyone else except the users of PATIS Plus

4. Who provides technical support for PATIS Plus. What are the various levels of support and how is that support accessed? Are all support personal based locally or are there expatriates that we hire?
   The ICT Department of MOH carries out all technical maintenance for PATIS Plus and all other software used by MOH. AusAID has donated the software but they are not responsible for further upgrades or technical assistance.

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8 Under the Ethics/Confidentiality agreement, participants of all interviews are anonymous
5. How many government hospitals do we have, and how many practitioners are they furnished with? How many hospitals have PATIS, do all staff have access to it?

There are 200 government hospitals and health centers in Fiji. Out of this, only 36 centers have PATIS Plus. The remaining centers still use paper based manual systems. We are also planning on implementing PATIS Plus in all other centers soon.

**Active Sites:**

<table>
<thead>
<tr>
<th>Central</th>
<th>Western</th>
<th>Northern</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOH Head Quarters</td>
<td>Sigatoka Hospital</td>
<td>Labasa Hospital</td>
</tr>
<tr>
<td>CWM Hospital</td>
<td>Nadi Hospital</td>
<td>Seaqaqa Health Center</td>
</tr>
<tr>
<td>St. Giles Hospital</td>
<td>Lautoka Hospital</td>
<td>Savusavu Hospital</td>
</tr>
<tr>
<td>Nausori MaternityHospital</td>
<td>Tavua Hospital</td>
<td>Nabouwalu Hospital</td>
</tr>
<tr>
<td>Hospital</td>
<td>Rakiraki Hospital</td>
<td>Waiyevo Hospital</td>
</tr>
<tr>
<td>Wainibokasi</td>
<td>Northern Health</td>
<td>Vunisea Hospital</td>
</tr>
<tr>
<td>SubDivisional Hospital</td>
<td>Services Office</td>
<td>Lomaloma Hospital</td>
</tr>
<tr>
<td>Hospital</td>
<td></td>
<td>Levuka Hospital</td>
</tr>
<tr>
<td>Korovou hospital</td>
<td></td>
<td>Lakeba Hospital</td>
</tr>
<tr>
<td>Vunidawa Hospital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lami Health Center</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samabula Health Center</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuffield Health Center</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raiwaqa Health Center</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valelevu Heath Center</td>
<td></td>
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</tr>
</tbody>
</table>
6. Is PATIS just an EMR system or does it have enterprise level of support, eg. Inventory, pharmacy, modules for proactive approaches - public health management, is PATIS connected to diagnosis systems such as CT scanners, ECG machine etc, PATIS Plus is intranet based, with the possibility of having remote access via Virtual Private Network tunnels. It has basic functionality of an EMR which includes patient administration, and details on medication, admissions and discharge.

7. What are the modules of PATIS Plus?

1) **Patient Master Index- PMI**- contains basic patient demographics and allows to search and view patients records. This is the first interface

2) **General Outpatients Department - GOPD**- shows information about encounters from triage to diagnosis for general outpatients

3) **Special Outpatient Department - SOPD**- specialty cases as accident and emergency, special clinics diabetics, eye clinic and family clinic

4) **Admission and Treatments Department- ATD**- admission for patients

5) **Pregnancy and Birth- P&B**- ante natal to birth cycle

6) **Surgery**- all data pertaining to surgical procedures

7) **Pharmacy**- medication inventory and dispensing

8) **Radiology**- bookings for radiology (linked RIS)

9) **Appointment**- appointments are decided for any module and booking are made

10) **Reports** (PATIS Plus reports of any module) and External Systems (Lab IS, RIS, other software are interoperable with PATIS plus)

11) **Site Administration**- create users, manage users, reset password
8. Is PATIS Plus integrated with PDAs/Smartphones, bar code reading, accessible anywhere for ease of use for our medical practitioners? No, but it is intranet based. It will work in all government hospital sites as long as they have intranet infrastructure, phone lines and PCs.

9. Is there an online portal which allows some level of access to patients for bookings, reminders, reports etc. No.

10. How much money has the government spent during the last 10 years in implementation/deployment of software solution for Health Informatics (PATIS or any other system used so far)? The government has not spent any money as PATIS was developed and donated AusAID. However, the technical support is done by the ICT staff of MOH.

11. What are your thoughts on PATIS (what is it really, is it fulfilling all requirements or are there flaws in it, are users appreciating the PATIS system, if not, why do you think they don’t use it? Is it due to the fact that they are always busy, or are there training issues, or flaws with the system interface or functionalities. We have a 3 tier backup support system for PATIS Plus. The system is good, however, there needs to be more commitment for training the staff. For any system to be successful, it is very important for processes to be aligned with the system.

12. What do you think of open source solutions for Health Informatics in Fiji (there are many developing countries who are using systems such as GNU Health, and OpenEMR- both web based free and open source solutions, which have enterprise level support as well as integrated with smart phones/PDAs)
Our software is donated. It is a custom made program, therefore we do not have a need to use any other software for now. We are in the process of rolling out PATIS Plus to all centers.

13. Are there any graphs or charts showing how PATIS Plus is deployed? We will not be able to give the screenshots of it as the intellectual rights of the software is with AusAID and since it's not a open source software we will not be able to release this. We will not be able to release the Network Diagram, however as mentioned earlier this system does not require any client installation. It is accessible on govnet and also via VPN.

14. I understand that PATIS Plus is currently under implementation. What is the difference between PATIS & PATIS plus? What are the significant changes (compared to PATIS & international standard HIS/EMRs) that PATIS plus will bring. PATIS Plus has more modules than PATIS. It will also have more accessibility and speed

All interviews conducted were confidential, therefore no names are mentioned. It seems that majority of the participants want an Electronic Medical Records system to manage patient data at government hospitals in Fiji. Patients as well as medical practitioners were favorable of the idea of having access to web based Electronic Medical Records system. They also want to be able to make their appointments for checkup online.

As observed, most health facilities in Fiji are under resourced in terms of computers. In some cases there are only 2 or 3 computers in the entire health center, where one is used at reception and one is used by the pharmacist. The same is the case of Nausori Health Center.

The medical practitioners have mentioned that they face a lot of difficulties in addressing the needs of their internal customers and stakeholders. For example, they only learn that a particular medication is out of stock when they check manually. Thereafter, it may take time from weeks up to months to procure the much needed medication from suppliers. Similarly, other areas of the hospital management and
administration are in dire need of a fully integrated Information System Solution to automate most of their manual tasks and to operate in an overall efficient and effective manner. Furthermore, the lack of finances has long impeded the idea of exploring quality Health/Hospital Information Systems that perform excellently. However, such solutions can be ridiculously expensive, particularly for developing countries like Fiji.

Overall, the results of the surveys and interviews indicate that the people of Fiji have enough access to technology to be able to use an online Electronic Medical Record System, such as OpenEMR. However, some participants have raised questions on security in terms of using a free and open source software, and up to which extent will public have access to the system, if such a system were to be implemented. Some overwhelming findings were that government health centers across the nation are lacking computers, individual PATIS Plus access, and trained staff. Existing PATIS Plus users also find it difficult to use PATIS Plus as it is generally slow, and there is a lot of downtime.

PATIS Plus is still in its implementation phase [130]. Not all sites are live yet, as they would require additional resources such as access to computers and intranet. According to Ministry of Health, currently, 36 out of 200 sites have PATIS Plus deployed; however it is not being fully utilized yet. Interviews with Ministry of Health state that there are no limitations in the PATIS Plus software, however, any ICT based tool may not solve the issues of record keeping in government hospitals. Processes need to be designed and mapped using the tools in order for a health information to be successful. PATIS Plus is reviewed quarterly and the information is consolidated into a report, which is acted upon in order to rectify any issues that have been reported. PATIS Plus is funded by AusAID, however, hardware and support is not funded [9]. Therefore, in order to realize the full potential of PATIS Plus, it is important to invest in the procurement of hardware, training and technical support.

In Fiji, health centers are smaller dispensaries which has fewer staff, which provide basic health care support to patients, but transfer them to one of the bigger hospitals if the issues need more serious attention.
4.6 PATIS Plus

It seems that not many health workers have access to PATIS Plus or a computer; however, if needed, they are able to access PATIS Plus from the computers in administration department using the login details of the PATIS Plus operator. Generally health workers are finding PATIS Plus slow, however many will be satisfied if they have their own computer with their own access, 24/7. Many stations are still waiting for PATIS Plus to be implemented so it can be used by all health workers across the country.

4.7 Comparison of PATIS Plus with OpenEMR

In this section, each module of PATIS Plus will be compared to the features of OpenEMR. According to the results of the surveys, it is evident that the end users of PATIS Plus are clearly not satisfied with the system. The ongoing support and maintenance charges are not paid for by AusAID either [9], therefore there is a need for studying alternative solutions.

The following table shows a general overview and summary of both PATIS Plus that is currently being used in 36 out of 200 government hospital sites and OpenEMR. Information on PATIS plus is based on the information provided by Ministry of Health, whereas information on OpenEMR is based on online information available.
### 4.7.1 Both the EMR systems at a glance

<table>
<thead>
<tr>
<th>PATIS Plus</th>
<th>OpenEMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Intranet based</td>
<td>- Web Based, fully integrated system</td>
</tr>
<tr>
<td>- Main EMR system in government hospitals</td>
<td>- Patient Demographics</td>
</tr>
<tr>
<td>- Admissions, transfers and discharges</td>
<td>- Electronic Medical</td>
</tr>
<tr>
<td>- Bookings and appointments -</td>
<td>- Patient Scheduling</td>
</tr>
<tr>
<td>(Outpatients and Inpatients)</td>
<td>- Reports</td>
</tr>
<tr>
<td>- Disease Index</td>
<td>- Multilanguage Support</td>
</tr>
<tr>
<td>- Special Outpatient Department Pharmacy</td>
<td>- Security</td>
</tr>
<tr>
<td>- Pregnancy and births</td>
<td>- Support</td>
</tr>
<tr>
<td>- General Outpatients Department -</td>
<td>- Community</td>
</tr>
<tr>
<td>- Admission and Treatments</td>
<td></td>
</tr>
<tr>
<td>- Department Surgery/Theatre</td>
<td>- Successfully customised and deployed in many</td>
</tr>
<tr>
<td>- Radiology</td>
<td>developing countries</td>
</tr>
<tr>
<td>- Death module</td>
<td>- Special patient Portal for reports and</td>
</tr>
<tr>
<td>- Enquiry module (including Pathology/</td>
<td>appointments</td>
</tr>
<tr>
<td>LabIMS interaction)</td>
<td>- fully integrated electronic health records</td>
</tr>
<tr>
<td>- Existing specialised reporting</td>
<td>- practice management</td>
</tr>
<tr>
<td>- Administrative functions</td>
<td>- scheduling</td>
</tr>
<tr>
<td>- Data management functions</td>
<td>- electronic billing</td>
</tr>
<tr>
<td>- Funded by AusAid</td>
<td>- internationalization</td>
</tr>
<tr>
<td>- Supported with a 3 tier support by</td>
<td>- free support from open source community</td>
</tr>
<tr>
<td>government’s ITC Services</td>
<td>- ONC Complete Ambulatory EHR Certified</td>
</tr>
<tr>
<td>- Can run on Windows</td>
<td>- Multilanguage support</td>
</tr>
<tr>
<td></td>
<td>- Free and Open Source</td>
</tr>
<tr>
<td>environment only, not on tablets and notebooks</td>
<td>Can run on Windows, Linux, Mac OS X, and many other platforms, mobiles and tablets</td>
</tr>
</tbody>
</table>
4.7.2 First Module: Patient Master Index

The PATIS Plus Patient Master Index module contains basic demographic information for patients, while OpenEMR contains more detailed information about patient demographics as well as insurance information.

<table>
<thead>
<tr>
<th>Modules of PATIS Plus</th>
<th>Functions</th>
<th>Features of OpenEMR</th>
<th>Functions</th>
</tr>
</thead>
</table>
| Patient Master Index  | - patient registration  
|                       |   - basic patient demographics  
|                       |   - search/view of patients  
|                       |   - first interface  
|                       |   - blood group information  |
|                       | *Patient Demographics*  |
|                       | - Track patient demographics  
|                       | - Primary information (name, date of birth, sex, identification)  
|                       | - Marital status  |
The General Outpatients Department module of PATIS Plus contains information about the first contact of any patient who comes through the outpatients department such as reason for visit, duration of the problem, referral source and attending clinician. OpenEMR has a summary all functionalities of an integrated EMR system ranging from patient demographics to medication, graphical charting, billings and dated reminders to patients. Most of the functionalities of PATIS Plus General Outpatients Department Module is available in Open EMR.
<table>
<thead>
<tr>
<th>Modules of PATIS Plus</th>
<th>Functions</th>
<th>Features of OpenEMR</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Outpatients Department (GOPD)</td>
<td>- information about general outpatients encounters from triage to diagnosis for</td>
<td><strong>Electronic Medical Records</strong></td>
<td>- Encounters</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Medical Issues</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Medications</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Immunizations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Forms and clinical notes:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Vitals (growth charts included)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Review of systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Template Driven Forms</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Computer Aided Medical Ordering System</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Ability to create and customize forms</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Graphical Charting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Labs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Procedures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Patient Reports</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Referrals</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Patient Notes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Disclosures</td>
</tr>
</tbody>
</table>
4.7.4 Third Module: Special Outpatient Department

<table>
<thead>
<tr>
<th>Modules of PATIS Plus</th>
<th>Functions</th>
<th>Features of OpenEMR</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Outpatient Department</td>
<td>- specialty cases as Anti Natal Clinic, special clinics diabetics, eye clinic, family</td>
<td><strong>Clinical Decision Rules</strong>&lt;br&gt;Plus&lt;br&gt;Integrated in <strong>EMR</strong></td>
<td>- Physician Reminders</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Patient Reminders</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Clinical Quality Measure Calculations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Automated Meaningful Use Measurement Calculations</td>
</tr>
</tbody>
</table>
4.7.5 Fourth Module: Admission and Treatments Department (ATD)

<table>
<thead>
<tr>
<th>Modules of PATIS Plus</th>
<th>Functions</th>
<th>Features of OpenEMR</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission and Treatments Department (ATD)</td>
<td>- admission for patients</td>
<td>Integrated</td>
<td>Integrated in EMR</td>
</tr>
</tbody>
</table>

Table 9 Fourth Module: Admission and Treatments Department (ATD)

4.7.6 Fifth Module: Pregnancy and Birth (P & B)

<table>
<thead>
<tr>
<th>Modules of PATIS Plus</th>
<th>Functions</th>
<th>Features of OpenEMR</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnancy and Birth (P &amp; B)</td>
<td>- patient information from ante natal to birth cycle</td>
<td>Integrated</td>
<td>Integrated in EMR</td>
</tr>
</tbody>
</table>

Table 10 Fifth Module: Pregnancy and Birth (P & B)

4.7.7 Sixth Module: Surgery
<table>
<thead>
<tr>
<th>Modules of PATIS Plus</th>
<th>Functions</th>
<th>Features of OpenEMR</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery</td>
<td>- deals all data surgical procedures</td>
<td>Integrated</td>
<td>Integrated in EMR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Integrated in Clinical Decision Rules</td>
</tr>
</tbody>
</table>

Table 11 Sixth Module: Surgery

4.7.8 Seventh Module: Pharmacy

<table>
<thead>
<tr>
<th>Modules of PATIS Plus</th>
<th>Functions</th>
<th>Features of OpenEMR</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacy</td>
<td>- inventory for medication</td>
<td>Prescriptions</td>
<td>- Online drug search</td>
</tr>
<tr>
<td></td>
<td>- track patient prescriptions and medications</td>
<td></td>
<td>- Track patient prescriptions and medications</td>
</tr>
<tr>
<td></td>
<td>- create and send prescriptions</td>
<td></td>
<td>- Create and send prescriptions</td>
</tr>
<tr>
<td></td>
<td>- E-Prescribe</td>
<td></td>
<td>- E-Prescribe</td>
</tr>
<tr>
<td></td>
<td>- print</td>
<td></td>
<td>- Print</td>
</tr>
<tr>
<td></td>
<td>- fax</td>
<td></td>
<td>- Fax</td>
</tr>
<tr>
<td></td>
<td>- email</td>
<td></td>
<td>- Email</td>
</tr>
<tr>
<td></td>
<td>- customizable layout including options.</td>
<td></td>
<td>- Customizable layout including options.</td>
</tr>
<tr>
<td></td>
<td>- in-house pharmacy dispensary support</td>
<td></td>
<td>- In-house pharmacy dispensary support</td>
</tr>
</tbody>
</table>

Table 12 Seventh Module: Pharmacy
### 4.7.9 Eighth Module: Radiology

<table>
<thead>
<tr>
<th>Modules of PATIS Plus</th>
<th>Functions</th>
<th>Features of OpenEMR</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiology</td>
<td>bookings for radiology (linked Radiology Information System)</td>
<td>Integrated</td>
<td>Integrated in <strong>EMR</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Integrated in <strong>Clinical Decision Rules</strong></td>
</tr>
</tbody>
</table>

*Table 13 Eighth Module: Radiology*

### 4.7.10 Ninth Module: Appointment

<table>
<thead>
<tr>
<th>Modules of PATIS Plus</th>
<th>Functions</th>
<th>Features of OpenEMR</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appointment</td>
<td>appointments are decided for any module-make booking tab</td>
<td><strong>Patient Scheduling</strong></td>
<td>- Supports multiple facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Patient appointment notification via email and sms</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Compact and flexible appointment calendar</td>
</tr>
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<td></td>
<td></td>
<td>- Calendar features include:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Find open appointment slots</td>
</tr>
</tbody>
</table>
### 4.7.11 Tenth Module: Reports

<table>
<thead>
<tr>
<th>Modules of PATIS Plus</th>
<th>Functions</th>
<th>Features of OpenEMR</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reports</td>
<td>-</td>
<td>(PATIS Plus reports of any module) and External Systems (Lab IS, RIS, other software, talk to PATIS plus)</td>
<td>- Appointments</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reports</td>
<td>- Patient Lists</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Prescriptions and Drug Dispensing</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>- Referrals</td>
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<td></td>
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<td></td>
<td>- Immunizations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Clinical Measure Calculations</td>
</tr>
</tbody>
</table>
Clinical Quality Measures (CQM) Calculations
- Automated Measure Calculations (AMC) and Tracking
- Syndromic Surveillance
- Pending Procedure Orders
- Ordered Procedure Statistics
- Paper Chart Tracking
- Sales
- Collections
- Insurance Distributions
- Insurance Eligibility

Table 15 Tenth Module: Reports

4.7.12 Eleventh Module: Site Administration

<table>
<thead>
<tr>
<th>Modules of PATIS Plus</th>
<th>Functions</th>
<th>Features of OpenEMR</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Administration</td>
<td>- create users, manage users, reset password</td>
<td><strong>4 Features for Support</strong></td>
<td><strong>Multilanguage Support</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Supports use of multiple languages within the same clinic</td>
</tr>
</tbody>
</table>
- Any language can be added and translated in a Collaborative Google Docs Spreadsheet maintained by the OpenEMR community

- Fully supports UTF-8 encoding

**Security**

- Ability to Encrypt Patient Documents

- Supports fine-grained per-user access controls

- Remotely accessible from any modern web browser with a suitable security certificate installed

**Support**

- Vast Online Documentation

- Free Online Support Forum

- Free IRC Chat Support Channel
Numerous Free and Professional Support Options

Community

- Dedicated to guarding OpenEMR's status as a free, open source software solution for medical practices.

- Thriving and enjoying some of the broadest user support and developer support.

- OpenEMR is the most popular free electronic medical records in use today with over 4,000 downloads per month.

- More than 82 developers/companies have contributed code to OpenEMR.

- OpenEMR codebase is openly improved on a daily basis.

- Community Website

- Community Wiki

- Community Forum
### Table 16 Eleventh Module: Site Administration

<table>
<thead>
<tr>
<th>Module</th>
<th>Functions</th>
</tr>
</thead>
</table>

4.7.13 Additional Modules

<table>
<thead>
<tr>
<th>Module</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>None</td>
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<tr>
<td>-------</td>
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</tbody>
</table>

*Table 17 Additional Modules*
Chapter 5  Discussion

This section discusses the results from the previous chapter in details. It covers Health Information Systems in Fiji, the use of PATIS Plus software in the government hospitals in Fiji, the potential of web based EMR systems and possibilities of using open source solutions such as Open EMR on cloud infrastructure for all Fijian government hospitals.

5.1 Health Information Systems in Fiji

The lack of computers makes it difficult for most staff to do data entry or check records of the patient’s medical history; therefore, they continue to use manual systems of folders and files. The majority surveyed and interviewed have expressed a need for having computers for better records keeping and information management.

There is a general shortage of qualified medical practitioners in Fiji [131]. The lack of a fully computerized Health Information Systems is adding to the woes of the already overloaded staff at the government hospitals in Fiji. Manual systems leads to cumbersome paperwork and long delays in attending to the patients.

The field of Health Informatics has become a significant field of study due to the various challenges faced by the medical field. Internationally, there has been a rapid growth in the volume of medical knowledge and patient information, due to advancement in more treatments and interventions. These have coincidently produced more information management needs. However, there is a need for the ability to catalogue the information to be archived for future purposes. In addition to this, information is not standardized, which creates provisions for further anomalies when accessing information about the same patient from different hospitals around the country. There is obviously a dire need for a highly versatile and efficient Health/Hospital Information Systems, which will be an enterprise level solution to cater for the various information management needs of any hospital.
5.2 Web based EMR

Most of the participants of the surveys are favorable to the idea of having an online web based EMR system that can be accessed by practitioners anywhere in Fiji. Participants would also like an integration of the EMR between private and government participants over a cloud based system, however, some participants have raised concerns of security if some integration were to happen.

There is an overwhelming response from the participants of the study that shows interest in a web based EMR system for hospitals in Fiji. Participants have shown interest in having a patient portal for reports and booking. They have also given favorable responses to the idea of sharing their medical records between private and government hospitals for ease of reporting resulting in faster services as well as online access for health workers to allow mobility.

However, as indicated in results, a major limitation of the Information Systems in Fijian hospitals is the lack of computers in general. Another issue is the fact that most medical practitioners do not have time to do data entry. However they do think applications on smart phones could help them do data entry easily and conveniently.

This study can guide medical practitioners and stakeholders would be able to know about better avenues for managing information relating to disease treatment and to better predict outbreak trends of epidemic diseases with EMR systems. This research will pave a pathway for all Information and Communication Technology and Information Systems professionals for any future Health Informatics project.

5.3 Open EMR on Cloud

The results indicate that OpenEMR has more features that can be used by Fijian Government Hospitals. It also highlights that cloud systems can support the proposed OpenEMR system that can be accessible though smart phone applications anywhere in Fiji.
This study has briefly explored the use of free and open source software with the assistance of hand held devices that may prove to be significant for those interested in Health Informatics for Fijian hospitals. OpenEMR can allow a practical insight into Health Informatics for Fiji. A future study will discuss free and open source software in more detail and compare and match the requirements of the current health system with modules of OpenEMR. OpenEMR will be able to perform various day to day tasks of a Health Information Systems, as well as Human Resource Management Systems, such as tracking attendance and performance of staff. The built in accounts system will be able to do instant billing, as well as raise orders for new stock. In addition to that, it will give our Health System ability to access information on a 24/7 basis anywhere in Fiji. This solution has the ability to expand, to allow private hospitals to link up to a National Database, which could be either a chargeable service to private practitioners or can be free for the country to help towards better standardized health care. Most importantly, it has the ability to generate reports on all aspects of the services of the software for example patient information, staff information and inventory reports.
Chapter 6 Conclusion and Future Work

This chapter highlights contributions after the successful completion of the study. It also discusses potential future research directions that can be pursued after this study.

6.1 Conclusion

In this thesis, we presented an assessment of the status of health informatics in Fiji through interviews and surveys. Our results show that a complete and fully integrated, web based EMR system is needed by patients and medical practitioners to fulfill the needs of computers and technology that is absent in hospitals for supporting EMRs. The obstacle in place has been the lack of computers in Fijian government hospitals. For web based EMRs, additional security measures may need to be implemented. Patient confidentiality, organizational ICT policies and the country’s legislation need to have such concerns addressed at their respective levels to support the technical measures.

This case of Nausori Health Center reveals that there are still many manual practices that is causing unnecessary delays for both patients and workers. The findings suggest that the majority of the staff at Nausori Health Center would appreciate a complete EMR system that is accessible from anywhere in Fiji, to handle patient records and reporting.

This study has established that those who took part in the surveys, including government health workers are interested in a web based EMR system for our government hospitals that has a patient portal so patients can access their reports and make appointments for their checkup themselves. This study has explored various options in ICT which can assist practitioners and hospital staff in reducing wait time and in making faster informed decisions. However, more studies need to be carried out regarding options for web based EMR systems that would meet the requirements of a developing nation such as Fiji. EMR systems should be accessible through smart phones and Tablets even in remote locations such as the outer islands.
This study has also focused on the successful implementation of Health Information Systems in various developing countries. It reviewed the use of free and open source software solutions for Health Informatics on a cloud based infrastructure, using mobile application and devices. More importantly, it highlights some important lessons learnt while deploying those systems across the globe. Implementing a free, open source healthcare solution will give a practical insight into innovative Health Informatics for Fiji by matching the requirements of the current health system with the modules of OpenEMR.

The main findings of this thesis are:

1. There is a general shortage of computers in government health facilities in Fiji
2. PATIS Plus was generally slow and very few users had access to PATIS Plus. Many users shared the same login as that of the PATIS Plus operator due to shortage of computers and individual accounts
3. The staff of government hospitals in Fiji think that they will be able to operate more efficiently if they had their own computers with their own logins for PATIS Plus
4. There are inconsistent practices in terms of information systems management across government hospitals in Fiji
5. Even with full implementation of PATIS Plus in all centres, the software may not necessarily be successful as it may need some business process re-engineering in order to meet the needs of Fijian hospitals
6. The people of Fiji (health practitioners and general public) have enough computer and internet access as well as literacy and are ready for a web based electronic medical records system that can be accessed through smart phones in any location. Patients would like to access their medical reports through their own portal which will also allow making online appointments for check-ups
7. Upon comparison of the existing PATIS Plus System and OpenEMR, it is evident that OpenEMR is highly versatile, interoperable and has more features than PATIS Plus system and comes at not direct cost to the government
8. It is possible to extend OpenEMR to hand held devices such as smartphones and PDAs with android application.

9. A cloud based infrastructure will allow ease of use and 24/7 accessibility to practitioners for better decision making and reporting, and to patients for appointments and reports.

6.1.1 Open EMR on Cloud Infrastructure for Fijian Government Hospitals

There are three major Internet Service Providers in Fiji, which are Vodafone, Connect and Digicel/Unwired. The cloud can potentially be leased through one of them, who will be able to meet the requirements of Ministry of Health in Fiji.

OpenEMR can be implemented by using the Voter Registration database which already contains demographic information about all citizens over the age of 18. Collaborating this database will make the initial implementation phase much easier as only the other citizens not accounted for in this database will need to be entered. Such a system can be used by private practitioners as well. Certain aspects of the database (demographic information) can be shared with other parties such as pharmacies and insurance companies to provide a platform for one seamless solution. This will make it easier for patients to share their reports with interested parties without having to wait in long lines for reports from their physicians.

However, it is important to consider privacy and security needs as both cloud computing technology as well as open source systems have their own security issues that need to be mitigated.

6.1.2 Potential Barriers to Successful Implementation of OpenEMR in Fiji

One of the major barriers of a successful Health/Hospital Information Systems/Electronic Medical Records system for a developing country like Fiji is lack of finance [132]. The fact that OpenEMR is a free open source software solution, makes
it a very viable option for medical systems in Fiji. Though free open source software for Health Informatics have significant benefits, when choosing a free open source solution for Health Informatics, one should not only consider that there is no cost for software licenses, but realize other costs within the project such as hardware, implementation, training and maintenance cost [133]. There could also be costs associated with expertise of the professionals deploying the project as well as training of end users. OpenEMR for information systems solution for Fijian Government Hospitals comes at no cost in terms of software licenses. It is interoperable and compatible with Windows or Linux platforms, and can be used on hand held devices such as tablets. However, there would be costs associated with having a physical platform, example servers, routers, personal computers, tablets and networking media. Our research is associated with a completely cloud based solution for Fijian Government Hospitals, in order to keep costs to minimum and yet have an environmentally safe solution.

6.2 Points Known Prior to the Study:

1. Most health facilities in Fiji operated manually in terms of information systems

2. There is a general shortage of computers in government health facilities in Fiji

3. PATIS Plus, which is an improved version of the previously used information system, is currently being used in some government hospitals but was generally slow and very few users had access to it.

6.3 Future Research Directions

This study can be extended to investigate the use of EMR systems through mobile applications on various platforms in order to fully utilize the benefits of cloud
computing in the health sector. The use of Open Source EMR systems and prospectus for their implementation in developing nations is also needed. Some study in collaboration with Internet Service Providers in Fiji may be helpful in order to assess options for cloud infrastructure in Fiji.

The next step would be to do an in depth testing of PATIS Plus system (black box testing) to understand the flaws in order to align OpenEMR as close to the requirements as possible. This will help in avoiding pitfalls in implementation and deployment. It is also necessary to explore the levels of service that cloud service providers can provide.
References


