



Faculty of Information and Communication Technology

**DEVELOPMENT OF ARCHITECTURE FOR PERVASIVE HEALTH
RECORD IN MOBILE APPLICATION**

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Master of Science in Information and Communication Technology

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**DEVELOPMENT OF ARCHITECTURE FOR PERVASIVE HEALTH RECORD
IN MOBILE APPLICATION**

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**A thesis submitted
in fulfillment of the requirements for the degree of Master of Science
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DECLARATION

I declare that this thesis entitled “Development of Architecture for Pervasive Health Record in Mobile Application” is the result of my own research except as cited in references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature: 

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Information and Communication Technology.

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1/11/2017
.....

DEDICATION

To my parents, family and fiancée this is for you. Without your support, blessings and patience I will not be where I am now. Thanks for everyone support and always pick me up when I'm down.

ABSTRACT

The advancement of the technology has made smartphones as one of the important device that everyone needs. Smartphones can be used as pervasive health records that can access the health records anywhere and anytime. Since 2013, the smartphones ownership rates have skyrocketed in many countries and in Malaysia the percentage have increase 34%. However, with many different mobile's operating system, it makes developing applications in multi-platform is time consuming. This study on 'Development of Architecture for Pervasive Health Records in Mobile Application' is a study on of the development of pervasive health records in mobile application that can be used in multi-platforms. The aim of this research is to develop and propose a validated architecture for pervasive health record in mobile application that is used for maintaining pervasive health records using smartphones; and to identifies the best hybrid model and the crucial patient health record datasets to be adopted in the proposed architecture. The objectives on this research firstly is to analyze appropriate mobile health application architecture that could be incorporated in the proposed architecture. Secondly to identifies crucial data needed for doctors when diagnose patients. Thirdly to developed the architecture for pervasive healthcare record in mobile application. Lastly to validate the architecture for pervasive health record in mobile application through the case study. The methodology of this research starts with analyzing the data current research. This include with the study in literature review and case study. The next process is the design and development. The design and development of the prototype will occur in this process. The next process is to validate the architecture and when the architecture has been validated, the process will stop and if the architecture does not validate the process will go to the start. In the process of validation, the prototype has been tested in the real-life situation. The prototype is developed to facilitate patients to retrieve and access their own healthcare records. Therefore, student of UTeM have been asked to test the prototype and they have been questioned their opinion about the prototype. From the results of Cronbach's Alpha it showed that the students are satisfied with the prototype. From the research, the prototype facilitates patients with the medical records that could be refer to doctor when in consultation. Furthermore, from the data collected from the expert user, a list of important medical datasets has been established. This could be used as guidelines of important medical datasets. The research of the proposed architecture only focuses on patients to monitor their own healthcare records. In the future, this architecture could be used to facilitate doctor to diagnose patients anywhere and anytime.

ABSTRAK

Kemajuan teknologi telah menjadikan telefon pintar sebagai salah satu alat penting yang diperlukan oleh semua orang. Telefon pintar boleh dijadikan sebagai alat peranti rekod kesihatan yang boleh digunakan pada bila-bila masa sahaja. Sejak daripada tahun 2013, kadar pemilikan telefon pintar di kebanyakan negara telah meningkat naik dan di Malaysia kadar peratusan telah meningkat sebanyak 34%. Walaubagaimanapun ianya susah untuk pembangunan aplikasi dengan adanya pelbagai sistem operasi telefon pintar, ianya akan memakan masa untuk membangunkan aplikasi untuk semua sistem operasi. Kajian ini adalah untuk merangka seni bina aplikasi kesihatan mudah alih yang boleh digunakan di semua sistem operasi. Tujuan kajian ini adalah untuk membangun dan mencadangkan seni bina aplikasi mudah alih yang digunakan untuk menguruskan rekod kesihatan dengan menggunakan telefon pintar; dan untuk mengenalpasti model hibrid yang terbaik dan data medik yang penting untuk digunakan di dalam model yang dicadangkan. Objektif pertama didalam kajian ini adalah untuk menganalisa model-model aplikasi rekod kesihatan mudah alih yang bersesuaian dan boleh diguna pakai ke seni bina aplikasi yang telah dicadangkan. Objektif kedua adalah untuk mengenalpasti data-data penting yang diperlukan oleh doktor-doktor ketika mendiagnosis pesakit. Objektif ketiga adalah untuk membangunkan seni bina aplikasi rekod kesihatan mudah alih. Objektif yang terakhir adalah untuk mengesahkan dan menguji aplikasi rekod kesihatan mudah alih melalui kaedah kajian kes. Metodologi kajian ini bermula dengan menganalisa sistem semasa termasuklah mengkaji kajian kes. Proses yang seterusnya adalah mereka dan membina. Proses ini adalah untuk mereka bentuk dan membina prototaip. Proses yang seterusnya adalah untuk mengesahkan dan menguji prototaip. Di dalam proses tersebut, prototaip akan diuji di dalam situasi yang sebenar. Prototaip telah dibangunkan untuk membantu pesakit-pesakit untuk mendapatkan rekod kesihatan masing-masing. Oleh itu pengujian dilakukan oleh pelajar-pelajar UTeM dan mereka telah memberikan pendapat mereka mengenai prototaip tersebut. Keputusan 'Cronbach's Alpha' menunjukkan pelajar-pelajar tersebut berpuas hati dengan prototaip itu. Dari kajian, prototaip tersebut mampu membantu pesakit ketika kaunsultasi dengan doktor. Mereka mampu merujuk rekod kesihatan mereka dengan mudah. Tambahan, data-data yang telah dikumpulkan dari pengguna pakar, senarai data medik yang penting telah dirangka. Ini boleh digunakan sebagai garis panduan untuk digunakan oleh aplikasi-aplikasi yang lain. Kajian ini hanya berfokus kepada pesakit untuk memantau rekod kesihatan sendiri. Pada masa akan datang, aplikasi ini mungkin boleh digunakan oleh doktor untuk mendiagnosis pesakit di mana-mana sahaja.

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"Success is not final, failure is not fatal: it is the courage to continue that counts."

By: Winston Churchill

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LIST OF ABBREVIATIONS

EHR	-	Electronic Health Records
EMR	-	Electronic Medical Records
PHR	-	Personalize Health Records
ECC	-	Elliptical Curve Cryptography
UTeM	-	Universiti Teknikal Malaysia Melaka
OS	-	Operating System
HTML	-	Hypertext Markup Language
CSS	-	Cascading Style Sheet
API	-	Application Programming Interface
PWD	-	People with Disability
RAD	-	Rapid Application Development
M-PHR	-	Mobile Personalized Health Records
VTs	-	Vital Sign

XML	-	Extensive Markup Language
OOP	-	Object Oriented Programming
DFD	-	Data Flow Diagram
1PHRS	-	1Personalised Health Record System
HTTP	-	Hypertext Transfer Protocol
WLAN	-	Wireless Local Area Network
GPS	-	Global Positioning System
JSP	-	Java Server Pages
PWD	-	People With Disability
RMI	-	Remote Method Invocation
JSON	-	JavaScript Object Notation
PhP	-	hypertext preprocessor
MVC	-	Model View Controller

LIST OF PUBLICATIONS

Aris, F., & Ghani, M. K. A. (2013, November). Hybrid Mobile Application Framework for Pervasive Health Record (HMAF4PHR). In e-Proceeding of Software Engineering Postgraduates Workshop (SEPoW) (p. 44).

Ghani, M. K. A., & Aris, F. (2015). The Design of Mobile Personalised Health Records. *Jurnal Teknologi*, 77(18).

LIST OF SYMBOLS

H_0	-	Null hypothesis
H_1	-	Alternative hypothesis
σ	-	Variance
$>$	-	More than
$<$	-	Less than
\bar{x}	-	Mean
α	-	Alpha
μ	-	Mean
Σ	-	Sum of
σ^2	-	Variance population

CHAPTER 1

INTRODUCTION

1.1 Background

Smartphones have become a new trend and advancement for healthcare domain. In fact since 2013, the smartphones ownership rates have skyrocketed in many countries and in Malaysia the percentage have increase 34% (Poushter, 2016). This is beneficial for the healthcare provider as the healthcare providers or the healthcare professionals can utilize the technology for making the healthcare services one step forward to the advancement. Based on the statistical analysis on the mobile operating system market share in Malaysia, it shows that on December 2016 android user with 81.19%, iOS with 13.25%. BlackBerry OS with 0.16% and Symbian OS with 0.15% (StatCounter, 2016). This data shows that each operating system has their own users and even Blackberry and Symbian OS still have their consumers that use it. These multiple platforms have their own languages and approaches, that making developer to develop the same application in many languages.

The healthcare records are the most crucial and important data that will be used by the medical practitioner for aiding their investigation on patient problems and providing accurate treatment to the patients. A pervasive health record is another step in the advancement of the healthcare domain and with a pervasive health record; the data can be accessed anytime and anywhere. The pervasive health monitoring, intelligent emergency management system, pervasive healthcare data access and ubiquitous mobile telemedicine

is some of the pervasive healthcare applications (Varshney, 2007 cited in Portela et al., 2012).

A pervasive healthcare systems are needed due to the healthcare professionals experiencing a high level of mobility and they need to share resources and information with the staffs, faculty and colleagues in a real time environment (Ahamed et al., 2007 cited in Theoharidou et al., 2014).

Development of Architecture for Pervasive Health Record in Mobile Application is an architecture that uses a wireless connection to access data on the server. The wireless healthcare application allows healthcare workers to access health data and information that in turns can be useful for them to assist in a temporary prescription and emergency treatment when providing immediate access to health information (Wang et al., 2008 cited in Kim, 2014).

The research on the pervasive healthcare is beneficial because there are several impacts to clinical workflows that may be expected from a pervasive access to images, patient's data, and analysis function becomes available via mobile and wireless device such as nomadic healthcare worker, radiologist and data explosion crisis, mission critical systems and the medical IT specialist (Pohjonen et al., 2007 cited in Valente et al., 2016).

1.2 Health Records Problem and its Context

Electronic Health Records (EHR) is the digital format of patient's medical records. EHR facilitate electronic collection and organization of important information such as basic demographics to billing and coding reports to medications to laboratory values (Miriovsky et al., 2012). The patient's health record contains crucial information that could ease the

doctors to determine the conditions of the patients and to prescribe a suitable medicine and treatment for the patients. Hoffman and Podgurski (2013) had stated that patient's medical records may scattered in different locations due to patients that may see different doctors in different facilities. This could hinder the surveillance and research efforts for the patients (Hoffman and Podgurski, 2013). These also showed that inadequate access to the patient's health record could lead to wrong treatment and could endanger the patient's life.

Electronic Medical Records (EMR) consists all type of data from texts, images, wave, audio, video etc. All the imaging modalities such as ultrasounds and others are important and needed by all hospitals (Pohjonen et al., 2007 cited in Viana-Ferreira et al., 2013). However, it is impossible for all these homogenous medical records could be stored in mobile devices. To overcome the problem, an analysis of important EMR datasets needs to be conducted for identifying the related and meaningful data to be viewed by the doctor.

1.3 Research Aim

The aim on this research is to develop and to propose a validated architecture for pervasive health record in mobile application that is used for maintaining pervasive health records using smartphones. This research also identifies the best hybrid model and the crucial patient health records datasets to be adopted in the proposed architecture.