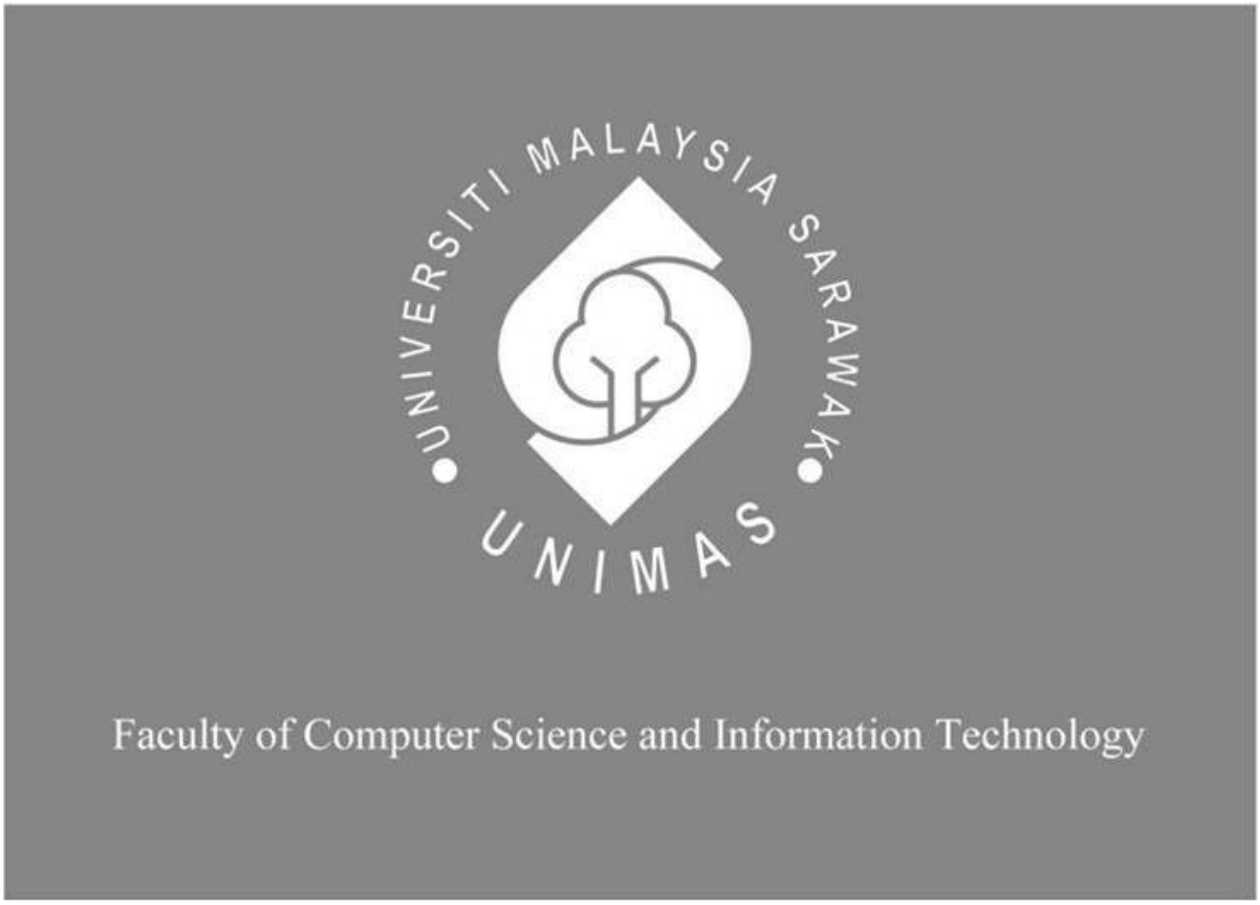

HOSPITAL INPATIENT TRACKING SYSTEM USING RFID TECHNOLOGY

Ling Chia Chin

Bachelor of Computer Science with Honors

(Computational Science)

2019-2020

HOSPITAL INPATIENT TRACKING SYSTEM USING RFID TECHNOLOGY

LING CHIA CHIN

This project is submitted in partial fulfilment of the requirements for the degree of

Bachelor of Computer Science with Honors

(Computational Science)

Faculty of Computer Science and Information Technology

UNIVERSITI MALAYSIA SARAWAK

2019-2020

HOSPITAL INPATIENT TRACKING SYSTEM USING RFID TECHNOLOGY

LING CHIA CHIN

Projek ini merupakan salah satu keperluan untuk

Ijazah Sarjana Muda Sains Komputer dengan Kepujian

(Sains Komputan)

Fakulti Sains Komputer dan Teknologi Maklumat

UNIVERSITI MALAYSIA SARAWAK

2019-2020

UNIVERSITI MALAYSIA SARAWAK

THESIS STATUS ENDORSEMENT FORM

TITLE HOSPITAL INPATIENT TRACKING SYSTEM USING RFID TECHNOLOGY

ACADEMIC SESSION: 2019/2020

LING CHIA CHIN

(CAPITAL LETTERS)

hereby agree that this Thesis* shall be kept at the Centre for Academic Information Services, Universiti Malaysia Sarawak, subject to the following terms and conditions:

1. The Thesis is solely owned by Universiti Malaysia Sarawak
2. The Centre for Academic Information Services is given full rights to produce copies for educational purposes only
3. The Centre for Academic Information Services is given full rights to do digitization in order to develop local content database
4. The Centre for Academic Information Services is given full rights to produce copies of this Thesis as part of its exchange item program between Higher Learning Institutions [or for the purpose of interlibrary loan between HLI]
5. ** Please tick (√)

☐	CONFIDENTIAL	(Contains classified information bounded by the OFFICIAL SECRETS ACT 1972)
☐	RESTRICTED	(Contains restricted information as dictated by the body or organization where the research was conducted)
☑	UNRESTRICTED	

Validated by

(AUTHOR'S SIGNATURE)

(SUPERVISOR'S SIGNATURE)

Permanent Address

NO 130, PASAR BATU 7, KOTA SENTOSA, JALAN PENRISSEN, 93250, KUCHING, SARWAK

Date: 5 August 2020

Date: 7 August 2020

Note * Thesis refers to PhD, Master, and Bachelor Degree

** For Confidential or Restricted materials, please attach relevant documents from relevant organizations / authorities

DECLARATION

I hereby declare that this thesis entitled "*Hospital Inpatient Tracking System Using RFID Technology*" is based on my original work. I have not copied from any other sources except for quotations and citations which have been duly acknowledge.

Signed,

(LING CHIA CHIN, 56461)

Faculty of Computer Science and Information Technology

Universiti Malaysia Sarawak

ACKNOWLEDGEMENT

First and foremost, I would like to express my deep and sincere gratitude to everyone who guided me I completing my final year project successfully. I would like to special thanks to my supervisor, Dr. Stephanie Chua Hui Li for providing invaluable guidance throughout this project. Her motivation and advice have deeply inspired me. She always ready for the meeting and discussion to ensure that I can proceed and complete the project with the smart way. Next, I would like to thank the final year project coordinator, Professor Dr. Wang Yin Chai for guiding me complete the project which fulfil all of the requirements and formats. Besides, I would like to thank to my examiner, Dr. Jacey Lynn Minoi for commenting my project for improving the work. Lastly, I would like to thank to my family and friends for supporting and helping me to complete my final year project.

ABSTRACT

Hospital Inpatient Tracking System Using RFID Technology is a web application developed for the medical personnel (doctors and nurses) to track the movements of the inpatients in the A&E departments of government hospital. RFID reader fixed in each of the rooms will detect the patient who is wearing a registered tag when enter and leave from the room. It is designed to solve the problems of long queues, overcrowding, delayed treatments and insufficient beds for patients. Tracking process is taken to track all of the registered patient. At the same time, duration of patient process in each of the room will be recorded and calculated to get the range of processing time in each of the room. It can used to reference and solve the bottlenecks faced by the hospital. All of the medical personnel need to register and approve by system administrator before can access in the system.

ABSTRAK

Hospital Inpatient Tracking System Using RFID Technology adalah aplikasi web yang dibuat untuk kakitangan perubatan (doktor dan jururawat) untuk mengesan pergerakan pesakit dalam jabatan A & E hospital kerajaan. Pembaca RFID yang tetap di dalam setiap bilik akan mengesan pesakit yang memakai tag berdaftar semasa masuk dan keluar dari bilik. Ia direka untuk menyelesaikan masalah antrian panjang, kesesakan, rawatan tertunda dan katil yang tidak mencukupi untuk pesakit. Proses penjejakan dilakukan untuk mengesan semua pesakit berdaftar. Pada masa yang sama, tempoh proses pesakit di setiap bilik akan direkodkan dan dikira untuk mendapatkan julat waktu pemprosesan di setiap bilik. Ia boleh digunakan untuk rujukan dan menyelesaikan kesesakan yang dihadapi oleh hospital. Semua kakitangan perubatan perlu mendaftar dan meluluskan oleh pentadbir sistem sebelum boleh mengakses dalam sistem.

Table of Contents

DECLARATION ..... **i**
ACKNOWLEDGEMENT ..... **ii**
ABSTRACT ..... **iii**
ABSTRAK ..... **iv**
LIST OF FIGURES ..... **v**
LIST OF TABLES ..... **viii**
1.0 CHAPTER 1: INTRODUCTION **1**
1.1 Project Title 1
1.2 Introduction/Background 1
1.3 Problem Statement 2
1.4 Aims and Objectives 2
1.5 Methodology 2
1.5.1 Analysis and Quick Design 3
1.5.2 Prototype Cycles 3
1.5.3 Testing 4
1.5.4 Implementation 4
1.6 Scope 4
1.7 Significance of Project 4
1.8 Project Schedule 5
1.9 Expected Outcome 6
1.10 Thesis Outline 6
1.10.1 Chapter 1: Introduction 6
1.10.2 Chapter 2: Literature Review 6
1.10.3 Chapter 3: Requirement Analysis and Design 6
1.10.4 Chapter 4: Implementation and Testing 7
1.10.5 Conclusion and Future Work 7
1.11 Summary **7**
2.0 CHAPTER 2: LITERATURE REVIEW **8**
2.1 Introduction 8
2.2 Reviews on Similar Existing Systems 8
2.2.1 Mobile RFID Kids Tracking System 8
2.2.2 Application using RFID Technology in Patient Management System 9

2.2.3 Indoor Positioning System Using Ultrasonic Technology....12
2.3 Comparison between the system reviewed and the proposed system....13
2.4 Reviews on Tools and Technology Used....15
2.4.1 Laravel....15
2.4.2 XAMPP....16
2.4.3 Bootstrap....16
2.4.4 RFID Technology....16
2.5 Summary....17
3.0 CHAPTER 3: REQUIREMENT ANALYSIS AND DESIGN....18
3.1: Introduction....18
3.2: Requirement Analysis....18
3.2.1: Software Requirements....19
3.2.2: Hardware Requirements....19
3.2.3: Functional Requirements....20
3.2.4: Non-Functional Requirements....21
3.3: Design....22
3.3.1: System Architecture Design....22
3.3.2: Module Design....23
3.3.3: Database Design....31
3.3.4: User Interface Design....37
3.4: Summary....49
4.0 CHAPTER 4: IMPLEMENTATION AND TESTING....50
4.1 Introduction....50
4.2 Development Tools and Technology Used....50
4.2.1 Sublime Text....50
4.2.2 Bootstrap....51
4.2.3 XAMPP....51
4.2.4 Laravel....51
4.2.5 RFID Technology....52
4.3 Website Implementation....53
4.3.1 System Design....53
4.3.2 Login Page....54
4.3.3 Registration Page....55
4.3.4 System Administrator Panel....57

4.3.5 Medical Personnel Panel 64
4.4 Database Implementation 82
4.5 Testing 89
4.5.1 Developer Site Testing 89
4.6: Summary 95
5.0 CHAPTER 5 CONCLUSION AND FUTURE WORK 96
5.1 Introduction 96
5.2 Contribution 96
5.3 Limitation 97
5.4 Future Works 97
5.5 Conclusion 98
REFERENCES 99

LIST OF FIGURES

Figure 1.1: Rapid Application Development (Anderson, 2019) 3
Figure 1.2: Gantt Chart for the Project Schedule 5
Figure 2.1: Hardware Architecture (Al-Ali et al., 2008) 9
Figure 2.2: Flow Chart of RFID Patient Tracking System (Mapa & Saha, 2015) 10
Figure 2.3: Schematic of Hospital (Mapa & Saha, 2015) 11
Figure 2.4: RFID Patient Tracking System (Mapa & Saha, 2015) 11
Figure 2.5: Overall System Design ("4th Year Project - Indoor Positioning System," n.d.) 12
Figure 2.6: Active RFID system 17
Figure 3.1: System Architecture Diagram in HITS 22
Figure 3.2: Context Diagram in HITS 23
Figure 3.3: Level 0 Data Flow Diagram in HITS 24
Figure 3.4: Level 1 Data Flow Diagram of Process 1.0 in HITS 25
Figure 3.5: Level 1 Data Flow Diagram of Process 2.0 in HITS 26
Figure 3.6: Level 1 Data Flow Diagram of Process 3.0 in HITS 27
Figure 3.7: Level 1 Data Flow Diagram of Process 4.0 in HITS 28
Figure 3.8: Level 1 Data Flow Diagram of Process 5.0 in HITS 29
Figure 3.9: Level 1 Data Flow Diagram of Process 6.0 in HITS 30
Figure 3.10: Entity Relationship Diagram 31
Figure 3.11: User Interface Design of Medical Personnel (Registration) 37
Figure 3.12: User Interface Design of Medical Personnel and System Administrator (Login) 38
Figure 3.13: User Interface Design of System Administrator (Manage Reader Section) 39
Figure 3.14: User Interface Design of System Administrator (Manage User) 40
Figure 3.15: User Interface Design of System Administrator (New User Request) 41
Figure 3.16: User Interface Design of System Administrator (Inactive User Record) 42
Figure 3.17: User Interface Design of Medical Personnel (Dashboard) 43
Figure 3.18: User Interface Design of Medical Personnel (Tag Exist Checking) 44
Figure 3.19: User Interface Design of Medical Personnel (Register New Patient) 45
Figure 3.20: User Interface Design of Medical Personnel (Patient Activity) 46
Figure 3.21: User Interface Design of Medical Personnel (Report Generator) 47
Figure 3.22: User Interface Design of Medical Personnel (Profile) 48

Figure 4.1: RFID Readers and Tags 52
Figure 4.2: System Design of HITS 53
Figure 4.3: Login Page 54
Figure 4.4: Registration Page 55
Figure 4.5: Waiting for Approval 56
Figure 4.6: Email Notification of New User 57
Figure 4.7: New User Request 58
Figure 4.8: Manage Reader Section 59
Figure 4.9: New Reader Section 60
Figure 4.10: Manage User 61
Figure 4.11: User Details 62
Figure 4.12: Inactive User Record 63
Figure 4.13: Email Notification for Approved User 64
Figure 4.14: Email Notification for Rejected User 65
Figure 4.15: User Profile 66
Figure 4.16: Register New Patient 67
Figure 4.17: Patient Profile List 68
Figure 4.18: Patient Activity 69
Figure 4.19: Dashboard 70
Figure 4.20: Outpatient Details 71
Figure 4.21: Real-Time Tracking Section Record 72
Figure 4.22: Tag Exist Checking 73
Figure 4.23: Pop-up Patient Details 74
Figure 4.24: Report Generator 75
Figure 4.25: Over Time Queuing for Each Section 76
Figure 4.26: Over Time Patients Queuing in Months 77
Figure 4.27: Average Time Spend Queuing for Each Section 78
Figure 4.28: Average Time Spend Queuing in Months 79
Figure 4.29: Patients Registered and Real-Time Tracking 80
Figure 4.30: Download PDF 81
Figure 4.31: Database of HITS, hits 82
Figure 4.32: “history” Table of hits database 83

Figure 4.33: “patients” Table of hits database 84
Figure 4.34: “readers” Table of hits database 85
Figure 4.35: “tags” Table of hits database 86
Figure 4.36: “tracks” Table of hits database 87
Figure 4.37: “users” Table of hits database 88

LIST OF TABLES

Table 2.1: Comparison betwen the System Reviewed and the Proposed System 14
Table 3.1: Software requirements of HITS.....19
Table 3.2: Hardware requirements of HITS 19
Table 3.3: Data dictionary for users table.....32
Table 3.4: Data dictionary for readers table.....33
Table 3.5: Data dictionary for patients table.....34
Table 3.6: Data dictionary for tags table.....34
Table 3.7: Data dictionary for tracks table.....35
Table 3.8: Data dictionary for history table.....36
Table 4.1: Test Case on Login Page 89
Table 4.2: Test Case on Registration Page 89
Table 4.3: Test Case on Email Notification.....90
Table 4.4: Test Case on New User Request.....90
Table 4.5: Test Case on Manage Reader Section 91
Table 4.6: Test Case on Manage User 91
Table 4.7: Test Case on Manage Patient.....92
Table 4.8: Test Case on Check Exist Tag.....92
Table 4.9: Test Case on Tracking 93
Table 4.10: Test Case on Dashboard 93
Table 4.11: Test Case on Generate Report 94
Table 4.12: Test Case on User Profile 94
Table 5.1: Objectives and Achievements.....97

1.0 CHAPTER 1: INTRODUCTION

1.1 Project Title

Hospital Inpatient Tracking System (HITS) Using RFID Technology

1.2 Introduction/Background

The Accident and Emergency Department (A&E) in general hospital provides care to patients who arrive following an accident or with an emergency medical condition without prior appointment. All patients will be triaged and given priority status by determining according to the condition of the patient. Patients belonging to the non-priority status category will be requested to register at the registration counter first. Then, the patients will be seen by the doctor following the visit number. The patients will be categorized into three zones that are green, yellow and red zone. Green zone states that the patient which is an outpatient and can be discharged directly after treatment. Yellow zone states that the patient is an inpatient who needs to be observed and may need to be admitted. Red zone states that the patient which is an inpatient with serious condition and needs to be admitted. After consultation, the patient will be admitted, observed or discharged. The inpatient in the yellow and red zone will be admitted to the wards and will undergo treatment and medical checkup processes for example X-Ray, Blood Test and Physiotherapy. Finally, the inpatient either will be discharged from the hospital, transferred to other hospital or transferred to the mortuary for deceased cases. This is the current scenario for the movement of patients from admission to A&E until the patient is being discharged from the hospital.

1.3 Problem Statement

The current problems faced by the A&E departments in government hospitals are long queues, overcrowding, delayed treatments and insufficient beds for patients (Eller, 2018). The medical personnel, comprising doctors and nurses track and monitor their patients' movements using phone call or orally asking among themselves. This tracking process is currently done manually in the hospitals. With the high number of patients per day, this is a time-consuming process and they sometimes missed out on patients who need treatment. The security of the patients in the hospital cannot be ensured because the medical personnel cannot track the location of patients 24 hours. These are cases where patients escaped from the hospital for various reasons such as refusing treatments and wanting to go home.

1.4 Aims and Objectives

The objectives of the project are

i. To design the HITS Using RFID Technology.
ii. To develop HITS as a web application.
iii. To test the proposed HITS through simulation cases.

1.5 Methodology

Rapid Application Development (RAD) with flexibility software development methodology is chosen to be used in this project. It is an approach to software development aimed at rapid delivery of the software (Sommerville et al., 2011). It is a development model that prioritizes rapid prototyping with quick feedback over long drawn out development and testing cycles (Kissflow, 2018). Due to the limited time for developing this project, RAD is suggested to be

used for producing quality project with frequent improvement and redesigning according to the requirements gathered during the process of development. RAD includes four basic steps in the process of building a software. They are analysis and quick design, prototype cycles, testing, and implementation.

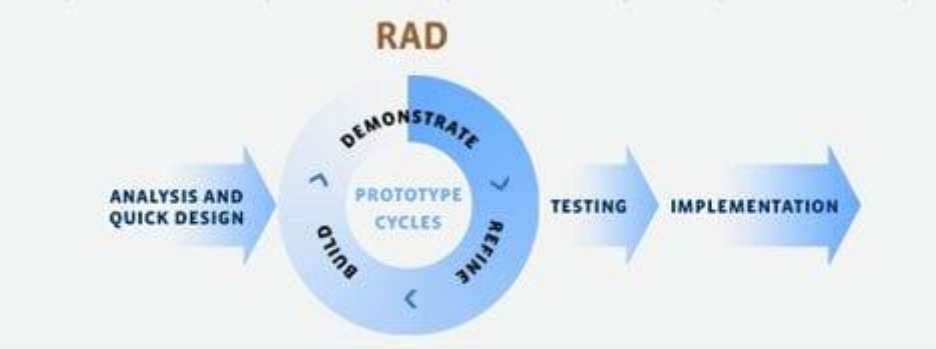

Figure 1.1: Rapid Application Development (Anderson, 2019)

1.5.1 Analysis and Quick Design

The first phase in the RAD is analysis and quick design for this proposed application. This is the process of collecting and interpreting facts, identifying the problems and design for the system according to the requirements gather from lecturer and research. A series of meeting with lecturer or research will be conducted to identify the issues and current situation. Then, a quick design will be done to analyze more of the details for the proposed application.

1.5.2 Prototype Cycles

The second phase is the prototype cycles. Development will be started after the quick design is done. Every version of prototype will be demonstrated to the lecturer and their feedbacks collected to do refinement. Various types of prototype will be developed due to the improvement and redesign according to the requirements needed.

1.5.3 Testing

The third phase is testing. Process of testing will be taken through different scenarios after the proposed application done. This proposed application will be always repeated testing until application can be fully functioned to accomplish the application's goal.

1.5.4 Implementation

The final phase is implementation. The application will be released to the stakeholders after fully tested and is able to function correctly.

1.6 Scope

The main scope of this proposed application is to track the movements of the inpatients in the hospital using RFID technology. The users for this proposed application are the administrator and medical personnel (doctors and nurses). The project will simulate the tracking of the movement of patients from the A&E department to the ward, as well as, covering movement to three procedure department; X-ray, blood bank and physiotherapy.

1.7 Significance of Project

The HITS is to track in real time movements of the inpatients in the hospital using RFID technology. The use of technology in this domain can help to study the congestion, long queues and bottleneck problems, particularly in the A&E department of public general hospitals.

1.8 Project Schedule

ID	Task Name	Duration	Start	Finish
1	**Final Year Project 1**	**117 days**	**Tue 17/9/19**	**Sat 11/1/20**
2	Define the project title	4 days	Tue 17/9/19	Fri 20/9/19
3	Preparation of Brief Proposal	6 days	Sat 21/9/19	Thu 26/9/19
4	Submission of Brief Proposal	1 day	Sun 29/9/19	Sun 29/9/19
5	Preparation of Full Proposal	15 days	Mon 30/9/19	Mon 14/10/19
6	Submission of Full Proposal	1 day	Sat 19/10/19	Sat 19/10/19
7	Chapter 1 Preparation	6 days	Sun 20/10/19	Fri 25/10/19
8	Chapter 1 Submission	1 day	Sat 26/10/19	Sat 26/10/19
9	Chapter 2 Preparation	16 days	Sun 27/10/19	Mon 11/11/19
10	Chapter 2 Submission	1 day	Sat 16/11/19	Sat 16/11/19
11	Chapter 3 Preparation	14 days	Sun 17/11/19	Sat 30/11/19
12	Project Analysis	4 days	Sun 17/11/19	Wed 20/11/19
13	Project Design	4 days	Thu 21/11/19	Sun 24/11/19
14	Discussion with Supervisor	2 days	Wed 27/11/19	Thu 28/11/19
15	Content Amendment	4 days	Fri 29/11/19	Mon 2/12/19
16	Chapter 3 Submission	1 day	Thu 5/12/19	Thu 5/12/19
17	FYP 1 Symposium Preparation	4 days	Fri 6/12/19	Mon 9/12/19
18	FYP 1 Full Report Preparation	4 days	Fri 6/12/19	Mon 9/12/19
19	FYP 1 Presentation Slides	4 days	Fri 13/12/19	Mon 16/12/19
20	FYP 1 Symposium	2 days	Tue 17/12/19	Wed 18/12/19
21	FYP 1 Report Amendment	20 days	Fri 20/12/19	Wed 8/1/20
22	FYP 1 Full Report Submission	2 days	Fri 10/1/20	Sat 11/1/20
23	**Final Year Project 2**	**201 days**	**Tue 28/1/20**	**Sat 15/8/20**
24	Revised Structure of FYP Report	3 days	Fri 14/2/20	Sun 16/2/20
25	Chapter 4: Implementation and Testing	138 days	Thu 30/1/20	Mon 15/6/20
26	Chapter 5: Conclusion and Future Work	14 days	Tue 16/6/20	Mon 29/6/20
27	First Draft for FYP 2 Full Report and Paper	6 days	Tue 30/6/20	Sun 5/7/20
28	Final Report and Paper	10 days	Mon 6/7/20	Wed 15/7/20
29	FYP 2 Symposium	4 days	Tue 21/7/20	Fri 24/7/20
30	Modification and Amendment of FYP 2	25 days	Tue 21/7/20	Fri 14/8/20
31	FYP 2 Final Report	1 day	Sat 15/8/20	Sat 15/8/20

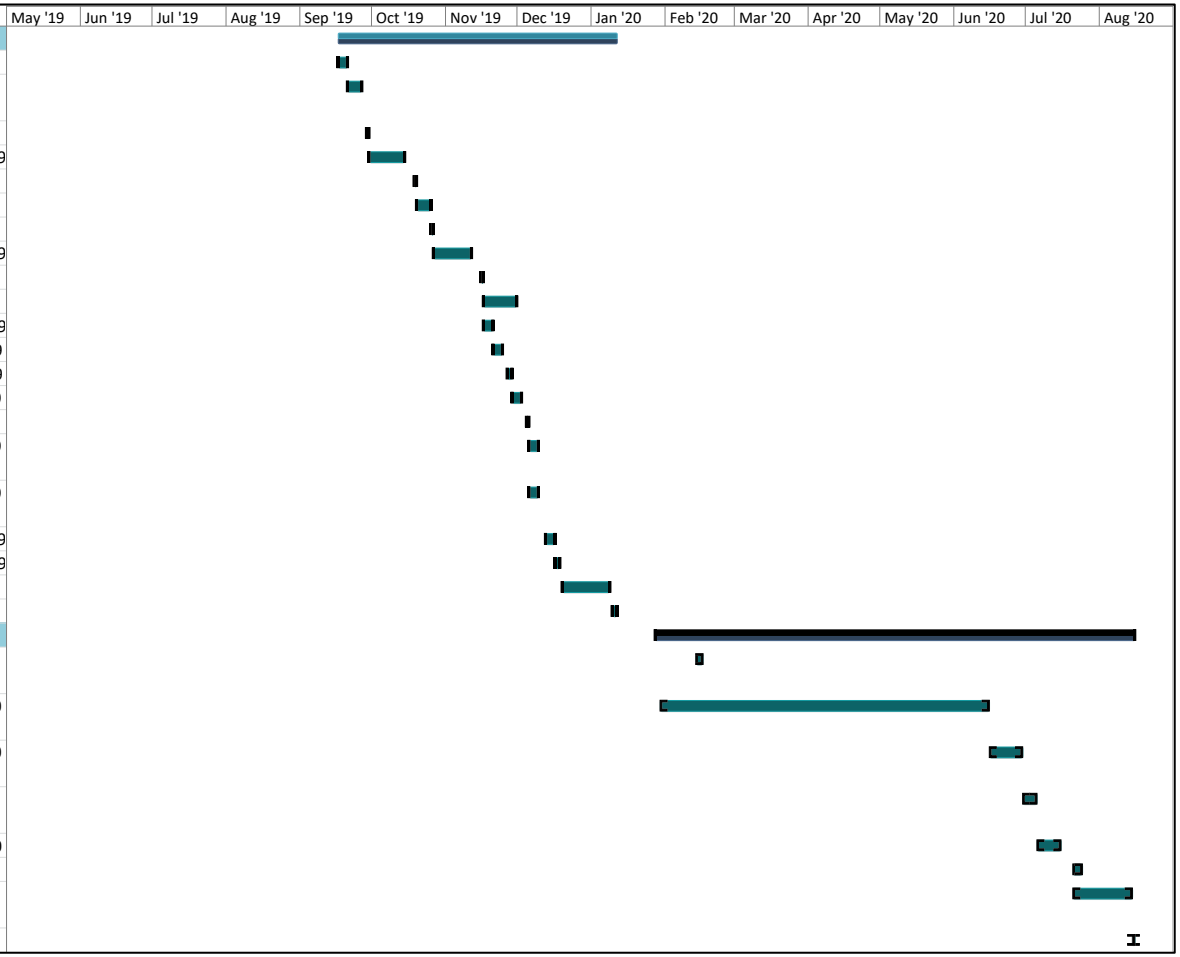

Figure 1.2: Gantt Chart for the Project Schedule

1.9 Expected Outcome

The expected outcome of this project is a web application for the Hospital Inpatient Tracking System (HITS).

1.10 Thesis Outline

1.10.1 Chapter 1: Introduction

Chapter 1 is an introduction or overview for this proposed application. This chapter contains the background for the current scenario, problem statements, objectives for doing this proposed application, software development methodology used to undertake the process of design, develop and testing. Next, the scope and significance of the project are stated, project schedule is planned and arranged and an expected outcome.

1.10.2 Chapter 2: Literature Review

Chapter 2 discusses about the existing applications which are similar to the proposed application through sources such as articles, books, websites and researches. The review and comparison will be discussed in this chapter. Tools and software used will also be discussed.

1.10.3 Chapter 3: Requirement Analysis and Design

Chapter 3 discusses about the requirement analysis and design for this proposed application. The methodology of the Rapid Application Development (RAD) is used to undertake the process of gathering the requirements, analysis and design for the system architecture, functions, database and interfaces.

1.10.4 Chapter 4: Implementation and Testing

Chapter 4 describes about the implementation and testing for this proposed application. Various type of testing will be taken. They are functionality, usability, interface, database, compatibility, performance, security and crowd testing.

1.10.5 Conclusion and Future Work

Chapter 5 discusses conclusion of the project and future work to enhance the system.

1.11 Summary

This chapter is the introduction for the proposed web application which is HITS using RFID Technology. The overview for this proposed application is explained. The patients' flow from A&E department to the ward until discharge from the general hospital is explained in the background. Problems according to the current scenario in the hospital and the objectives need to do in this chapter is stated. RAD is chosen to be used as software development methodology. Scope and significance of this project are stated too. Project schedule is planned and performed in the form of Gantt Chart. Then, the expected outcome for this project is a web application.

2.0 CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Chapter 2 discusses about the reviews on similar existing systems and the tools and technologies used for this proposed application. The features and functions for each of the existing systems will be stated and compared. This is to study the existing systems for improving the proposed application. Then, the tools and technology used for this proposed application will be discussed and analyzed. This is to determine which software and technology is the best fit for the development of this proposed application.

2.2 Reviews on Similar Existing Systems

2.2.1 Mobile RFID Kids Tracking System

Al-Ali et al. (2008) proposed a mobile tracking system using RFID technology. This tracking system is designed for the kids. The objective of their project is to track the lost kids in a large open area. Movements of the kids in an open area, such as a park or mall can be tracked using RFID technology. The tag readers are distributed around the open area. The kids wear the RFID tags can communicate between the tag reader by antenna and the signals are sent to the web server via wireless LANs. All communication functions are done at the main station, an Application Programming Interface (API) to analyse the connection, receive and analyse signal from the reader and finally update the reading and client information to the database (Al-Ali et al., 2008). This system requires active readers with an omni-directional antenna that provides a coverage area of at least 30 meters.

The kids need to be registered as user in the system by providing name, age and parent's phone name. The system will assign a new tag number to the new user from the pool of

unassigned tag numbers. Location of the kids will be displayed in the system. Route taken by the child by plotting the last detected position will be shown and the parents are able to connect with their kids. This system can delete a user by suspending the tracking from the system by specifying the tag number.

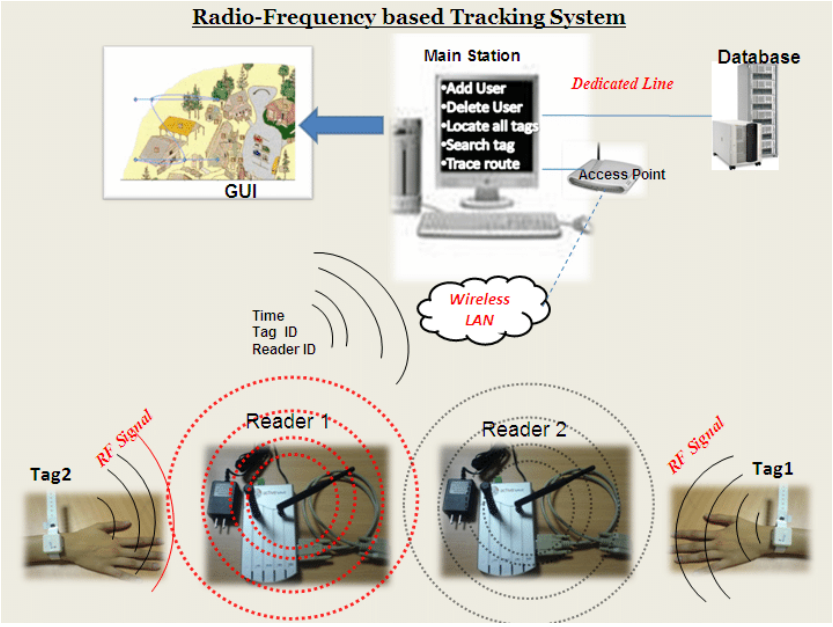

Figure 2.1: Hardware Architecture (Al-Ali et al., 2008)

2.2.2 Application using RFID Technology in Patient Management System

Mapa & Saha (2015) proposed an application using RFID Technology in Patient Management System. The objective of their project is to minimize the time serving a patient by identifying the patient, type of service required, history of treatment, waiting time and accessing personal information. Each of the patients will be given a passive RFID tag with personal information during registration in the hospital. Data is collected from the time the patient enters into a processing area (admission, waiting, nurse exam, waiting, doctor exam, billing) until being discharged. The flow chart for this patient tracking system and schematic of the hospital is as shown in Figure 2.2 and Figure 2.3 respectively.