

**TIER CLASSIFICATIONS FOR RFID LIBRARIES
IN THAILAND**

NATTACHATR SOPITKAMOL

**A THEMATIC PAPER SUBMITTED IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE
(INFORMATION TECHNOLOGY MANAGEMENT)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2015**

COPYRIGHT OF MAHIDOL UNIVERSITY

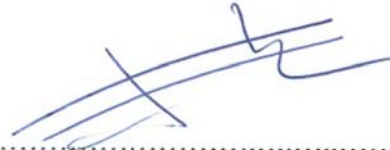
Thematic Paper
entitled
**TIER CLASSIFICATIONS FOR RFID LIBRARIES
IN THAILAND**



.....
Miss Nattachat Sopitkamol
Candidate



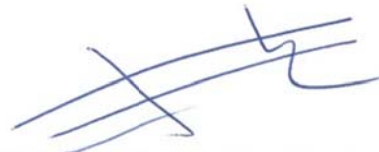
.....
Lect. Sotarath Thammaboosadee,
Ph.D. (Information Technology)
Major advisor



.....
Asst. Prof. Supaporn Kiattisin,
Ph.D. (Electrical and Computer
Engineering)
Co-advisor



.....
Prof. Patcharee Lertrit,
M.D., Ph.D. (Biochemistry)
Dean
Faculty of Graduate Studies
Mahidol University



.....
Asst. Prof. Supaporn Kiattisin,
Ph.D. (Electrical and Computer
Engineering)
Program Director
Master of Science Program in
Information Technology Management
Faculty of Engineering
Mahidol University

Thematic Paper
entitled
**TIER CLASSIFICATIONS FOR RFID LIBRARIES
IN THAILAND**

was submitted to the Faculty of Graduate Studies, Mahidol University
for the degree of Master of Science
(Information Technology Management)

on
August 4, 2015



.....
Miss Nattachatr Sopitkamol
Candidate



.....
Asst. Prof. Adisorn Leelasantitham,
Ph.D. (Electrical Engineering)
Chair



.....
Lect. Sotarath Thammaboosadee,
Ph.D. (Information Technology)
Member



.....
Asst. Prof. Kairoek Choeychuen,
Ph.D. (Electrical and Computer
Engineering)
Member



.....
Asst. Prof. Supaporn Kiattisin,
Ph.D. (Electrical and Computer
Engineering)
Member



.....
Prof. Patcharee Lertrit,
M.D., Ph.D. (Biochemistry)
Dean
Faculty of Graduate Studies
Mahidol University



.....
Asst. Prof. Jackrit Suthakorn,
Ph.D. (Robotics)
Dean
Faculty of Engineering
Mahidol University

ACKNOWLEDGEMENTS

I would like to express my special appreciation to my advisor, Dr. Sotarat Thammaboosadee, who has not only been patiently provides his guidance, but also a mentor to me throughout the course. I thank her for pushing me for this research.

I am grateful to Asst. Prof. Supaporn Kiattisin, who is a great inspiration to this course. I thank all the lecturers for the knowledge provided and the faculty members for all the assistance extended. It was a fun and memorable time of my life.

A special thanks to my family. I am very grateful to my mother and father for all the care, love and great encouragement always.

Many thanks also to all the fellow classmates, colleague, and friends and to those whom I have not listed above.

Nattachatr Sopitkamol

TIER CLASSIFICATIONS FOR RFID LIBRARIES IN THAILAND

NATTACHATR SOPITKAMOL 5637431 EGIT/M

M.Sc. (INFORMATION TECHNOLOGY MANAGEMENT)

THEMATIC PAPER ADVISORY COMMITTEE: SOTARAT

THAMMABOOSADEE, Ph.D., SUPAPORN KIATTISIN, Ph.D.

ABSTRACT

This study proposes a model of radio frequency identification system (RFID) to support the library management in making a decision that most suitable for their library, whether to deploy the complete RFID or choose the partial RFID system. Each library has its own objectives and set of characteristics. The RFID library system also consists of several components supporting the different functions that enhance and change the face of the overall library services. However, having a full system deployment may not prove to be an efficient solution for all the libraries.

The study offers an improved classifications model, based on a Decision Tree that includes all library characteristics and is also suitable for all types of libraries. The proposed model was proved effective and useful management for any library considering the deployment of RFID as a guideline for the best decision under the library's circumstances leading to the optimum solution for that particular library eventually.

KEY WORDS: RFID / LIBRARY CLASSIFICATIONS MODEL

48 pages

การแบ่งกลุ่มห้องสมุดที่ใช้เทคโนโลยีคลื่นความถี่วิทยุ (RFID) ในประเทศไทย

TIER CLASSIFICATIONS FOR RFID LIBRARIES IN THAILAND

ณัฐฤกษ์ ใศภิชญกุล 5637431 EGIT/M

วท.ม. (การจัดการเทคโนโลยีสารสนเทศ)

คณะกรรมการที่ปรึกษาสารนิพนธ์: โยทศรัต ธรรมบุษดี, Ph.D., สุภาภรณ์ เกียรติสิน, Ph.D.

บทคัดย่อ

การศึกษา เรื่อง การแบ่งกลุ่มห้องสมุดที่ใช้เทคโนโลยีคลื่นความถี่วิทยุ (RFID) ในประเทศไทย เกิดขึ้นโดยมีวัตถุประสงค์เพื่อพัฒนา Model ในการแบ่งกลุ่มห้องสมุด RFID ให้ผู้บริหารห้องสมุดสามารถใช้เป็นเครื่องมือสนับสนุนการตัดสินใจเลือกใช้ระบบยืม-คืนอัตโนมัติด้วยเทคโนโลยี RFID ในระดับที่เหมาะสมและสอดคล้องกับห้องสมุดของตน เนื่องจากห้องสมุดแต่ละแห่งมีวัตถุประสงค์และปัจจัยตลอดจนสภาพแวดล้อมที่แตกต่างกัน ประกอบกับระบบคลื่นความถี่วิทยุ (RFID) สำหรับงานห้องสมุดก็ประกอบด้วยอุปกรณ์ที่หลากหลายซึ่งมีลักษณะการทำงานที่แตกต่างกันในการอำนวยความสะดวกงานบริการผู้ใช้บริการของห้องสมุดยุคใหม่ การเลือกใช้ระบบ RFID อย่างเต็มรูปแบบทุกอุปกรณ์อาจไม่ใช่คำตอบที่เหมาะสมและก่อให้เกิดประสิทธิภาพสำหรับห้องสมุดทุกห้องสมุด

ผลจากการศึกษาดังกล่าวได้รับการปรับปรุงเป็นแบบจำลองต้นไม้มัดตัดสินใจที่คำนึงถึงปัจจัยทั้งหมดที่เกี่ยวข้องกับห้องสมุด และได้รับการพิสูจน์ว่าเป็นแบบจำลองที่สามารถนำไปใช้งานได้จริงสำหรับผู้บริหารห้องสมุดทุกประเภทและทุกห้องสมุดในการพิจารณาปัจจัยที่เกี่ยวข้องตามลำดับก่อน-หลัง และนำไปสู่ผลการตัดสินใจเลือกใช้ระบบยืม-คืนอัตโนมัติด้วยเทคโนโลยีคลื่นความถี่วิทยุ (RFID) ในระดับที่เหมาะสมกับห้องสมุดแต่ละแห่งในประเทศไทย

CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
ABSTRACT (ENGLISH)	iv
ABSTRACT (THAI)	v
LIST OF TABLES	viii
LIST OF FIGURES	ix
CHAPTER I INTRODUCTION	1
1.1 Background and problem statement	1
1.2 Objectives	2
1.3 Target of the Study	3
1.4 Expected Result	3
1.5 Timeline	3
CHAPTER II LITERATURE REVIEW	4
2.1 Definition Support Tool	4
2.2 Radio Frequency Identification (RFID)	4
2.2.1 Comparison between RFID and Barcode	6
2.3 RFID Application for Libraries	7
2.3.1 Components for RFID System for Libraries	8
2.4 Related Works	12
2.4.1 Use of RFID Technology in Libraries	16
CHAPTER III RESEARCH METHODOLOGY	19
3.1 Literature Review	20
3.2 Identification of Study Populations and Sample	20
3.3 Experts Opinion and Questionnaire to Librarian	20
3.4 Data Analysis and Data Processing	22

CONTENTS (cont.)

	Page
3.5 Constructing a Classification Model for RFID Libraries	24
3.6 Presentation of the Findings	24
CHAPTER IV RESULTS AND DISCUSSION	25
4.1 Data Analysis	26
4.2 Implementation	36
CHAPTER V CONCLUSION	40
5.1 Summary of the Results	40
5.2 Limitation and Suggestions	41
REFERENCES	42
APPENDIX	44
BIOGRAPHY	48

LIST OF TABLES

Table	Page
1.1 Study Timeline	3
2.1 Major Differences between Barcode and RFID Technologies	7
2.2 Overview of sample firms	13
2.3 Adoption pattern and characteristics	15
3.1 Analyzed Data Collected from Librarians	22
4.1 Experts Opinion on Each Library Criteria	32
4.2 Outcome of the Analyzed Library Surveys According to Experts' View	34

LIST OF FIGURES

Figure	Page
2.1 How RFID tag and reader communicate and send data for processing	5
2.2 RFID Frequencies	6
2.3 RFID Tags	8
2.4 Self-Check Kiosk	9
2.5 Staff Station	9
2.6 Tagging Station	10
2.7 Intelligent Security Gate	10
2.8 Book Drop/Return Unit	11
2.9 Mobile Inventory Unit	12
2.10 Different Tag Positions Tested	17
3.1 Research methodology framework	19
4.1 Total Budgets and Books from the 32 Surveys Response	25
4.2 Number of Experts Opinion on Each Library Problem	26
4.3 Number of Experts Opinion on Number of Books for Each Classification	27
4.4 Number of Experts Opinion on Library Location	28
4.5 Expert's Opinion on Library IT Budget	29
4.6 Number of Experts Opinion on Library Type	29
4.7 Number of Experts Opinion on Number of Patrons	30
4.8 Experts Opinion on Frequency of Monthly Visits to Library	31
4.9 Resulted Decision Tree	37
4.10 Suggested Decision Tree	39

CHAPTER I

INTRODUCTION

1.1 Background and problem statement

Nowadays, libraries must provide their patrons with better and faster services than ever. Patrons expect the faster books' checking out and in of books by librarian and leaves the least possible queuing delay. Each transaction must consume the minimal time. Patrons expect, wherever and whenever possible, a self-service transaction that they are more used to nowadays. In addition, the required books for patron's need must be found immediately.

Over the last decade, technology has evolved and provided a new revolution in library services. Such technology has played a significant role in facilitating libraries in Thailand to improve their services and the library operation method. Such technology is called Radio Frequency Identification (RFID) [1]. RFID technology for library has been developed since 1990 and deployed worldwide.

RFID, a small electronic device, consists of a small chip and an antenna. It is capable of carrying some data and serves the same purpose as barcode but it has many advantages over the barcode. Some advantages surrounding communication support of the library aspect also include the multiple items scan support, ability to communicate with regardless of positioning the book at a certain angle, ability to communicate with another RFID device at a distance much greater than barcode communicates with a barcode reader, etc. Its advantages lead to new service experience to patrons such as 24-hour self-checking in, and self-checking out. Transaction time can be reduced drastically from 20 seconds per book to 5 seconds for 20 books at self-check machine. Advantages of RFID for libraries include the time saving for staff operations, higher efficiency in operations, and easier inventory.

Most RFID libraries in the world apply the passive 13.56 MHz RFID transponders to the inside cover or spine of each book. The transponders are usually based on the ISO 15693 and ISO18000-3 standard. Each specific book in the library's

database is linked to a transponder, called tag. One benefit of such a system is self-checkout. Library patrons can walk up to a kiosk, place all chosen books near the reader and then swipe their own library card. The books can then pass a portal reader at the door without setting off an alarm. Interrogators can be placed in return bins, so the book can be recorded as having been returned. RFID speeds up work processes for librarians. Locating books can be performed quickly as well as it can take inventory with a handheld reader and other tasks.

Libraries wanting to implement RFID system have options to optimize their budget to their needs and various criteria such as the type of library they are, their locations, number of books, the problem they are facing, etc. Some may choose to implement the whole system. Others may partially employ the certain equipment which is suitable to their resources and services provided at the time. For example, libraries with inadequate staff relative to the provided services may require more self-service machines than others while relatively small-sized libraries may require only security items. Having a classification model will help libraries in many ways. It provides information on how the experts in the field classify the RFID libraries. It can be an easy guideline to consider the factor which is the first priority for determination for the decision making.

This paper attempts to create model for RFID classifications for libraries into two tiers, which are full system and partial system, according to the certain criteria from experts and collected factors of libraries in order to support the library executives to determine the most suitable combinations of equipment to their needs.

1.2 Objectives

The objective is to create the model for RFID classifications for libraries by collecting factors of existing libraries and matching them with the RFID implementation criteria from experts.

CHAPTER II

LITERATURE REVIEW

2.1 Decision Support Tool

There are many decision support tools. One that is commonly used in decision analysis is decision tree [2]. A decision tree is a flowchart like or tree like structure consisting of nodes. Each internal node represents one of the input variables with outgoing edges. The objective is to create a forecasting model, based on various input variables and a target variable. The forecasted outcome is the class to which the data belongs. Each class is represented by a leaf holding the most appropriate value.

2.2 Radio Frequency Identification (RFID)

Radio-Frequency Identification (RFID) is a form of automatic identification technology that transmits the identity of an object or a person wirelessly, using radio waves.

RFID system consists of a transponder (or RFID tag) that has a microchip attached to an antenna, and RFID reader/writer. The tag can store some data. Both tag and reader must work within the same frequency range in order to communicate with each other. When a tag is in the radio field, the reader captures the data on tag and sends to a computer system for processing. In Figure 2.1, it shows how RFID system works [3].

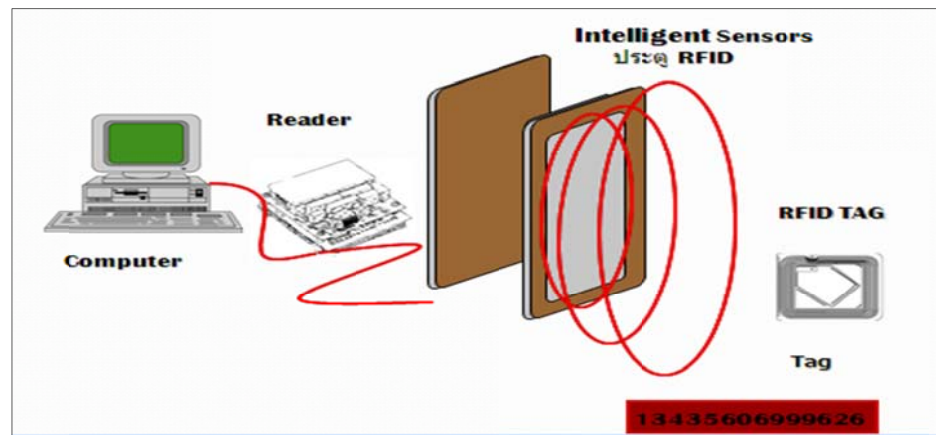


Figure 2.1 Mechanism of RFID System for Data Processing.

RFID has a wide range of spectrum group generally categorized as shown in Figure 2.2 [4]. Low frequency (LF), 125-134 KHz, has shorter read range and low reading speed. LF system read one tag at a time. Common application is animal identification. Ultra high frequency (UHF) operates around 860-960 MHz can read multiple tags at a fast speed though can be absorbed by liquid and humidity. High frequency (HF) system operates at 13.56MHz. In this frequency, RFID system reads tags at a fast speed and reads multiple tags simultaneously. HF also has the ability to penetrate liquid and humidity. Applications most commonly seen are library books identification and smart cards.

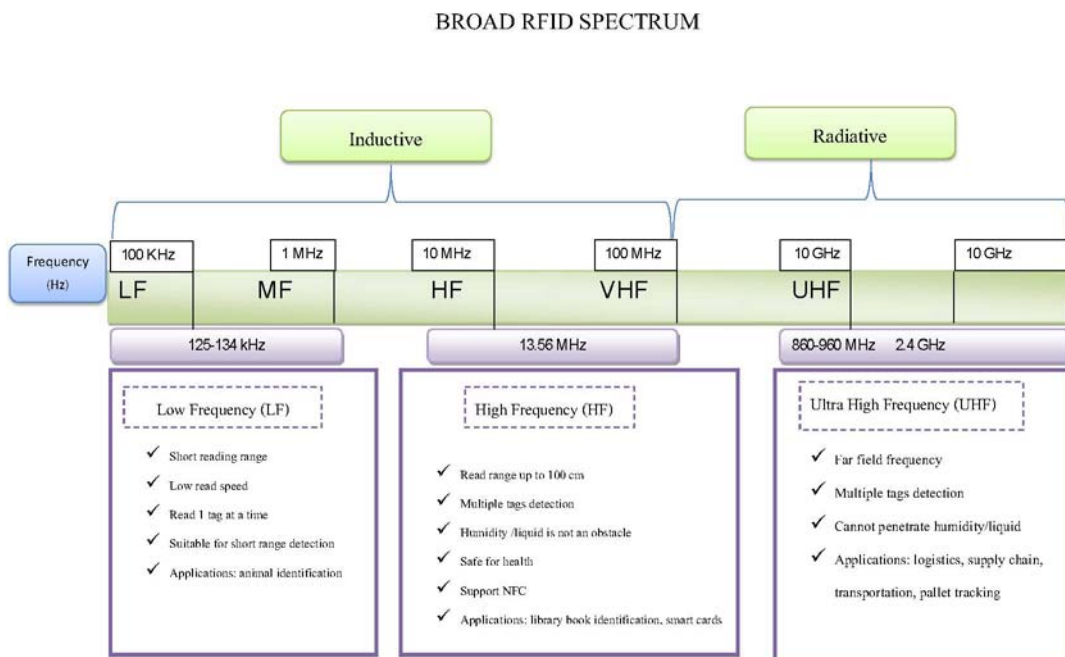


Figure 2.2 RFID Frequencies.

2.2.1 Comparison between RFID and Barcode

Barcode, an automatic identification technology, requires a person to manually scan the barcode on tag to capture data. We are all familiar with the difficulty that store checkout clerks sometimes have in making sure that a barcode can be read. Obviously, credit cards and ATM cards must be swiped through a special reader for payment.

In contrast, RFID device does not need to be positioned precisely relative to the scanner for the data to be read, and works within a few feet (up to 20 feet for high-frequency devices) of the scanner. For example, we could just put all of our groceries or purchases in a bag, and set the bag on the scanner. It would be able to query all of the RFID devices and total our purchase immediately.

Both barcode and RFID tag carries information about a product. However, there are important differences between these two technologies as shown in Table 2.1.

Table 2.1 Major Differences between Barcode and RFID Technologies.

Barcode Technology	RFID Technology
1. Requires line of sight of printed bar-code to be read.	1. Does not require any line of sight of tag or code to be seen when read.
2. Reads one barcode tag at a time.	2. Reads multiple tags at a time (anti-collision)
3. Requires correct positioning of the label to the reader.	3. Does not require particular positioning of the tag to the reader.
4. Requires close distance between the reader and label.	4. Can read tags at much greater distance.
5. Exposes to wear and tear of label.	5. Less exposes to wear and tear, due to hidden tag.
6. Cannot alter the information on the printed tag.	6. Can rewrite information on the tag many times (100,000times for HF technology).
7. Reads at a slow speed.	7. Reads at much faster detection speed.

2.3 RFID Application for Libraries

There are various applications of RFID that has been deployed in many industries worldwide, including ID card identification, logistics and supply chain management, access control, payment systems, and libraries.

RFID application for libraries has been developed and deployed in libraries since 1990 [5]. As the popular use of RFID, the international libraries and relevant organizations had come up with the standards for the different industries so that manufacturers of RFID hardware and tags can follow. For library industry, the passive 13.56MHz frequency is chosen as an international library standard, which RFID readers/writers and tags manufacturers create their products.

2.3.1 Components for RFID System for Libraries

There are many vendors in the world that develop RFID systems for libraries and offer various components to enhance library services. Most components are similar and can be configured to be inter-operable. Components offered to date for libraries can be listed as follows[6].

1) RFID Tags



Figure 2.3 RFID Tags.

Passive (no battery required) RFID tag as shown in Figure 2.3, called transponder, is the core of the RFID system. The tag is applied to the inside cover or spine of each book. Each specific book in the library's database must be linked to a tag. Most of the time, it is linked the book's particular identifying number. The tag works without any power incorporated in it. Once the tag enters the radio field, it is induced and generates very small amount of power enough to send out its own data to the RFID reader/writer.

2) Self-Check Kiosk



Figure 2.4 Self-Check Kiosk.

One great benefit of the system is self-check kiosk as shown in Figure 2.4. Patrons can do their own self service borrow, and return without seeking any help from the librarian. The library patrons can walk up to a kiosk, place all chosen books near the reader and then swipe their own library cards. The books can then pass a portal reader at the door without setting off an alarm. Most self-check kiosk can be configured to either check-out only or both check-out and check-in books.

3) Staff Station



Figure 2.5 Staff Station.

Figure 2.5 shows how staff station helps librarian perform the check-in and check-out tasks efficiently. It streamlines the service and reduces the service time required for the task. Many items can be placed on the RFID reader and processed. Both identification and security functions can be done at one time.

4) Tagging Station



Figure 2.6 Tagging Station.

When converting to RFID system, tagging station shown in Figure 2.6 is used to program or link each particular book to each RFID tag. New books must be tagged into the system ready for all the services offered.

5) Intelligent Security Gate



Figure 2.7 Intelligent Security Gate.

Intelligent security gate or portal readers, shown in Figure 2.7, are placed at the exit (in case the library separate the exit from the entrance) of the library. In general, each gate consists of two antennas with an aisle width of about 80 cm for patrons to walk through. Once patrons walk through the gate, it communicates with the tags placed in the books carried by patrons. The gate will set off an alarm if there is any book not yet checked out properly from the library system. Some more advanced system also identifies particular books that set off the alarm and are shown to the librarian for easy identification.

6) Book Drop/Return Unit



Figure 2.8 Book Drop/Return Unit.

Figure 2.8 shows the samples of book drop unit, which allows library to provide 24-hour book return service even when the library is closed. The unit can be placed outside the library where it is convenient for patrons to drop the books in order to return the books into the library system ready to be put away on shelf for the next patron to borrow.

7) Mobile Inventory Unit



Figure 2.9 Mobile Inventory Unit.

Mobile inventory unit, shown in Figure 2.9, allows the inventory operations, which is a tedious and time-consuming task with the traditional barcode system. With the mobile inventory, locating books can be performed quickly as it can take inventory with a handheld reader and other tasks. Librarian simply scans the handheld unit over the books and the unit communicates with the tags inside the books. The unit alerts when the searched items are found.

Implementing full RFID system has been proved to help libraries all over the world achieving their objectives in providing the best possible services to their patrons. However, some libraries employ only partial system with the selected components. The next chapter will explore opinions from the experts in RFID industry for different classifications of RFID libraries.

2.4 Related Works

There have been quite a few works related to this study on RFID usage in library as well as classification of RFID. Some of the works that are selected will be discussed below.

Roh et al. [6] proposed the classification of RFID adoption of different organizations in various business types using expected benefits approach. Business studied include seven firms ranging from the top 100 Fortune list, including Wal-Mart

and Library of University of Nevada. According to the study, each firm adopted RFID in different scale and scope according to their objectives. Table 2.1 shows the firms studied.

Table 2.2 Overview of sample firms.

Company	Profile	Products or services	Main objectives of RFID adoption
Lego land	An amusement park in Denmark.	To provide creative family-oriented fun activities.	To prevent, track and minimize children being lost in the park.
Library in the University of Nevada, Las Vegas (UNLV)	A Premiere library in metropolitan city.	To provide services of monographs, subscriptions, databases, and the like.	To track, identify and control library material more efficiently.
The International Air Transport Association (IATA)	A global trade organization of air transport.	To improve the operations of the global airline industry.	To diminish the number of mishandled baggage.
Wal-Mart	The world's largest retailer.	To offer a variety of retail merchandises at the lowest possible cheap price.	To freely get products in and out and track the movement of the products.
Intel	The largest semiconductor manufacturer in the world.	To manufacture and deliver semiconductors on a global scale.	To reduce human errors in checking and delivering car seats.

Table 2.2 Overview of sample firms. (Cont.)

Company	Profile	Products or services	Main objectives of RFID adoption
Johnson Controls	Second tier supplier of Toyota and GM.	To supply a range of car seats for first tier and automotive manufacturers.	To reduce human errors in checking and delivering car seats.
Metro Group	The third biggest retailer in the world.	To sell a variety of retail merchandise and offer excellent customer experience.	To set new standards for the retail industry and foster modernization process in commerce

Firms adopted RFID in their business processes recognized various benefits such as cost saving and cycle time improvement, better inventory control, reduced labor costs, inventory obsolescence reduction, rich information exchange among participants in a supply chain. The benefits were grouped into three key categories: cost savings, supply chain visibility, and new process creation. Then, the relationship between the three expected benefits and the scale and scope of adoption were demonstrated as shown in Table 2.2. Under the various circumstances, it was concluded that an organization may perceive the different value and benefits, which leads the business to choose a certain type of RFID application or integrate RFID with other technologies to gain more advantages.

Table 2.3 Adoption pattern and characteristics.

Category	Internal solo application (ISA)	Multiple solo application (MSA)	Internal integrated application (IIA)	Multiple integrated application (MIA)
Definition	RFID in one organization taking advantage of its tracking accuracy and convenience.	RFID in more than two organizations to track and manage inventory or product.	RFID with other technologies in one organization to create new business process and provide cost-saving	RFID with other technologies of systems in more than two organizations, creating new process.
Scale	Low Single Organization	High Multiple organization	Low Single organization	High Multiple organization
Scope	Low RFID alone	Low RFID alone	High Integrated with other technologies	High Integrated with other technologies
Impact		Economies of scale, Supply chain integration	Economies of scope	Economies of scale, economies of scope, supply chain integration

Table 2.3 Adoption pattern and characteristics.(Cont.)

Category	Internal solo application (ISA)	Multiple solo application (MSA)	Internal integrated application (IIA)	Multiple integrated application (MIA)
Expected benefits				
Cost-saving	Low	High	Medium	High
Supply chain visibility	Low	High	Low	High
New process creation	Low	Medium	Medium	High
Example	Lego land	Wal-Mart, International Air Transport Association	Johnson Controls	Intel, Metro Group

Roh et al. also offers the decision makers to adopt RFID broad views in considering their scale and scope. Details of the applications and budgets, however, were not discussed. Hence, we will emphasize on RFID adoption for libraries of different level with the applications details. The essential direct and indirect advantages that are grouped into the three categories of expected benefits, i.e. (1) cost savings through reduction in theft, labor, and inventory costs, (2) supply chain visibility, and (3) new business creation, are recognized by libraries with RFID.

2.4.1 Use of RFID Technology in Libraries

There are previous works studied in the use of RFID technology in library environment in different aspects. Here are some of the selected works to be discussed.

Syed [7] discussed about the application of RFID 13.56 MHz (high frequency – HF) for library, its advantages and disadvantages, and best practices. One of the best practices is the suggestion to use tag that is compliant to ISO18000-mode 2 tag [8] (the next generation then) as well as ISO15693, which was the only choice at the time. Though now, ISO15693 [9] has been integrated with ISO18000-mode3 already.

Dhanalakshmi et al.[10] carried out the experiment in a library using UHF equipment and tags. The different positions of tags in books were tested to decide the tag position that maximizes the readability in normal conditions. Figure 2.10 shows the different tag positions being tested.

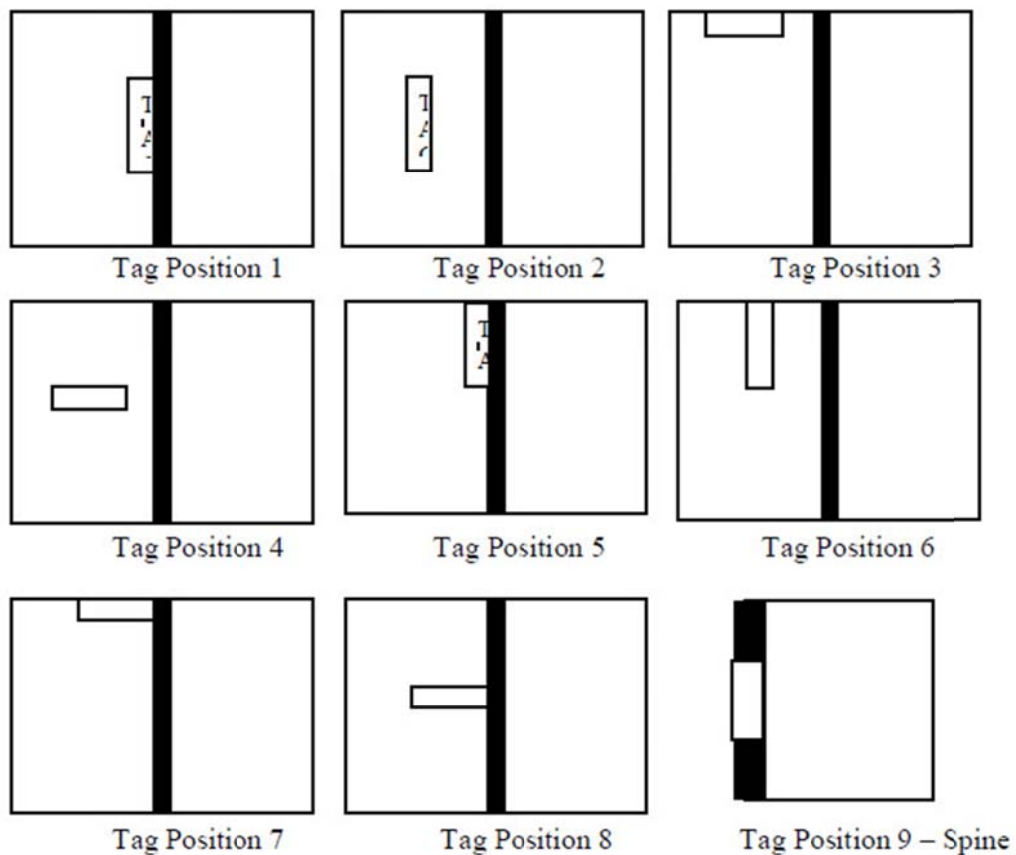


Figure 2.10 Different Tag Positions Tested.

Different antenna positions were also experimented, i.e. single antenna placed at 1.5 meter above the ground, two antennas put at two sides of the gate at 1.5 meter distance apart. The former shows the readability result of different tag positions varies between 40% to 87%, at average distance of 60 cm. to 91 cm. The latter shows a 100% result at tag position – 7.

Different tag positions were also tested with handheld reader in searching module. The results indicated that tag positions providing the better searching result did not give good result in monitoring module as it is prone to be hidden by human hand or body while carrying books in the gate area of the library. Finally, tag position- 7 was chosen for the deployment. It was also concluded that though RFID in the library has proved to enhance efficiency in operations, the performance of the system depends greatly on the vendors of the RFID readers and tags chosen.

Another study by Dr. Prabhat Pandey et al. [11] was concluded that RFID is not only emerging but also more effective, convenient, cost efficient in library security. The technology has slowly replaced the traditional barcode and electromagnetic security strip. It greatly improves services for patron, and allows more effective use of librarian staff time as well as it reduces repetitive stress injuries for librarian. It is the role of librarian to ensure that the use of RFID in library follows the best practices guidelines and privacy principles consistent with library values.

Richard W. Boss suggested some precautions to educate the library staff and patron prior to implement the technology that RFID is several technologies. Easypass on toll way is meant to be read from a distance. Hence, it is not practical to affix the Easypass tag onto library materials. The same is true of the tags used on pallets in warehouse - not practical for library materials.

Therefore, it can be concluded that libraries all over the world are slowly shifting towards RFID deployment for the proven advantages that the technology has provided. There are choices between two frequencies. About 90% of worldwide libraries choose 13.56MHz frequency, the rest of 10% choose 860-960 MHz range.

CHAPTER III

RESEARCH METHODOLOGY

This qualitative research gathers data and information about libraries in order to classify them according to the various factors available. Expert opinions are sought after on classifications of RFID libraries in general practice among international libraries. Then, surveys to libraries management and librarians will be used carried out to gather information of different libraries in order to analyze each library, whether to deploy full or partial system of RFID, according to the expert's opinion gathered.

From Figure 3.1, research methodology can be described as follows:

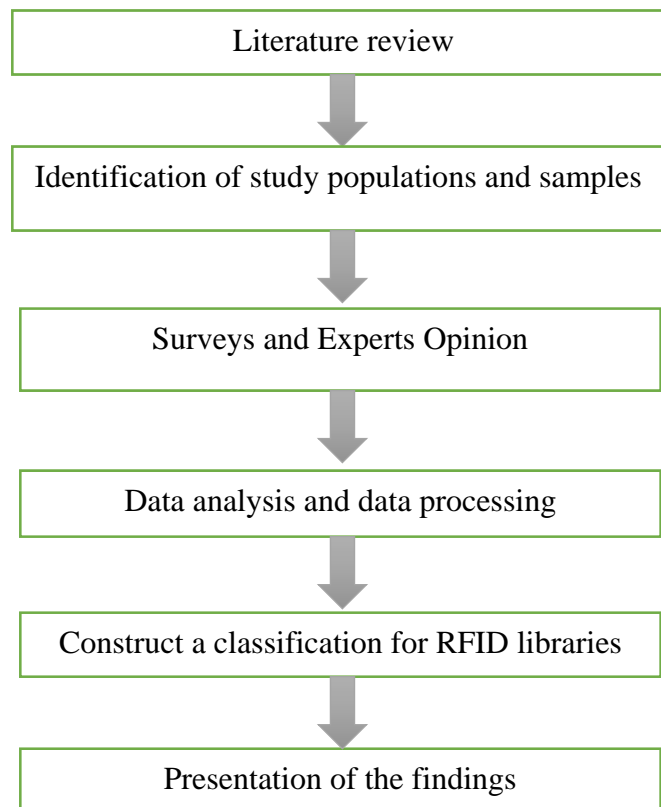


Figure 3.1 Research methodology framework.

3.1 Literature Review

This step is to study and review the relevant theories and previous researches described in Chapter II in order to use as a guideline for this research.

3.2 Identification of Study Populations and Sample

This step is to identify research populations and samples used to study and analyze.

1) Study Populations

Study populations of this research are libraries of different academic levels. Higher education libraries, school libraries, and special libraries in Thailand will be focused. In Thailand, there are about 39,330 academic libraries, including higher educational level, schools, and special libraries [4]. Information for our study is related to the criteria stated by the experts. The information includes number of patrons, library location, budget allocated for the library IT as it indicates emphasis placed on the library, number of books in the library, number of library staff, frequency of visits by patron on a weekly basis, and the main problem that the library is facing.

2) Samples

This qualitative research uses selected meaningful sampling to represent each classification of libraries. In this study, we look at 32 samples.

3.3 Experts Opinion and Questionnaire to Librarian

Given definition of full system versus partial system components, experts in the library RFID industry are sought after for their consideration on each criteria whether to fit into full or partial system. The survey used in this step is shown in Appendix A.

RFID systems deployed by libraries can be categorized in an attempt to classify them according to features and functionalities provided by the system into full system and partial system.

Full RFID system consists of at least the following components:

- Self-Check Kiosk – 1 unit,
- Staff Station – 2 sets,
- Tagging Station – 1 set,
- Intelligent Security Gate – 1 pair,
- Book Return Unit – 1 unit,
- Mobile Inventory Unit – 1 unit,
- RFID Tags – for all the physical books collection.

Partial RFID system refers to basic system that helps library improve the circulation efficiency and support long term system expansion for library services. The system consists of the following components:

- Staff Station and Tagging System – 1 set
- RFID Tags – for all the physical books
- Intelligent Security Gate

Access Control Turnstile System for patrons statistics, though gaining more popularity in RFID library usage, is not taken into consideration in this study.

After gathering all the information from the experts, similar criteria and classifications of libraries are found.

From the experts' point of view summary table, we attempt to find a switching point from partial to full system of each criteria in order to try to come up with a discrete rule, and derive the result as seen on the right column.

Each criteria is ranked and given the score according to its influence on the need for technology deployment. For example, library problem is seen as the most importance factor of technology deployment and hence ranked number one of all the criteria. Maximum score of '8' is given to the most important factor.

Primary source of data was collected by questionnaires handed out to librarians in 100 libraries with 32 replies. The questionnaire emphasis on the criteria stated in the expert's opinion survey as detailed below:

- number of students and library members (patron),
- number of collections that are physical books,
- number of library staff,

- major service issue that the library is facing,
- budget allocated for the library information technology.

3.4 Data Analysis and Data Processing

The questionnaire handed out to the librarian is analyzed according to the experts' view.

Each questionnaire is analyzed by comparing each factor to the expert's view. Each factor is classified whether it falls into full or partial system, one by one. After all the factors are analyzed, if there are more full system factors, then the library is considered a full system classification. If more partial system, the library would fall into partial system classification.

This analyzed data is then put into processed using decision tree classification analysis to obtain a decision model that is easier to understand and make use of.

Table 3.1 Analyzed Data Collected from Librarians.

LIBRARY TYPE	NO. OF PATRONS	NO. OF STAFF	NO. OF BOOKS	LOCATION	BUDGET (Baht)	VISIT FREQUENCY/MONTH	PROBLEM	TIER
1	30,000	150	350,000	1	500,000	5	3	Full
1	30,000	150	350,000	1	10,000,000	2	3	Full
3	10,000	20	50,000	1	2,000,000	2	1	Full
1	30,000	80	250,000	1	3,000,000	2	2	Full
1	20,000	50	150,000	2	2,000,000	2	1	Full
1	20,000	50	150,000	3	5,000,000	3	1	Full
3	10,000	20	30,000	3	1,000,000	4	3	Full
1	20,000	100	150,000	3	5,000,000	3	3	Full

Table 3.1 Analyzed Data Collected from Librarians. (Cont.)

LIBRARY TYPE	NO. OF PATRONS	NO. OF STAFF	NO. OF BOOKS	LOCATION	BUDGET (Baht)	VISIT FREQUENCY/MONTH	PROBLEM	TIER
1	30,000	100	300,000	3	10,000,000	5	3	Full
2	5,000	20	30,000	1	3,000,000	2	2	Partial
1	30,000	50	250,000	3	2,000,000	3	3	Full
1	20,000	50	100,000	4	2,000,000	2	1	Full
1	30,000	150	300,000	3	3,000,000	2	2	Partial
1	10,000	100	150,000	3	2,000,000	2	1	Full
1	20,000	80	100,000	3	5,000,000	2	1	Full
2	10,000	50	100,000	1	3,000,000	3	2	Full
2	10,000	20	50,000	1	3,000,000	5	3	Full
1	20,000	80	200,000	3	5,000,000	3	3	Full
1	30,000	150	300,000	1	10,000,000	4	3	Full
1	30,000	150	300,000	1	10,000,000	3	3	Full
1	10,000	50	150,000	3	2,000,000	1	2	Partial
1	10,000	50	150,000	4	2,000,000	2	2	Full
1	20,000	50	100,000	3	4,000,000	2	1	Full
3	10,000	50	100,000	4	2,000,000	1	1	Full
2	10,000	20	50,000	3	2,000,000	3	2	Full
1	20,000	50	100,000	1	2,000,000	1	1	Full
2	10,000	20	50,000	1	2,000,000	1	1	Full
2	10,000	20	50,000	1	3,000,000	1	1	Full

Table 3.1 Analyzed Data Collected from Librarians. (Cont.)

LIBRARY TYPE	NO. OF PATRONS	NO. OF STAFF	NO. OF BOOKS	LOCATION	BUDGET (Baht)	VISIT FREQUENCY/MONTH	PROBLEM	TIER
1	20,000	80	100,000	1	2,000,000	1	1	Full
1	10,000	20	50,000	1	2,000,000	1	1	Full
1	10,000	20	50,000	1	2,000,000	1	1	Full

3.5 Construct a Classification Model for RFID Libraries

From Figure 3.4, classification of a library is done using decision tree analysis which helps the library management to consider the order of each factor relevant to their libraries.

3.6 Presentation of the Findings

After deriving the classification model for RFID libraries in Section 3.5, strategies will be presented in the later chapter of this research.

CHAPTER IV

DATA ANALYSIS AND IMPLEMENTATION RESULTS

One interesting dimension gained from the survey based on the experts' view can be shown in Figure 4.1. This could be useful and very interesting for the trade as it shows that from the 32 libraries response, there are total of 4.7 million books to be tagged with RFID tags. Total budget on RFID for the 32 libraries, all library types combined including full and partial libraries, sum up to 113.5 million baht.

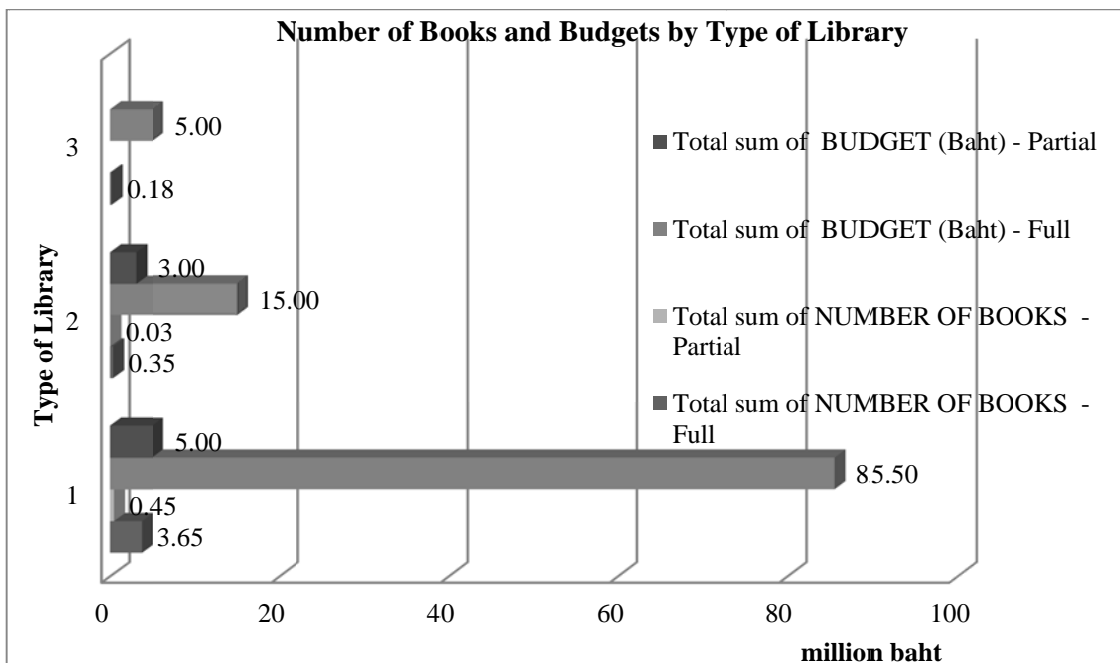


Figure 4.1 Total Budgets and Books from the 32 Surveys Response.

4.1 Data Analysis

According to the expert's view, library service problems should be viewed as the most important factor to be taken into consideration when investing in new technology. The problems can be in different dimensions. All experts agree that if service problem lays in redundant process or service waiting queue, full system of RFID would be the right option for the library. While if material lost or shelf arrangement is the more important issue, only partial system would be sufficient to resolve the issue. Figure 4.2 represents the interpretation clearly.

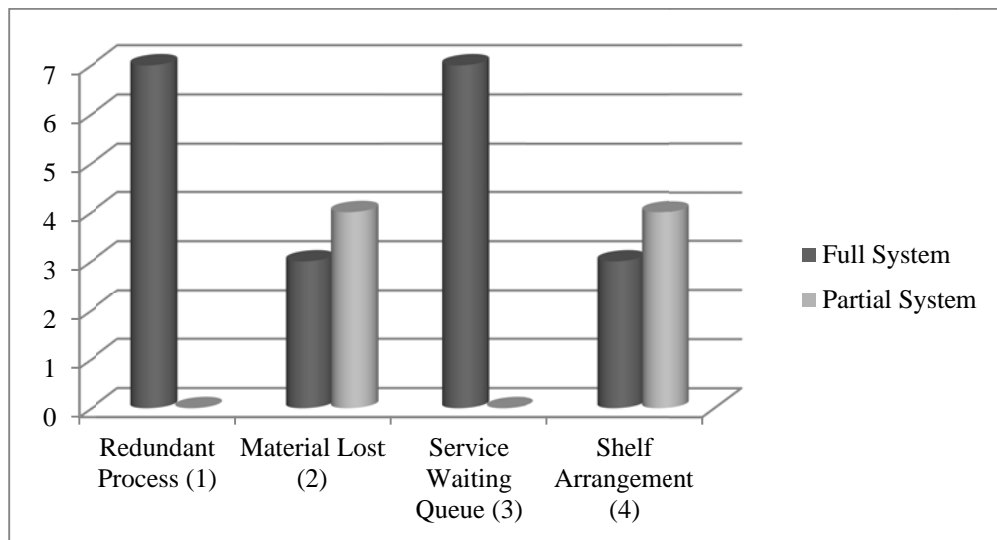


Figure 4.2 Number of Expert's Opinion on Each Library Problem.

On number of books in each library, all experts agree that library with total physical collections below 10,000 items, partial RFID system is sufficient for the library. As the collections increase, two out of the seven experts suggest partial system while the majority recommends a full system deployment, as shown in Figure 4.3.

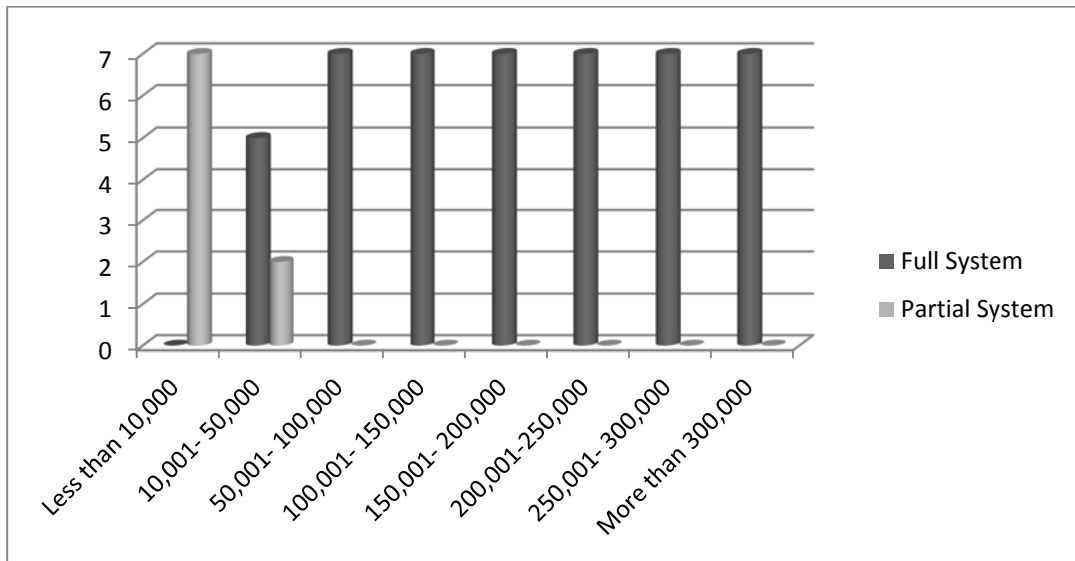


Figure 4.3 The Number of Expert Opinion versus The Number of Books for Each Classification.

Location of the library is categorized into four group, Bangkok, Bangkok metropolitan, provincial library, and remote library. All experts agree that all libraries in Bangkok and all provincial libraries should employ full RFID system. Remote libraries are suggested to employ the partial system. Bangkok metropolitan library is suggested to employed full system by the majority of the experts (only one expert think partial system is sufficient for libraries in the metropolitan area.) Figure 4.4 shows the number of experts’ opinion on each location.

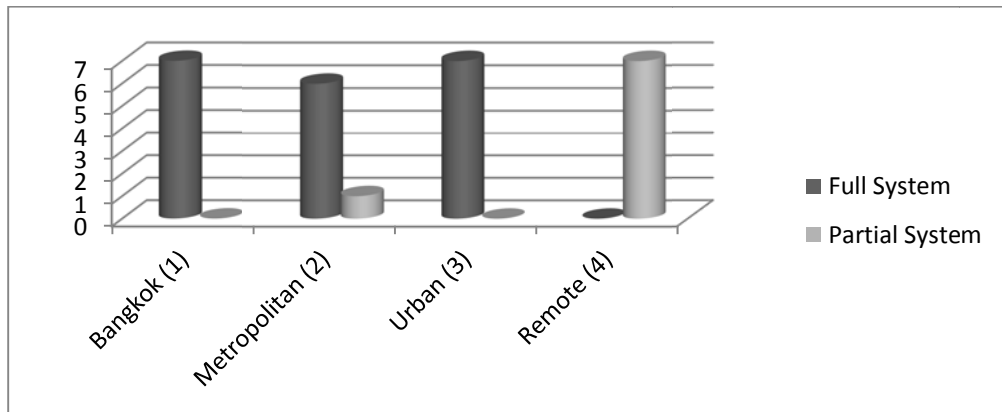


Figure 4.4 Number of Expert Opinion on Library Location.

Figure 4.5 shows experts view on budget allocated for library information technology. IT budget for library gains interesting view from the experts as there is no clearly divided point from partial to full RFID system. This could mean other criteria must be taken into account as well. In general, it could be summarized that if IT budget allocated for the library does not exceed 2 million baht, all experts suggest a partial system. Library with IT budget exceeds 4 million baht that should employ the full system. Five experts suggest a partial system for budget between two to three million baht. Four experts suggest a full system for budget between three to four million baht.

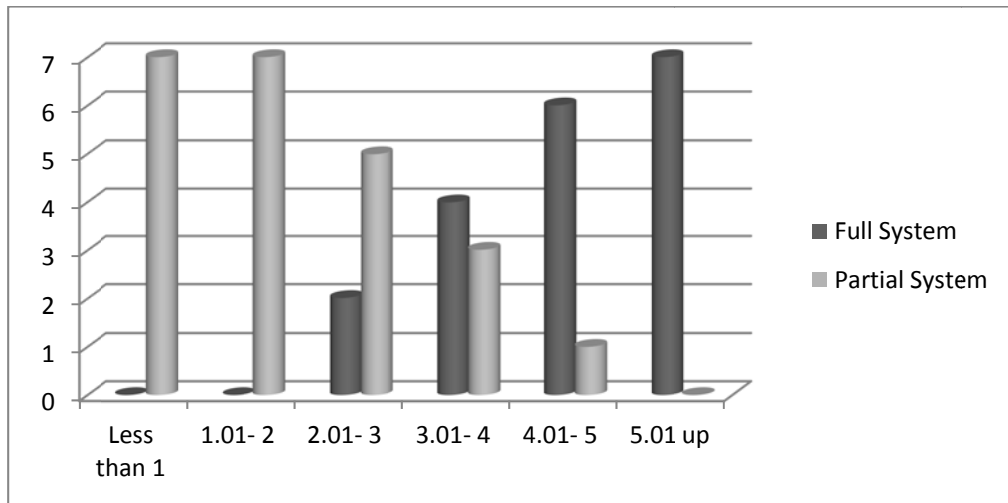


Figure 4.5 Experts' Opinion on Library IT Budget.

Opinion of experts shows that type of library does not have distinct influence on whether to deploy full or partial system. Figure 4.6 indicates that experts think no matter a library is academic higher educational, school, or specialized library, full system should be deployed.

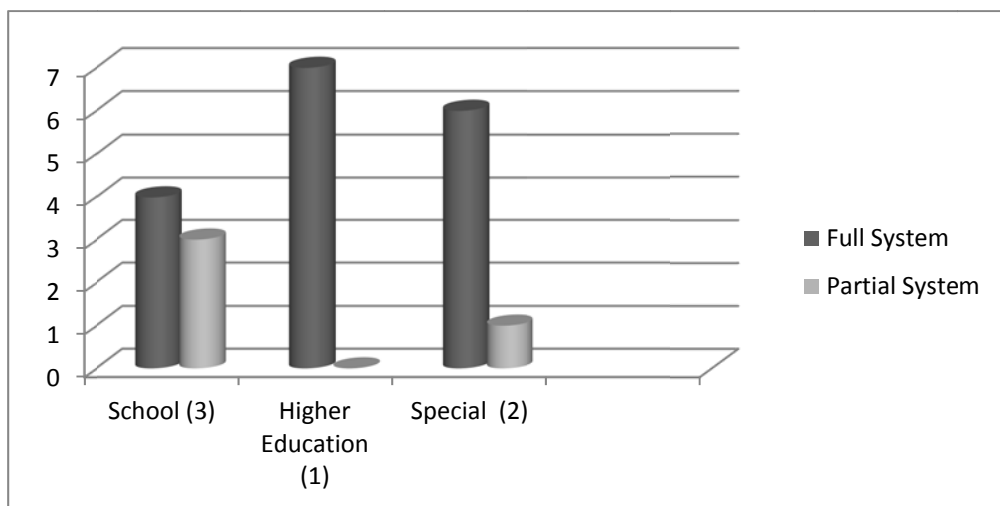


Figure 4.6 Number of Experts Opinion on Library Type with Full vs Partial System.

From Figure 4.7, it shows for library with the number of patrons not exceeding 5,000 patrons, a partial RFID system is suggested by the experts. If total patrons higher than 5,000 the library should deploy a full system.

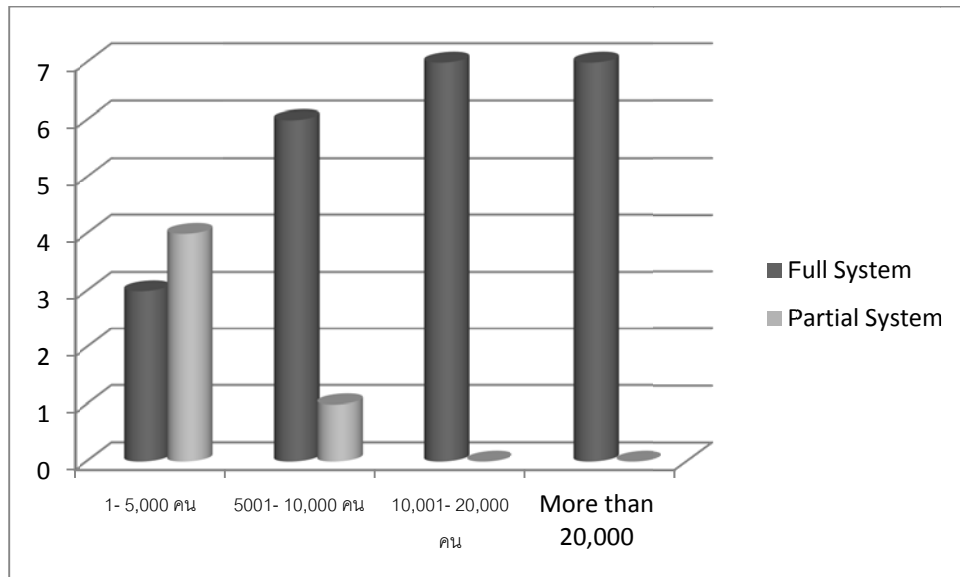


Figure 4.7 Experts Opinion on Number of Patrons and Full vs Partial System.

Frequency of visits to library per month does not have any influence on whether the library should deploy partial or full system, according to the expert. All experts basically agree on full system deployment from the number of visit from one time per month, as shown in Figure 4.8.

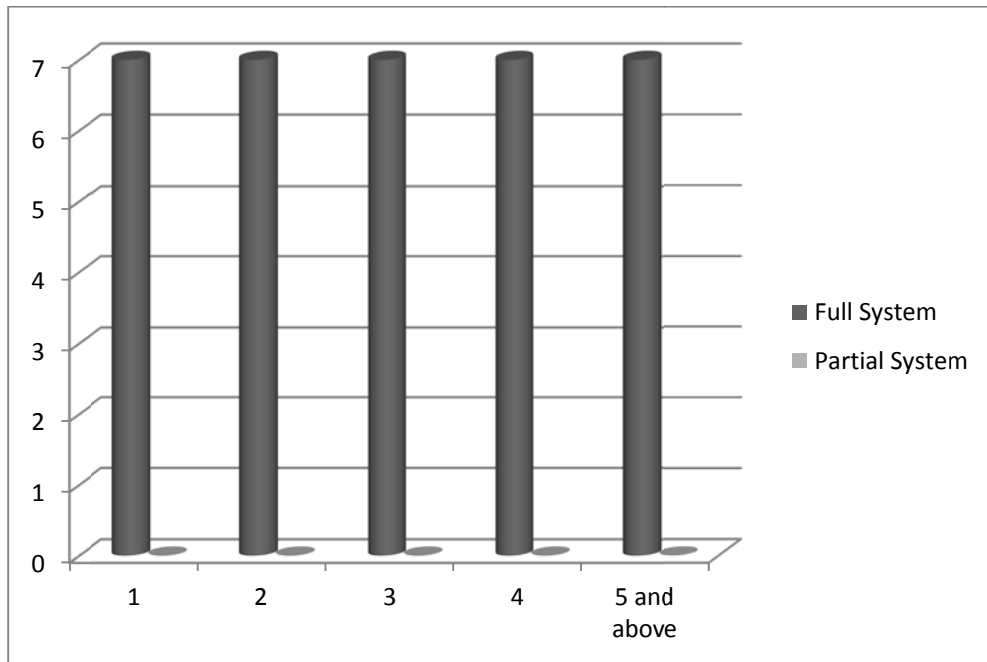


Figure 4.8 Experts Opinion on Frequency of Monthly Visits to Library.

In the previous chapter, explanation was given how the experts' opinion were gathered and analyzed to derive the breaking point between partial and full system. Table 4.1 shows the experts opinion for each library criteria and the turning point from partial to full system of each criteria.

Table 4.1 Experts Opinion on Each Library Criteria.

	Full System	Partial System	Critical Point
Library Type		Rank 5, Score 4	
School (3)	4	3	
Higher Education (1)	7	0	
Special (2)	6	1	
Library Staff		Rank 8, Score 1	35
1 - 20	3	4	
21-50	5	2	
51-80	7	0	
More than 80	7	0	
Number of Patrons		Rank 2, Score 7	7,500
1- 5,000	3	4	
5001- 10,000	6	1	
10,001- 20,000	7	0	
More than 20,000	7	0	
Number of Books		Rank 3, Score 6	40,000
Less than 10,000	0	7	
10,001- 50,000	5	2	
50,001- 100,000	7	0	
100,001- 150,000	7	0	
150,001- 200,000	7	0	
200,001-250,000	7	0	
250,001- 300,000	7	0	
More than 300,000	7	0	

Table 4.1 Experts Opinion on Each Library Criteria.(Cont.)

Location		Rank 6, Score 3	3
Bangkok (1)	7	0	
Metropolitan (2)	6	1	
Urban (3)	7	0	
Remote (4)	0	7	
Library IT Budget (million baht)		Rank 7, Score 2	3.5m
Less than 1	0	7	
1.01- 2	0	7	
2.01- 3	2	5	
3.01- 4	4	3	
4.01- 5	6	1	
5.01 up	7	0	
Library Visit Frequency/Month		Rank 4, Score 5	3 times/month
1	7	0	
2	7	0	
3	7	0	
4	7	0	
5 and above	7	0	
Library Problem		Rank 1, Score 8	
Redundant Process (1)	7	0	
Material Lost (2)	3	4	
Service Waiting Queue (3)	7	0	
Shelf Arrangement (4)	3	4	

From Table 4.1, it could be interpreted that for the library problem criteria, if the library is facing the redundant process, all experts agree that the library should deploy full RFID system. Therefore, library problem is the most important criteria to take into consideration ranking number 1 with the highest score of 8.

Surveys to librarians were distributed with criteria based on that of the experts. Then, response from the surveys was processed to determine whether each library would fall into which classification. Each criteria is compared to the opinion of the expert, one on one. If there are more criteria that fall into full system, the library is classified into the full system group. The outcome of this process is shown in Table 4.2.

Table 4.2 Outcome of the Library Surveys Analyzed According to Experts' View.

TYPE OF LIBRARY	NUMBER OF PATRONS	NUMBER OF STAFF	NUMBER OF BOOKS	LO CA TION	LIBRARY IT BUDGET (Baht)	LIBRARY VISIT FREQUEN CY/MONT H	PROB LEM	TIER
1	30,000	150	350,000	1	500,000	5	Queue	Full
1	30,000	150	350,000	1	10,000,000	2	Queue	Full
3	10,000	20	50,000	1	2,000,000	2	Redund ant Process	Full
1	30,000	80	250,000	1	3,000,000	2	Material Lost	Full
1	20,000	50	150,000	2	2,000,000	2	Redund ant Process	Full
1	20,000	50	150,000	3	5,000,000	3	Redund ant Process	Full
3	10,000	20	30,000	3	1,000,000	4	Queue	Full
1	20,000	100	150,000	3	5,000,000	3	Queue	Full
1	30,000	100	300,000	3	10,000,000	5	Queue	Full

Table 4.2 Outcome of the Library Surveys Analyzed According to Experts' View.

(Cont.)

TYPE OF LIBRARY	NUMBER OF PATRONS	NUMBER OF STAFF	NUMBER OF BOOKS	LO CA TION	LIBRARY IT BUDGET (Baht)	LIBRARY VISIT FREQUEN CY/MONT H	PROB LEM	TIER
2	5,000	20	30,000	1	3,000,000	2	Material Lost	Partial
1	30,000	50	250,000	3	2,000,000	3	Queue	Full
1	20,000	50	100,000	4	2,000,000	2	Redundant Process	Full
1	30,000	150	300,000	3	3,000,000	2	Material Lost	Partial
1	10,000	100	150,000	3	2,000,000	2	Redundant Process	Full
1	20,000	80	100,000	3	5,000,000	2	Redundant Process	Full
2	10,000	50	100,000	1	3,000,000	3	Material Lost	Full
2	10,000	20	50,000	1	3,000,000	5	Queue	Full
1	20,000	80	200,000	3	5,000,000	3	Queue	Full
1	30,000	150	300,000	1	10,000,000	4	Queue	Full
1	30,000	150	300,000	1	10,000,000	3	Queue	Full
1	10,000	50	150,000	3	2,000,000	1	Material Lost	Partial
1	10,000	50	150,000	4	2,000,000	2	Material Lost	Full
1	20,000	50	100,000	3	4,000,000	2	Redundant Process	Full
3	10,000	50	100,000	4	2,000,000	1	Redundant Process	Full
2	10,000	20	50,000	3	2,000,000	2	Queue	Full
2	10,000	20	50,000	3	2,000,000	3	Material Lost	Full

Table 4.2 Outcome of the Library Surveys Analyzed According to Experts' View.

(Cont.)

TYPE OF LIBRARY	NUMBER OF PATRONS	NUMBER OF STAFF	NUMBER OF BOOKS	LOCATION	LIBRARY IT BUDGET (Baht)	LIBRARY VISIT FREQUENCY/MONTH	PROBLEM	TIER
1	20,000	50	100,000	1	2,000,000	1	Redundant Process	Full
2	10,000	20	50,000	1	2,000,000	1	Redundant Process	Full
2	10,000	20	50,000	1	3,000,000	1	Redundant Process	Full
1	20,000	80	100,000	1	2,000,000	1	Redundant Process	Full
1	10,000	20	50,000	1	2,000,000	1	Redundant Process	Full
1	10,000	20	50,000	1	2,000,000	1	Redundant Process	Full

4.2 Implementation

In order to see the different perspective of the classification, decision tree analysis is employed followed the above result, the outcome could be interpreted as shown in Figure 4.9.

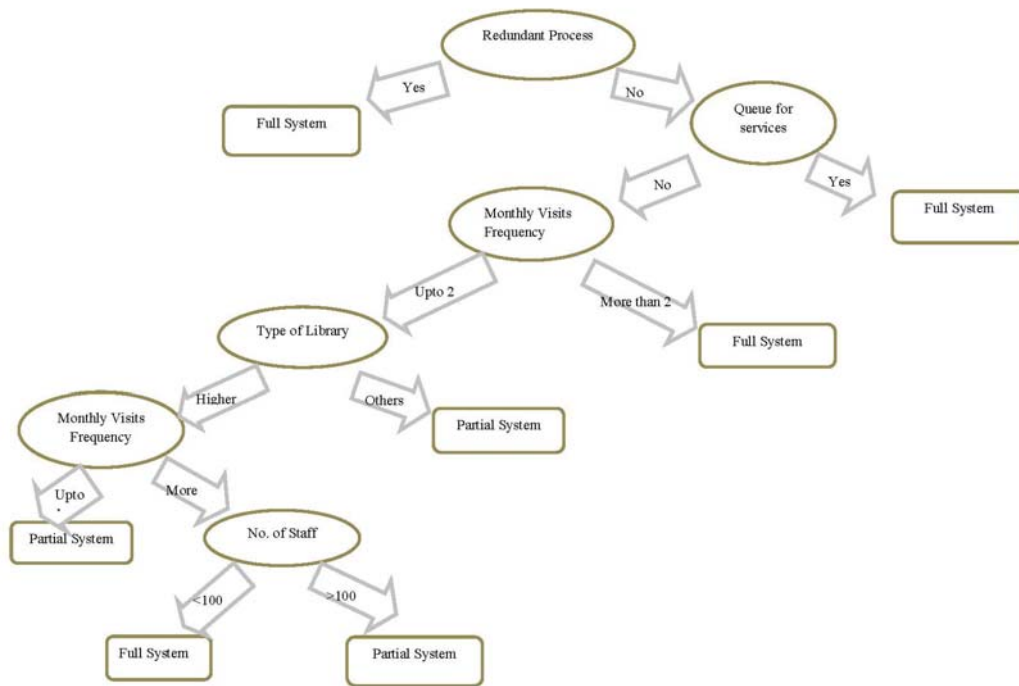


Figure 4.9 Resulted Decision Tree.

Figure 4.9 indicates that if we are a library management thinking of investing on an RFID system for our library, we may consider the following procedures.

1) Library management should begin their consideration with the first criteria, i.e. whether their services process is redundant. If it is, the library should consider deployment of a full RFID system.

2) Otherwise, consider the next criteria on services queue, if the queue is often long, then the library should consider the full RFID system installation.

3) If queue is not an issue then consider number of visits to the library of an average patron per month. When an average monthly library visits exceed two times, the library should consider a full RFID system.

4) If monthly visits frequency does not exceed two times, consider what type of library we are. Choose a partial RFID system if it is not a higher education library, i.e. if we are a school or special library.

5) If we are a higher education library and your patron's library visits frequency is less than one time per month, deploy a partial RFID system.

6) A higher education library with visits frequency of a patron on average is more than one time per month and has more than 100 library staff could deploy a partial system. While the one with library staff less than 100 could choose a full RFID system.

Though the derived model above is helpful, it did not mention location of the library, which also gained some significant view from the expert.

Hence, the decision tree could be adjusted to be more synchronized to the experts' view. At the step of considering your type of library, if we are not an academic higher educational library, consider our library location. If our library is located in Bangkok or we are a provincial library, deploy full system. Otherwise, we may choose a partial system.

Then, if we are not a higher educational library, follow step 5 above, consider the visits frequency per month, and so on. Hence, the adjusted considerations diagram will look like Figure 4.10, with the additional library location criteria taken into account

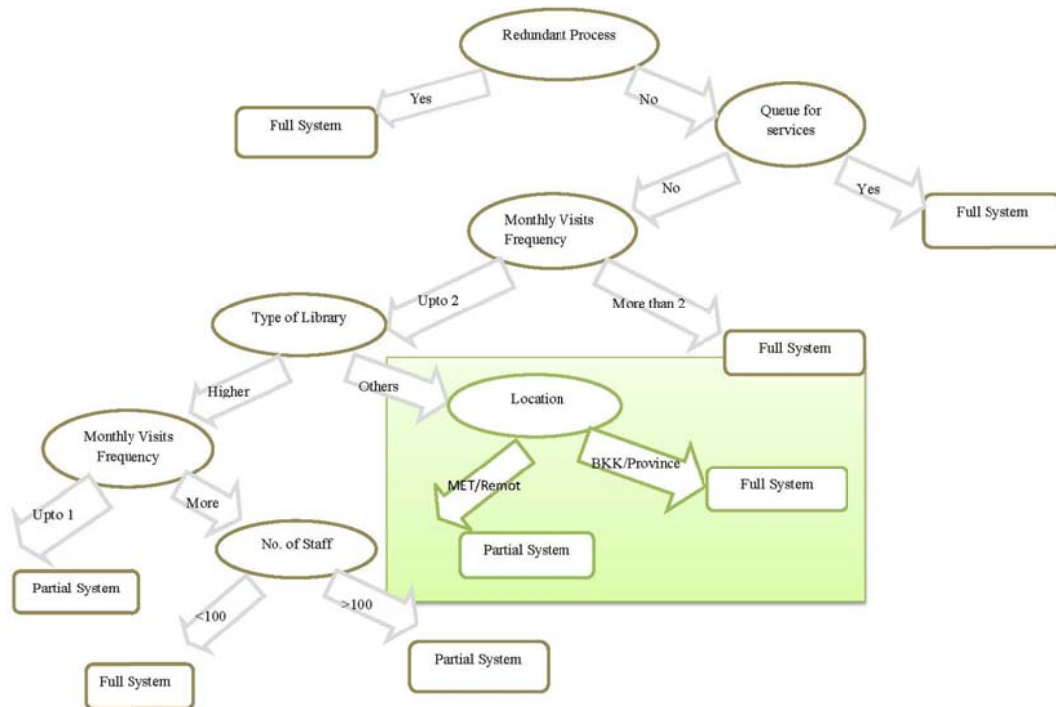


Figure 4.10 Suggested Decision Tree.

Once the classifications of RFID libraries model is derived as above, it is tested to see if applicable and practical to support the library management in making their decisions. Ten of the thirty two library management who responded to the survey are given the classifications model for their opinion. The model proved applicable and satisfactory for the management to use as a tool to support their decision making in the deployment level of RFID library system.

CHAPTER V

CONCLUSION

In this chapter, the results of classifications of RFID libraries in Thailand are summarized. Suggestions for improvement of the future work are also provided.

5.1 Summary of the Result

Libraries in the 21st century face many challenges due to technology advancement and demand from new generation consumers. To keep up with the consumers' requirement, libraries must improve their services to patrons and increase operations efficiency at the same time. Radio frequency identification (RFID) is one technology that many leading libraries in the world have deployed to enhance their library services and improve efficiency.

Many libraries in Thailand have invested in such technology, while many are considering doing so. However, what level or classification that each library should invest their limited budget in and what factors they should take into considerations.

This paper suggests a model for classifications of RFID library system in order to support the library management with advanced technology implementation to enhance their library services which are most suitable solutions to their criteria. The model provides a guideline for the management to realize which criteria should start and follow in order for their consideration process.

The study sought opinion of the experts in the library industry on each criteria considered suitable solutions for full system or partial system. The experts include those who involve in international library commercial and academic experts cum library management with extensive RFID knowledge. Surveys to librarians are collected and compared to the experts' view and processed using decision tree analysis. A model is derived as the result.

Necessary adjustment is carried out so that the model most reflects the experts' view. Then, the model is put to test by the library responded to the survey for its applications and satisfaction to the management of the outcome of the model for their particular libraries. It is proven that the model derived from this study is satisfactorily applicable for the library management to employ in order to select the most suitable level of RFID library system to their organization.

5.2 Limitation and Suggestions

RFID library system and equipment can be expanded to include other components that enhance further services. However, at the time of this study standard, full RFID system for library from most vendors consists of the components described only.

This study emphasized more on library RFID system that is deployed in about 95% of the libraries internationally, i.e. 13.56 MHz (HF) frequency range, which is slightly more costly than the 860-960 MHz range (UHF). It does not mention the technical differences between both frequencies and, hence, could cause some misunderstandings that they are equally efficient.

For libraries considering the ultra-high frequency range, 920-925 MHz for Thailand, it is highly suggested to explore deeply about that ultra-high frequency range. Most libraries in developed countries choose to deploy 13.56MHz. In China, where the ultra-high frequency library system originated, the use of HF and UHF percentage is 50:50, with big public libraries, which is more family-children-oriented, choose to deploy a more mature technology HF standard.

Experts suggest if the library's main objective is emphasized on improving the services via self-service efficiency and reliability, HF is the technology to implement as UHF self-check tends to read books out of the required area as well, i.e. from other patrons nearby the self-service unit.

REFERENCES

- 1 McCombs G, Maylone T. Qualitative research [issue theme]. *Library Trends*. 1998; 46(4).
- 2 Bowker G C, Star S L. The MIT Press. *Sorting things out: Classification and practice*. Cambridge, MA, 2000.
- 3 Pennueng Holding. *Intelligent Library System & Services* [Internet]. [cited 2015 May 15]. Available from: <http://www.pen1.biz/newww/index.php/th/product-2/intelligent-library/>.
- 4 Daniel M Dobkin. *Enigmatics. The RF in RFID – The Tutorial* [Internet]. 2012 [cited 2015 May 20]. Available from: <http://www.enigmatic-consulting.com/Communications/>.
- 5 Boss Richard W. *RFID Technology for Libraries*[Internet]. 2009 [cited 2015 May 20]. Available from: <http://www.ala.org/ala/pla/plapubs/technotes/rfidtechnology/>
- 6 Roh James Jungbae, Kunnathur Anand, Tarafdar Monideepa. *Classification of RFID adoption: an expected benefits approach*. Elsevier 2009;46: 357-363.
- 7 Syed Md Shahid. *Use of RFID technology in libraries: a new approach to circulation, tracking, inventorying and security of library materials. Library philosophy and practice*. 2005[cited 2015 May 25]; 8(1): 15-21. Available from: <http://unllib.unl.edu/LPP/shahid.htm/>.
- 8 Wikipedia. *ISO/IEC18000-3* [Internet]. 2015 [cited 2015 May 25]. Available from: http://en.wikipedia.org/wiki/ISO/IEC_18000-3
- 9 Wikipedia. *ISO/IEC15693* [Internet]. 2015[cited 2015 May 25]. Available from: http://en.wikipedia.org/wiki/ISO/IEC_15693
- 10 Dhanalakshmi M, Uppala Mamatha. *RFID based library management system. Proceedings of ASCNT-2009; 2009; CDAC, Noida, India: p. 227-34.*
- 11 Pandey Prabhat, Mahajan K D. *Application of RFID in libraries and role of librarian. 12th Manlibnet Convention 2010; 2012; Jaipur, India: p. 208-16.*

- 12 Wikipedia. Decision Tree Learning [Internet]. 2015 [cited 2015 March 18]. Available from: https://en.wikipedia.org/wiki/Decision_tree_learning
- 13 Wikipedia. Decision Tree [Internet]. 2015 [cited 2015 May 18]. Available from: https://en.wikipedia.org/wiki/Decision_tree
- 14 Maimon Oded, Rokach Lior, editors. Decision Trees. In Data mining and knowledge discovery handbook [Internet]. Springer; 2010 [cited 2015 March 18]. Available from: <http://www.ise.bgu.ac.il/faculty/liorr/hbchap9.pdf/>.
- 15 Feig Electronic. Libraries [Internet]. [cited 2015 May 5]. Available from: <http://www.feig.de/en/products/obid/applications/libraries/>.
- 16 Coye Karen. Management of RFID in Libraries, preprinted version of article published in the Journal of Academic Librarianship. v.31, n.5, pp.486-489
- 17 Roberti Mark. RFID Journal. The History of RFID Technology [Internet]. 2002-2015 [cited 2015 June 20]. Available from: <http://www.rfidjournal.com/articles/view?1338/>.

APPENDIX

SATISFACTION ASSESSMENT FOR THE USERS OF INSTRUCTORS

Questionnaire

Objective: To seek RFID expert’s opinion on Classifications of RFID libraries
in Thailand.

Name:

Definition:

1. “Full system” refers to a complete RFID system for library. The system consists of at least one unit of each system component. The components are self-check unit, 24-Hr book return unit, staff circulation station, tag programming station, Mobile inventory unit, RFID tags, and access control turnstile with statistics system.

2. “Partial system” refers to an RFID system for library that consists of a combined staff circulation and tag programming station, self-check kiosk, RFID tags, and access control turnstile with statistics system.

Partial system also refers to a system with a combined staff circulation and tag programming station, intelligent security gate, RFID tags, and access control turnstile with statistics system.

Please provide your valuable opinion on each of the criteria in the table below by checking “√” mark- whether each particular criteria of a library should deploy full or partial system.

Data collected by

.....
...../...../.....

	Full System	Partial System	Others
Library Type			
School (3)			
Higher Education (1)			
Special (2)			
Library Staff			
1 - 20			
21-50			
51-80			
More than 80			
Number of Patrons			
1- 5,000 คน			
5001- 10,000 คน			
10,001- 20,000 คน			
More than 20,000			
Number of Books			
Less than 10,000			
10,001- 50,000			
50,001- 100,000			
100,001- 150,000			
150,001- 200,000			
200,001-250,000			
250,001- 300,000			
More than 300,000			
Location			
Bangkok (1)			
Metropolitan (2)			
Urban (3)			
Remote (4)			

	Full System	Partial System	Others
Library IT Budget (million)			
Less than one			
1- 2			
2.01- 3			
3.01- 4			
4.01- 5			
from 5.01 up			
Library Visit Frequency/Month			
1			
2			
3			
4			
5 and above			
Library Problem			
Redundant Process (1)			
Material Lost (2)			
Service Waiting Queue (3)			
Shelf Arrangement (4)			

BIOGRAPHY

NAME	Ms. Nattachatr Sopitkamol
DATE OF BIRTH	18 June 1967
PLACE OF BIRTH	Bangkok, Thailand
EXCHANGE PROGRAM	American Field Service (AFS) International and Intercultural Program, 1985, exchange student to Australia
INSTITUTIONS ATTENDED	Thammasat University, 1986-1989 Bachelor of Art (Economics, English program) Mahidol University, 2014-2015 Master of Science (Information Technology Management)
CAREER	Owner, Pennueng Holding Co., Ltd. 1999- Present
HOME ADDRESS	576/18 Ladprao112 Road, Phlub Pla, Wangthonglang, Bangkok 10310 Tel 084 674 4444 Email: nattachatr@pen1.biz