THE DEVELOPMENT OF BUSINESS INTELLIGENCE FOR LIBRARY MANGEMENT DECISION MAKING ON RFID TECHNOLOGY

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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

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Thematic Paper
entitled

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ABSTRACT

This study proposes a business intelligence tool to support library executives in making decisions on radio frequency identification (RFID) technology deployment. The RFID system is still a new technology for several libraries in Thailand. To consider RFID deployment, librarians and library management want to know which libraries have installed either high frequency RFID or ultra-high frequency systems and are located in the same district area or at other locations. The budget spent on the system installation for a certain number of books is also useful information for them.

The study shows libraries already equipped with RFID components, together with budget, number of the books, and type of library. It also shows deployment figure in each region of the country and an overview of the libraries with HF and UHF RFID are displayed. Various characteristics of the information that was derived can be useful for the management for strategic planning. Information about different devices available in the RFID system is also useful for the library.

The developed results of this study could prove useful to library directors as well as vendors of RFID systems. Library management can see an overview of RFID libraries and use it to obtain more detailed information to plan the development of a system for their libraries. Moreover, the vendors of RFID systems are also able to use the results to develop their marketing plans.

KEY WORDS: RFID / LIBRARY/ BUSINESS INTELLIGENCE

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การพัฒนา BUSINESS INTELLIGENCE เพื่อสนับสนุนการตัดสินใจของผู้บริหารห้องสมุดในการเลือกใช้เทคโนโลยี RFID

THE DEVELOPMENT OF BUSINESS INTELLIGENCE FOR LIBRARY MANAGEMENT DECISION MAKING ON RFID TECHNOLOGY

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บทคัดย่อ

การศึกษา เรื่อง การพัฒนา BUSINESS INTELLIGENCE เพื่อสนับสนุนการตัดสินใจของผู้บริหารห้องสมุดในการเลือกใช้เทคโนโลยี RFID สืบเนื่องจากระบบ RFID ยังเป็นระบบใหม่สำหรับห้องสมุดหลายแห่งในประเทศไทย ผู้บริหารห้องสมุดดังกล่าวจึงต้องการทราบว่ามีห้องสมุดใดบ้างที่ใช้ระบบห้องสมุด RFID แบบ HF และ ที่ใดใช้ RFID แบบ UHF ในเขตหรือจังหวัดเดียวกันดับตนบ้าง และต้องใช้งบประมาณเท่าไหร่ในการติดตั้งระบบสำหรับจำนวนหนังสือที่ห้องสมุดมี สามารถเข้าเยี่ยมชมที่ใดเพื่อให้ได้ข้อมูลจริงจากห้องสมุดที่นำเทคโนโลยี RFID มาใช้ช่วยในการบริหารจัดการทรัพยากรห้องสมุดแล้ว

การศึกษาครั้งนี้แสดงข้อมูลห้องสมุดในประเทศไทยที่ใช้ระบบ RFID จริง ผู้บริหารห้องสมุดสามารถดูงบประมาณ จำนวนหนังสือ ตลอดจนแต่ละภูมิภาคของประเทศไทยที่ได้ใช้งานระบบ RFID จริง และสามารถเห็นภาพรวมของห้องสมุดที่ใช้RFID แบบ HF และUHF ผู้บริหารสามารถนำข้อมูลมาใช้วางแผนห้องสมุด และผู้บริหารสามารถเห็นภาพรวมในหลายมิติของห้องสมุด RFID ตลอดจนได้ทราบข้อมูลเกี่ยวกับอุปกรณ์ที่ใช้ในห้องสมุดระบบ RFID ได้

ผลการศึกษาครั้งนี้ เป็นประโยชน์กับผู้บริหารห้องสมุด และผู้จำหน่ายระบบ RFID คือ ผู้บริหารสามารถเห็นภาพรวมของห้องสมุด RFID และสามารถนำข้อมูลมาใช้วางแผนการพัฒนาห้องสมุดระบบ RFID ในด้านผู้จำหน่ายระบบ RFID สามารถใช้ประกอบการวางแผนทางการตลาดได้

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CHAPTER I
INTRODUCTION

1.1Background and problem statement

Thailand government has been trying to encourage Thai citizens and children to read more. Many campaigns are carried out in an attempt to improve the public libraries in order to increase the number of libraries and to improve the infrastructure to support those campaigns. One major campaign is called Living Library. Various events and activities are carried out to support the campaign, and motivate children to come to the library. New design and colors are part of the building renovation. Library has to not only improve the building, but also emphasize the technology in order to render proper services offered to their patrons nowadays. One of the technologies that can facilitate in improving library services is Radio Frequency Identification (RFID).

RFID refers to an automatic identification technology using radio waves. The technology has been deployed and proven successful in various industries, including libraries. RFID enhances the library services in such a way that patrons can borrow and return books by themselves from a machine. Patrons also have the privacies to borrow books that they like to read. The technology also helps libraries know what kind of books that people like to read. RFID system also reduces the redundant work, increases the operations efficiency, and provides convenience for both the user and librarians.

Though there are increasing numbers of libraries deploying RFID technology, many libraries are facing the dilemma whether to invest in such technology or provide library service, the old ways. Hence, looking at the whole picture of technology usage of the country could help the library management to make decision in a more meaningful way.Business Intelligence (BI) is one of the toolsthat can be employed to support in decision making and planning the right strategies.This

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study aims to develop a Business Intelligence tool to support the library management in decisionsmaking (GIS) .

1.2 Objectives

The objective of this study is to develop Business Intelligence (BI) tool for the library management in decisions making on RFID technology.location ofwith

1.3 Scope of the Study

This study aims at libraries in Thailand with emphasis on educational libraries, including higher education libraries, school libraries, and special libraries.

1.4 Expected result

- The distribution of RFID libraries in Thailand can be obviously seen.
- RFID vendors can use this result to create the right business strategies.
- Libraries can use this information to create the right strategies for themselves.

1.5 Timeline

Table 1.1 Study Timeline

	Research Schedule																											
No.	Tasks	Duration	Jan-15				Feb-15				Mar-15				Apr-15				May-15				Jun-15				Jul-15			
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Discussion with advisor	60 days																												
2	Survey Design	7 days																												
3	Distributing surveys to selected library management	23 days																												
4	Gathering the information from su	2 days																												
5	Technical writing on Chapter 1-3	15 days																												
6	IS topic presentation	1 day																												
7	Technical writing on Chapter 4-5	20 days																												
8	Final paper presentation	1 day																												

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CHAPTER II
LITERATURE REVIEW

2.1 Library

As technology and economics are changing other institutes such as supermarkets, banks, and retail business, technology trend also change library services. Libraries are driven to cater for rapidly changing consumer behavior. Access for information from multiple locations, making it available at the time of need with less intervention by library staff are the basic key service features that library users demand of modern libraries.

2.2 Radio Frequency Identification (RFID)

RFID is an acronym for Radio Frequency Identification, which is the use of electromagnetic to transfer data for the purposes of automatically identifying and tracking tags attached to objects [1]. The technology comprises RFID tags that contain data and transfer data to RFID readers.

RFID has been widely used in many industries worldwide. For example, automobile production line use RFID tags to track the production process of each part though the assembly line. RFID tags can be attached to any object or implanted in animal or human body as shown in Figure 2.1.

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Figure 2.1 RFID Tag Implanted into Human Body.

2.3 RFID in Learning Center: Libraries

The study was prepared on the management of existing services of Chumpae Vocational College Library. There are problems in the operation. The problem was a delay for finding work and checking information. This is because the data is stored in paper file, thus causing delays. The lack of modern technology in handling and managing the resources is another cause. Therefore, it is necessary for Chumpae Vocational College Library to deploy modern technology of information system management to resolve the issues.

The problems, as shown in Figure 2.2, are given as:

1. Checking of pre-borrow of books and return of books is not systemized.
2. There are frequent errors and redundancy of data, such as books information or location of books.
3. Books are misplaced or hard to find.
4. There is inconvenience of services in searching of required books because patrons have to manually search for the required items on bookshelves without status information whether the book is on-shelf or lent out.
5. There is the lack of modern technologies to assist in service operation.

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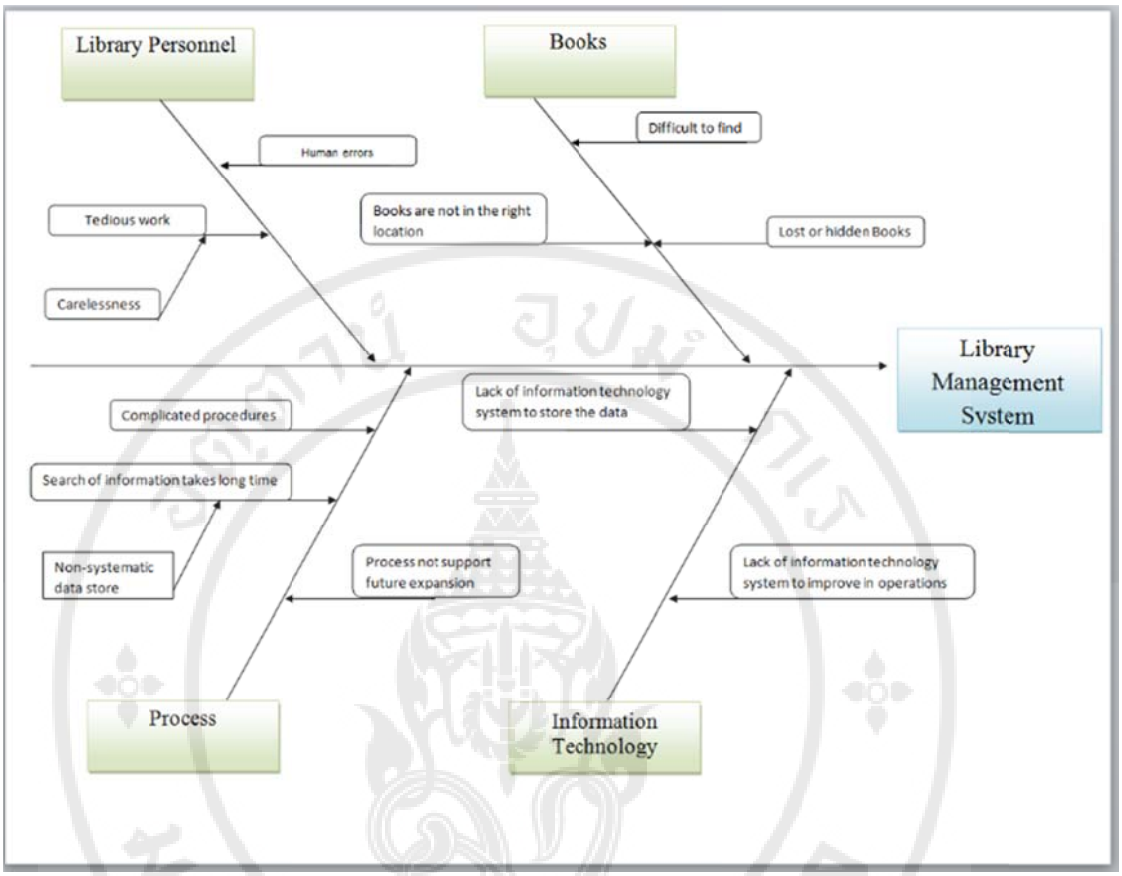

Figure 2.2 Causes to the Problems in Library Management System.

Suggestions:

1. Modern technology should be deployed to verify the information in various fields.

2. The application of RFID is used to enhance the faster operation.

3. Devices that enhance convenience in the work of librarians should be employed.

From the suggestions, the library decided to make the use of RFID technology to assist in handling and managing books collection for more accuracy and efficiency.

Library RFID technology has been applied to libraries with the main objective to improve the library services due to the system reliability, ease of use, and advantages of RFID system and tag.[4]

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Greater efficiency can be achieved and operation costs can be reduced by increasing self-service transactions by patrons. Security from books stealing is enhanced and library resources are easily inventoried and better managed to increase item circulation rate. Therefore, human resources and financial budget are more effectively managed [2].

The system consists of RFID Tag being attached to every book to prevent theft and to enhance the services. Patron can choose to check out and check in books by themselves through a machine, called self-check kiosk, and book drop or book return unit, which makes 24 hour (or after office-hour) return service possible. Shelf management is also handled much easier than traditional barcode system. Figure 2.3 shows RFID library system standard components.

Figure 2.3 RFID Library Systems.

RFID technology has many advantages, and can be developed and applied for usage in conjunction with other technologies to improve the efficiency in work process and operations as well as significant costs are also reduced. However, the implementation costs are still relatively high. Moreover, there are still some technical issues and complexity in the system integration and operation issues to be resolved.

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RFID technology, hence, is still not yet widely deployed in learning centers, especially in Thailand.

It depends greatly on each learning center or library's own policy, objectives, and readiness in their resources to choose whether to install RFID library system or the traditional barcode with a separate security system for their premises.

The study found that reasons for choosing RFID technology applications vary in different learning centers according to their purposes, limitation, and nature of the services provided.

2.3.1 RFID Advantages and Library Applications

Unlike a barcode, an earlier form of automatic identification technology, RFID tag works without line of sight and can be embedded in a tracked object. It is capable of communicating more than one tagged objects at a time to the readers of the same frequency range, making it far more efficient than barcode.

However, since the technology evolution and the arising of RFID technology, library can extend more services, never before available, to their patrons. Each transaction takes much less time. Up to 20 books, which is an average maximum each patron is allowed to borrow, can be read altogether at the same time. Checking out of 20 books takes 5 seconds on an average. Book's identification and security are handled by RFID in the same procedure. In addition, borrow and return of books can be carried out by patrons on a self-service machine in simple steps, leaving counter staff without queue. Staff will have more available time to provide other value-added and new services like helping researchers to access the needed resources. In Figure 2.4, a book return unit outside the library helps enhance 24-hour library service.[6]

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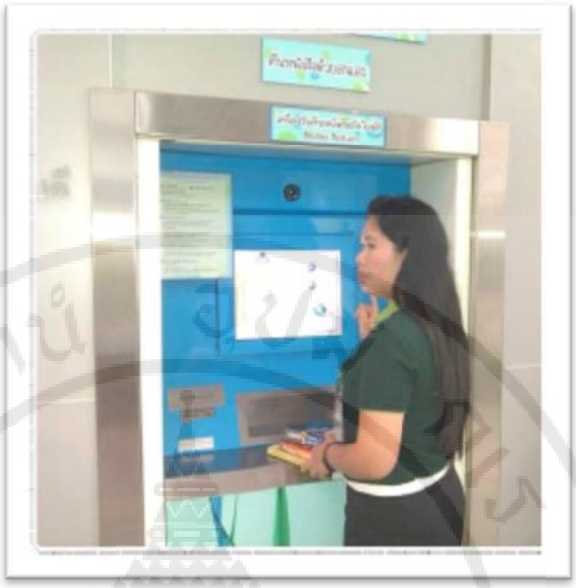

Figure 2.4 Twenty-four Hour Library Self-Service Book Return.

The advantages of RFID technology in library services are significant. The budget required to deploy an RFID system though seems much higher for investment compared to a barcode system. Its benefits are many folds higher, especially when staff resources are limited and yet services expectations by patrons cannot be compromised. Apart from reducing time, increasing the efficiency in many transactions, RFID also makes possible the search of misplaced books which is the tracking capability of the technology. RFID member cards offer both identification and cashless payment for fees and fines on a self-service machine. With all the proven benefits, RFID have been providing to RFID libraries, more and more library management are encouraged to consider deploying in such technology.

2.3.2 RFID Integrated Systems for Library

Let's look at what can comprise RFID systems for library in brief. RFID can enhance library's operations and services with many systems integrated. To dates, some sample systems can be shown in Figure 2.5.[5]

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Figure 2.5 A Sample of Integrated Systems with RFID Technology.

2.3.3 Circulation System

With RFID tags attached in each book, the system allows automatic self-check and speeds up all transactions, resulting in increased efficiency of each transaction and shorten the process time as a whole. Each book takes lesser time to return to shelf ready for the next service.

2.3.4 Access Control System with RFID Patron Card

Access control turnstile system offers library access with detailed statistics of patrons in various dimensions. With RFID patron card, patron enjoy ease of use with less time for the system to read RFID card compared to barcode card that must be precisely positioned for the barcode to be read.

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2.3.5 Payment System

RFID patron card can be configured to carry some value of money in the card, deduct for payment by waving it over an RFID reader/writer, allowing less cashed to be carried with a patron. Payment amount is selectable at the patron's will. Payment module can be integrated into 24-hour book return unit so that patron can pay for selected services and fines at their convenience.

One favorable feature of the above system is the reports function that can be viewed in graph in a dashboard format on any smart-phone and tablet as shown in Figure 2.6.

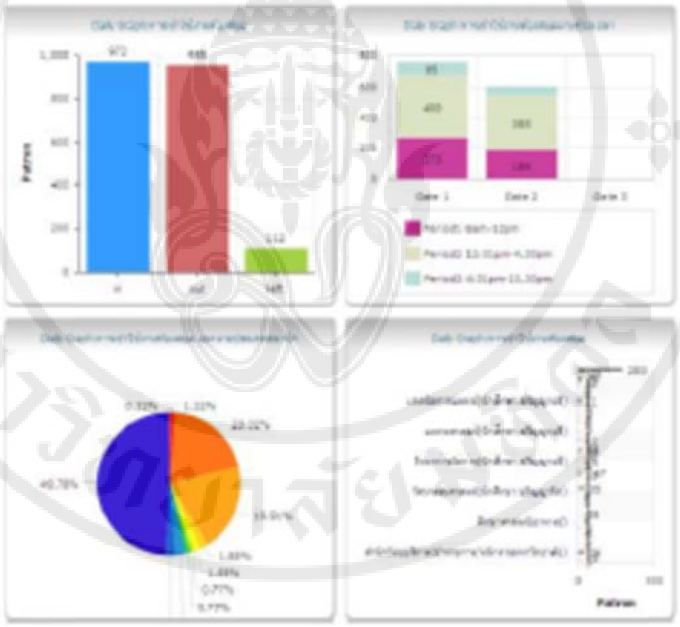

Figure 2.6 Dashboard Format Reports Available on Smart-phones.

2.4 BUSINESS INTELLIGENCE (BI)

Business Intelligence is a software tool designed to support in decisions making by retrieving, analyzing, transforming, and reporting data in a multi-dimensional model [8].

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Elements of BI software, as shown in Figure 2.7, feature three main sections:

1. The data collection for handling classified information into a form that is easy to process the application, known as ETL (Extract-Transform-Load).

2. The data analysis that pulls some interesting information out of the stored data, such as data mining and on-line analytical programming (OLAP).

3. The information display that presents the analyzed data in different dimensions in formats easy to understand, e.g. report, chart, graph, and dashboard.

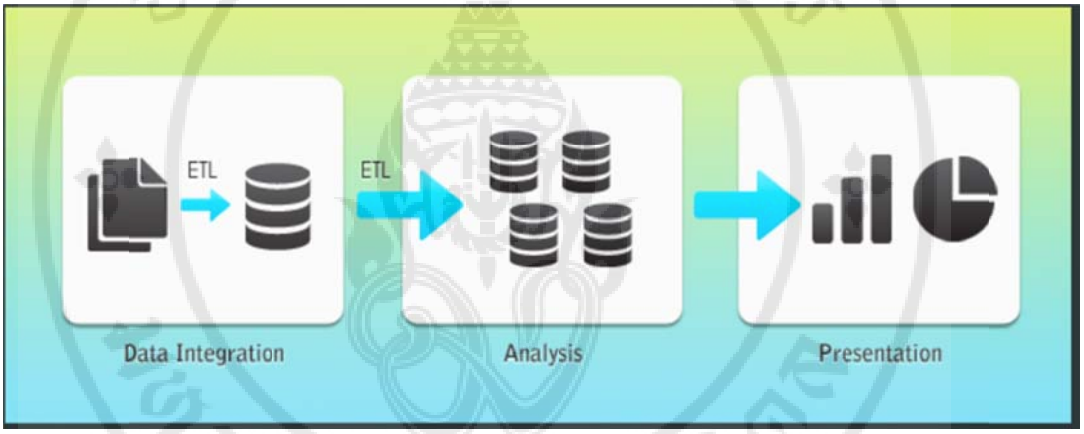

Figure 2.7 BI Elements.

Business Intelligence (BI) refers to a group of different information technologies, not just one technology, integrated to create BI tool. BI covers from the data collection process to the usage of the outcome of the presentation of various dimensions of results. How the use of BI supports in decisions making of the management is what makes BI stands out from other IT tools that support in decisions making.[9]

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2.5 BI and Library Management

- **Related Work**

In Business Intelligence Infrastructure for Academic Libraries, Joe Zucca [8] wrote that the University of Pennsylvania Libraries have been working on creating an information technology infrastructure that facilitates the collection, transport, and use of library activity data-services and user behavior. After completing five reference projects to prove basic concepts of framework and a set of applications are made available for other institutions to test deployment. It is concluded that, given the costs and complexity of the challenge, deep collaboration among libraries is essential if libraries think that a business intelligence infrastructure is strategically important.

Business intelligence has become an increasingly essential tool for libraries in this century. This is obviously reflected by the fact that in February 2015 American Library Association (ALA) has organized an e-course to help librarians become proficient in business intelligence, competitive advantages, and other strategic approaches to tackle modern library challenges [3].

2.6 BI and RFID Library in Thailand

In Thailand, there are total 39,330 academic libraries [2], including school libraries, special libraries, and higher education level libraries. Each type of library comprises its own sets of values and factors to be considered in selecting infrastructure, information technology mixes, and necessary investment in order to provide their services to the community it serves. As RFID technology advanced in a leap-frog rate, it is becoming challenge for the library management to understand and to make the right decision to deploy the suitable technology mix, system components, and systems integration for themselves. Hence, the development of BI on RFID libraries could help the library management in many aspects, given as:

- Monitoring the greater vision of libraries of Thailand,
- Monitoring their activities of libraries,
- Classifying type and technology of libraries,
- Trend of technology being deployed in libraries,
- Considering the right strategies for their libraries.

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CHAPTER III
RESEARCH METHODOLOGY

This quantitative research gathers data and information from RFID libraries in Thailand in order to develop a Business Intelligence tool to support libraries management and librarians in decisions making.

Research methodology can be described as follows:

- Literature review,
- Identification of study populations and samples,
- Surveys,
- Data analysis and data processing,
- Business Intelligence (BI) implementation,
- Presentation of the development.

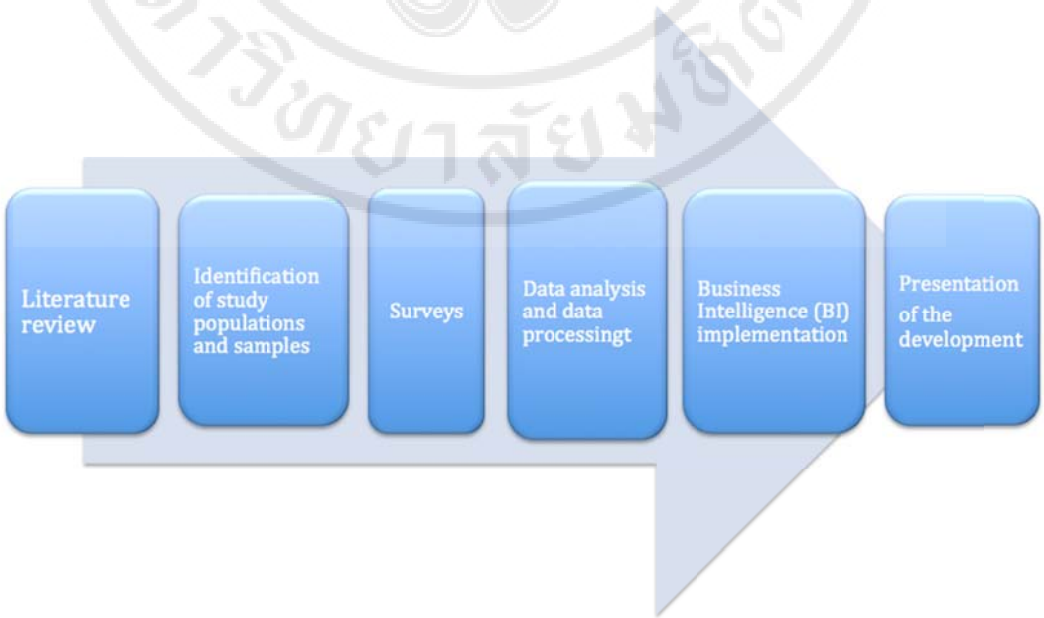

Figure 3.1 Research methodology framework.

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3.1 Literature Review

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

3.2 Identification of Study Populations and Sample

This section of research identifies research populations and sample.

- Study Populations

Study populations of this research are libraries in Thailand. Previous surveys to educational libraries of different levels including higher education libraries, school libraries, and special libraries, are studied. Without limitation of library management system, information studied includes number of books collections, statistical data collection system on patrons, services issues often faced by the library, and other relevant information that is mentioned by the library in the surveys.

- Samples

This qualitative research uses additional selected sampling from librarians and the library management who are current members of Thai Library Association (TLA) and visitors who attended the annual Conference of 2015 to represent both libraries that have already implemented RFID system and those not yet implement. In this study, there are 50 samples surveyed.

3.3 Survey

Primary source of data was previously collected. The survey questions are designed to answer the most frequently asked questions that the author come across most from the past experience meeting with customers, i.e. libraries in Thailand. The surveys are distributed to the current TLA members who attended 2015 Conference. The details emphasize on the following:

- Library management system being used
- Number of collections that are physical books

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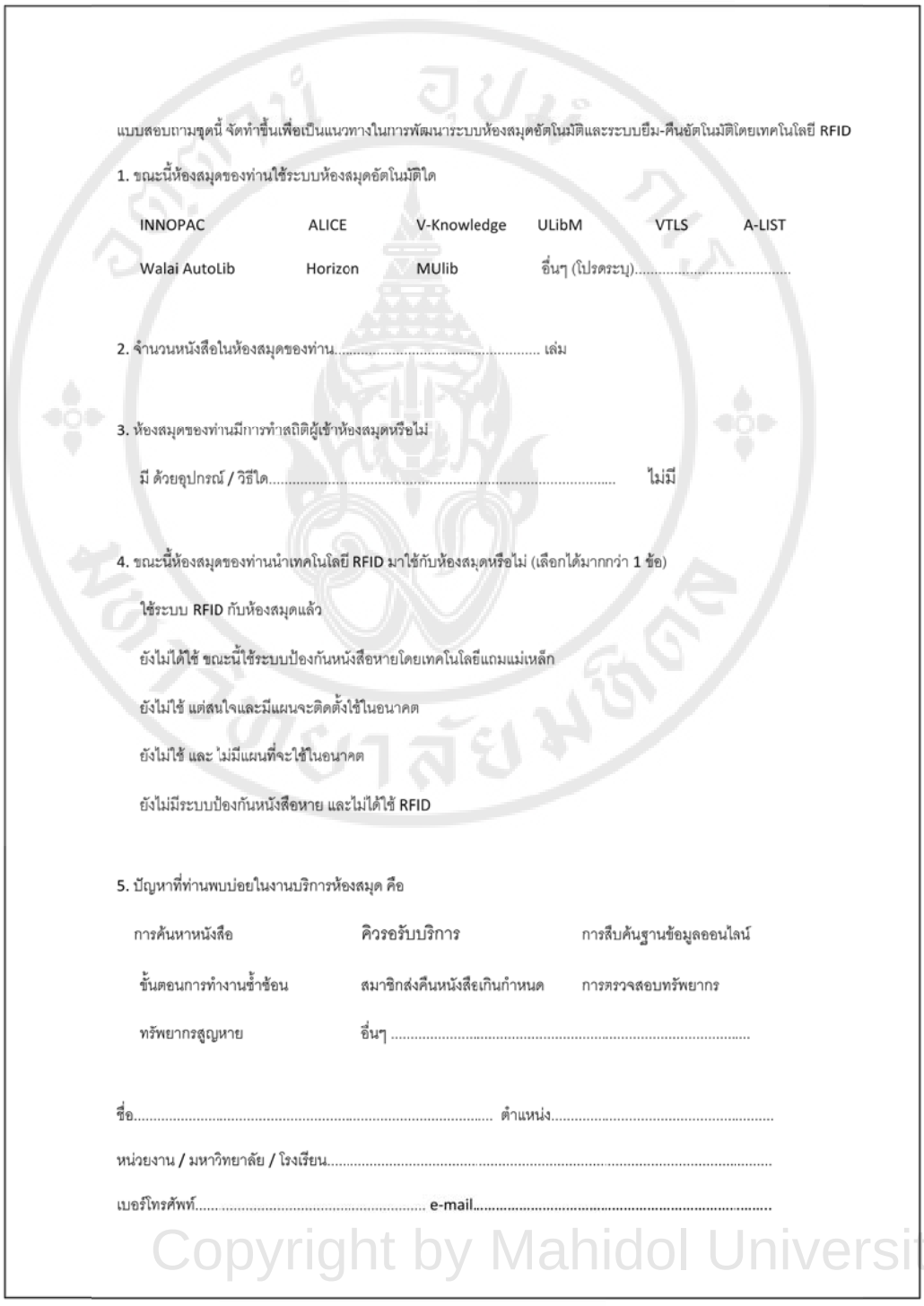
- Whether the library is using any access control system to collect statistical data of patrons library usage
- Whether the library is deploying on any RFID system

The questionnaire used in this study is shown in Figure 3.2.



แบบสอบถามชุดนี้ จัดทำขึ้นเพื่อเป็นแนวทางในการพัฒนาระบบห้องสมุดอัตโนมัติและระบบยืม-คืนอัตโนมัติโดยเทคโนโลยี RFID

1. ขณะนี้ห้องสมุดของท่านใช้ระบบห้องสมุดอัตโนมัติใด

INNOPAC ALICE V-Knowledge ULibM VTLS A-LIST

Walai AutoLib Horizon MUlib อื่นๆ (โปรดระบุ).....

2. จำนวนหนังสือในห้องสมุดของท่าน..... เล่ม

3. ห้องสมุดของท่านมีการทำสถิติผู้เข้าห้องสมุดหรือไม่

มี ด้วยอุปกรณ์ / วิธีใด..... ไม่มี

4. ขณะนี้ห้องสมุดของท่านนำเทคโนโลยี RFID มาใช้กับห้องสมุดหรือไม่ (เลือกได้มากกว่า 1 ข้อ)

ใช้ระบบ RFID กับห้องสมุดแล้ว

ยังไม่ได้ใช้ ขณะนี้ใช้ระบบป้องกันหนังสือหายโดยเทคโนโลยีแถมแม่เหล็ก

ยังไม่ใช้ แต่สนใจและมีแผนจะติดตั้งใช้ในอนาคต

ยังไม่ใช้ และ ไม่มีแผนที่จะใช้ในอนาคต

ยังไม่มีระบบป้องกันหนังสือหาย และไม่ได้ใช้ RFID

5. ปัญหาที่ท่านพบบ่อยในงานบริการห้องสมุด คือ

การค้นหาหนังสือ คิวรอรับบริการ การสืบค้นฐานข้อมูลออนไลน์

ขั้นตอนการทำงานซ้ำซ้อน สมาชิกส่งคืนหนังสือเกินกำหนด การตรวจสอบทรัพยากร

ทรัพยากรสูญหาย อื่นๆ .....

ชื่อ..... ตำแหน่ง.....

หน่วยงาน / มหาวิทยาลัย / โรงเรียน.....

เบอร์โทรศัพท์..... e-mail.....

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Figure 3.2 Survey to Library Management.

3.4 Data Analysis and Data Processing

Data from the survey distributed in 2015 TLA Conference can be summarized in Table 3.1.

Table 3.1 Data Collected from Surveys

No	Location	Already RFID		Have Plan		Have Other System		Access statistics	
		Yes	No	Yes	No	Yes	No	Yes	No
1	Ramkhamhaeng	/		/			/	/	
2	Mahasarakham	/		/			/	/	
3	Khonkaen		/			/		/	
4	Nakornrachasima	/		/			/	/	
5	Chiangmai	/		/			/	/	
6	Suratthain	/		/			/	/	
7	Nakhonsrithammarat	/		/			/	/	
8	Hatyai		/	/		/		/	
9	Pattani	/		/			/	/	
10	Yala	/		/			/	/	
11	Ladkrabng	/		/			/	/	
12	Deves,Bangkok	/		/			/	/	
13	Pranakon	/		/			/	/	
14	Patumwan	/		/			/	/	
15	Nakornpatom		/	/		/			/
16	Nakornpatiom		/	/		/			/
17	Chachoengsao	/		/			/	/	
18	Kanchanaburi		/	/		/			/
19	Chonburi	/		/			/	/	

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Table 3.1 Data Collected from Surveys. (Cont.)

No	**Location**	**Already RFID**		**Have Plan**		**Have Other System**		**Access statistics**	
		Yes	No	Yes	No	Yes	No	Yes	No
20	Rayong		/	/		/			/
21	Petchburi	/		/			/	/	
22	Pattaluing		/	/			/		/
Total		15	7	22	0	6	16	17	5

The table shows that out of 50 surveys distributed to participants from different libraries, 22 responses returned. Out of the 22 feedbacks, 15 libraries have already deployed RFID systems in their libraries and still continue to have plan in expanding the usage. The 17 libraries have some form of access statistics of patrons come into the libraries. 16 libraries are no longer equipped with other systems, such as security system with electro-magnetic strips, while 6 libraries having not deployed RFID have electro-magnetic security system in place.

However, due to insufficient data responded, another 100 questionnaires are addressed to library management at specific libraries. Results of the 50 respondents are shown in Table 3.2.

Table 3.2 Data Collected from Second Survey.

LIBRARY	HF	UHF	EM	REGION	MANAGEMENT	NO. OF BOOKS	BUDGET
RU	yes	no	no	Mid	Innopac	500,000	6,000,000
KKU	no	no	yes	NE	Innopac	400,000	5,000,000
KU	yes	yes	no	Mid	Innopac	300,000	4,500,000

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Table 3.2 Data Collected from Second Survey.(Cont.)

LIBRARY	HF	UHF	EM	REGION	MANAGEMENT	NO. OF BOOKS	BUDGET
CU	yes	no	no	Mid	Innopac	300,000	3,500,000
THU	yes	no	no	S	Walai	200,000	5,000,000
TU	no	yes	no	Mid	KOHA	200,000	15,000,000
NU	no	yes	no	N	Innopac	250,000	5,000,000
BUU	yes	no	no	E	Magic Library	100,000	3,000,000
MSU	yes	no	no	NE	Innopac	300,000	7,500,000
MU	no	no	yes	Mid	Innopac	250,000	3,500,000
RAMA	yes	no	no	Mid	Innopac	30,000	3,600,000
SWU	no	no	yes	Mid	ALEPH	150,000	4,000,000
SU	yes	no	no	Mid	Innopac	120,000	3,500,000
PSU PATTANI	yes	no	no	Mid	A-LIST	150,000	2,500,000
PSU HATYAI	no	no	yes	S	A-LIST	250,000	1,200,000
UBRU	yes	n	no	NE	Walai	200,000	1,500,000

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Table 3.2 Data Collected from Second Survey.(Cont.)

LIBRARY	HF	UHF	EM	REGION	MANAGEMENT	NO. OF BOOKS	BUDGET
KMUTNB	no	yes	no	Mid	Innopac	110,000	1,000,000
KMITL	yes	no	no	Mid	Innopac	300,000	15,000,000
KMUTT	no	no	yes	Mid	Innopac	100,000	1,500,000
NIDA	no	no	yes	Mid	Horizon	120,000	2,000,000
WU	yes	no	no	S	Walai	150,000	1,500,000
SUT	yes	no	no	NE	A-LIST	250,000	10,000,000
MJU	no	no	yes	N	VTLS	100,000	1,500,000
NSTRU	yes	no	no	S	Walai	250,000	2,000,000
BU	no	no	yes	Mid	Horizon	80,000	1,200,000
ABAC	no	no	no	Mid	in-house	70,000	1,200,000
SPU	yes	no	no	Mid	Not available	50,000	2,000,000
PAYAP	no	no	yes	N	Ulib-M	80,000	1,250,000
NLT	no	no	yes	Mid	Not available	300,000	1,200,000

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Table 3.2 Data Collected from Second Survey.(Cont.)

LIBRARY	HF	UHF	EM	REGION	MANAGEMENT	NO. OF BOOKS	BUDGET
MOJ	no	no	no	Mid	Millib	20,000	1,000,000
MARUEY	no	yes	no	Mid	VTLS	30,000	2,000,000
TCDC	yes	no	no	Mid	Walai	30,000	5,000,000
TCDC Chiang Mai	yes	no	no	N	Walai	15,000	1,500,000
TK Park Central World,	yes	no	no	Mid	Walai	35,000	5,000,000
KCC	yes	no	no	Mid	Walai	30,000	3,000,000
THE BOOK PHUKET	yes	no	no	S	Liberty	30,000	4,000,000
RPCA	yes	no	no	Mid	V-Knowledge	50,000	3,000,000
RMUTP THEWES	yes	no	no	Mid	Walai	30,000	2,500,000
RMUTP CHOTIWET	yes	no	no	Mid	Walai	25,000	2,000,000
SRP	yes	no	no	S	V-Knowledge	50,000	3,000,000
BPI	yes	no	no	Mid	Not available	30,000	1,500,000

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Table 3.2 Data Collected from Second Survey.(Cont.)

LIBRARY	HF	UHF	EM	REGION	MANAGEMENT	NO. OF BOOKS	BUDGET
NHRC	yes	no	no	Mid	Ulib-M	30,000	2,500,000
PSRU	yes	no	no	N	Ulib-M	150,000	6,000,000
UBU	no	yes	no	NE	Walai	150,000	600,000
CHUMPHAE	yes	no	no	NE	Not available	12,000	3,250,000
WEBSER	no	no	yes	W	(American software)	30,000	500,000
KN	yes	no	no	W	(Chinese software)	45,000	3,000,000
KRU	no	no	yes	W	Liberty	120,000	1,200,000
CMU	yes	no	no	N	Innopac	250,000	2,500,000

3.5 Business Intelligence (BI) Implementation

All the collected data above as well as input from previous surveys and historical data will be input into Business Intelligence software for a clearer overview picture of the whole country libraries. Figure 3.3 shows the sample of dashboard form of statistical reports.

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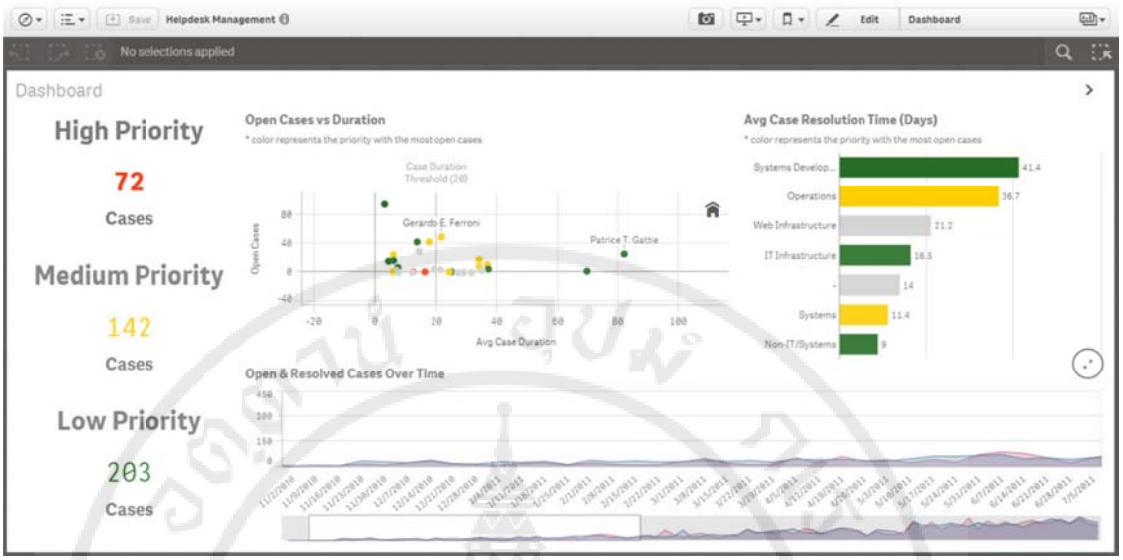

Figure 3.3 Sample Dashboard.

3.6 Presentation of the Development

Upon deriving a clearer overview from the result of BI development, business strategies for both library management and vendors could be better established in the later chapter.

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CHAPTER IV
DATA EXPLORATION AND DATA PROCESSING

This chapter explores data collected in various dimensions and formats. Explorations are shown in forms of pivot table, bar chart, and geographical information diagram.

4.1 Data Exploration by Region

From previous chapter, surveys to the libraries were collected and analyzed. Information derived indicates the library management system that each library is using, and whether the library is deploying electromagnetic system (EM), RFID High Frequency (HF) or Ultra High Frequency (UHF) system. Resulted pivot table that supports decision making can be created as shown in Table 4.1.

Table 4.1 Library Management System and RFID Deployment by Region.

REGION	TYPE OF LIBRARY	LIBRARY MANAGEMENT SYSTEM	LIBRARY	HF	EM	UHF
East	Higher Education	Magic Library	BUU	yes	no	no
Central	Higher Education	ALEPH	SWU	no	yes	no
		Horizon	BU	no	yes	no
			NIDA	no	yes	no
		(in-house)	ABAC	no	no	no
		Innopac	RAMA	yes	no	no
			KU	yes	no	yes
			KMITT	no	yes	no
			KMITNB	no	no	yes
			CU	yes	no	no
			MU	no	yes	no
			RU	yes	no	no

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Table 4.1 Library Management System and RFID Deployment by Region.(Cont).

REGION	TYPE OF LIBRARY	LIBRARY MANAGEMENT SYSTEM	LIBRARY	HF	EM	UHF
			SU	yes	no	no
			KMITL	yes	no	no
		KOHA	TU	no	no	yes
		Not available	SPU	yes	no	no
		UlibM	BPI	yes	no	no
		V-Knowledge	RPCA	yes	no	no
		Walai	RMUTP-CHTWC	yes	no	no
			RMUTP-THEWES	yes	no	no
	PUBLIC	Not available	NLT	no	yes	no
		Walai	TK Park	yes	no	no
			KCC	yes	no	no
	SPECIALIZED	Millib	MOJ	yes	no	no
		Ulib-M	NHRC	yes	no	no
		VTLS	MARUEY	no	no	yes
		Walai	TCDC	yes	no	no
North	Higher Education	Innopac	CMU	yes	no	no
			NU	no	no	yes
		Ulib-M	PAYAP	no	yes	no
			PSRU	yes	no	no
		VTLS	MJU	no	yes	no
	SPECIALIZED	Walai	TCDC Chiang Mai	yes	no	no
North Eastern	Higher Education	A-LIST	SUT	yes	no	no
		Innopac	KKU	no	yes	no
			MSU	yes	no	no
		Walai	UBRU	yes	no	n
			UBU	no	no	yes
	SCHOOL	Not available	CHUMPHAE	yes	no	no
South	Higher Education	A-LIST	PSU-PATTANI	yes	no	no
			PSU-HAITYAI	no	yes	no
		Horizon	TSU	yes	no	no
		Walai	NSTRU	yes	no	no
			WU	yes	no	no
	PUBLIC	Liberty	INFINITE INSIGHT	yes	no	no
	SCHOOL	V-Knowledge	ST	yes	no	no

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Table 4.1 Library Management System and RFID Deployment by Region.(Cont).

REGION	TYPE OF LIBRARY	LIBRARY MANAGEMENT SYSTEM	LIBRARY	HF	EM	UHF
West	Higher Education	(American software)	WEBSTER	no	yes	no
		Liberty	KRU	no	yes	no
	SCHOOL	Chinese Software	KN	yes	no	no

Table 4.1 shows a clear picture of the most frequently asked questions by librarians and library management in any library. The majority installations of RFID, in terms of number of libraries, are in the central part of Thailand. Most libraries choose to deploy high frequency (HF) system.

4.2 Data Exploration by Budget

Another information dimension derived is number of books and budget of libraries in each province, whether planned or already deployed RFID system. Table 4.2 displays the information in details.

Table 4.2 RFID Deployment Status with Number of Books and Budgets.

TYPE OF LIBRARY	DEPLOYED	PROVINCE	LIBRARY	NO. OF BOOKS	BUDGET
Higher Education	Planned	BKK	5	520,000	9,900,000
		CHIANGMAI	1	100,000	1,500,000
		CHIANGMAI	1	80,000	1,250,000
		KARNCHANABURI	1	120,000	1,200,000
		KHONKHAEN	1	400,000	5,000,000
		NAKORNPATOM	1	250,000	3,500,000
		PETCHBURI	1	30,000	500,000
		SONGKHLA	1	250,000	1,200,000
	Planned Total		12	1,750,000	24,050,000

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Table 4.2 RFID Deployment Status with Number of Books and Budgets.(Cont.)

TYPE OF LIBRARY	DEPLOYED	PROVINCE	LIBRARY	NO. OF BOOKS	BUDGET
	Yes	BKK	12	1,995,000	60,100,000
		CHIANGMAI	1	250,000	2,500,000
		CHONBURI	1	100,000	3,000,000
		MAHASARAKHAM	1	300,000	7,500,000
		NAKORNPATOM	1	50,000	3,000,000
		NAKORNRACHASIMA	2	500,000	12,000,000
		NAKORNSRITHAMMARAT	1	150,000	1,500,000
		PATTALUNG	1	200,000	5,000,000
		PATTANI	1	150,000	2,500,000
		PITSANULOK	2	400,000	11,000,000
		UBONRACHATHANI	2	350,000	2,100,000
	Yes Total		25	4,445,000	110,200,000
PUBLIC	Planned	BKK	1	300,000	1,200,000
	Planned Total		1	300,000	1,200,000
	Yes	BKK	1	35,000	5,000,000
		CHACHOENSAO	1	30,000	3,000,000
		PHUKET	1	30,000	4,000,000
	Yes Total		3	95,000	12,000,000
SCHOOL	Yes	KARNCHANABURI	1	45,000	3,000,000
		KHONKHAEN	1	12,000	3,250,000
		SURATTHANI	1	50,000	3,000,000
	Deployed Total		3	107,000	9,250,000
SPECIALIZED	Planned	BKK	1	20,000	1,000,000

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Table 4.2 RFID Deployment Status with Number of Books and Budgets.(Cont.)

TYPE OF LIBRARY	DEPLOYED		PROVINCE	LIBRARY	NO. OF BOOKS
	Yes	BKK	3	90,000	9,500,000
		CHAINGMAI	1	15,000	1,500,000
	Yes Total		4	105,000	11,000,000
Grand Total			49	6,822,000	168,700,000

From the RFID deployment status shown in Table 4.2, there are total of 49 survey respondent libraries, with 168 million baht budget. Twelve higher educational libraries, with total budget of 24 million baht and 1.7 million books have plans to deploy RFID systems. Those in this type and already have their services enhanced with RFID account for 25 libraries, 110 million baht budget allocated and 4.4 million books attached with RFID tags.

4.3 Data Exploration by Total Deployment

Total number of RFID deployment is another interesting dimension. Table 4.3 and Figure 4.1 indicate libraries already equipped with RFID components. Number of books and budget are also shown.

Table 4.3 Libraries Already Deployed RFID.

TYPE OF LIBRARY	Deployed	LIBRARY	NO. OF BOOKS	Budget
Higher Education	Yes	25	4,445,000	110,200,000
PUBLIC	Yes	3	95,000	12,000,000
SCHOOL	Yes	3	107,000	9,250,000
SPECIALIZED	Yes	4	105,000	11,000,000
TOTAL		35	4,752,000	142,450,000

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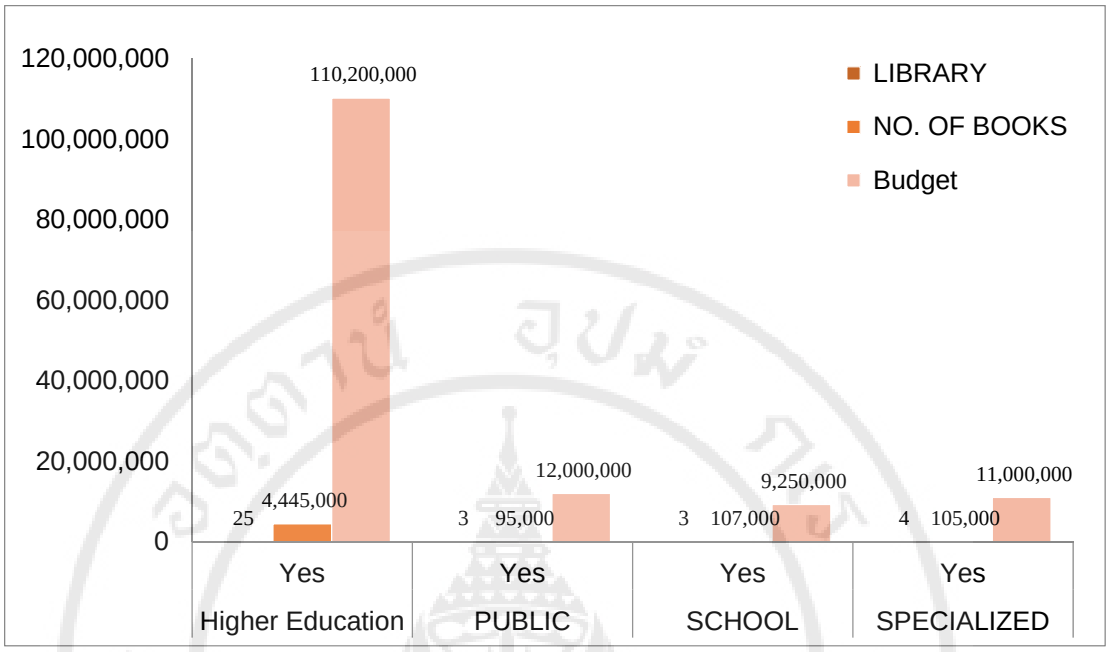

Figure 4.1 Deployment of RFID by Library Type.

From Table 4.3, there are 35 libraries that have installed RFID in their facilities. Figure 4.1 shows a clear perspective of amount of books and budget allocated for the system for each library type. For example, there are 3 public libraries for which 12 million baht have been allocated for 95,000 books to be serviced with RFID.

4.4 Data Exploration by Deploying Plan

Number of libraries with deployment plans is another dimension that could be extended from the data. Each type of libraries and total amount of books and budgets of each are shown in Table 4.4 and Figure 4.3.

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Table 4.4 Libraries with Plan to Deploy RFID.

TYPE OF LIBRARY	DEPLOYED	LIBRARY	NO. OF BOOKS	BUDGET (THB)
Higher Education	Planned	12	1,750,000	24,050,000
PUBLIC	Planned	1	300,000	1,200,000
SPECIALIZED	Planned	1	20,000	1,000,000
TOTAL		14	2,070,000	26,250,000

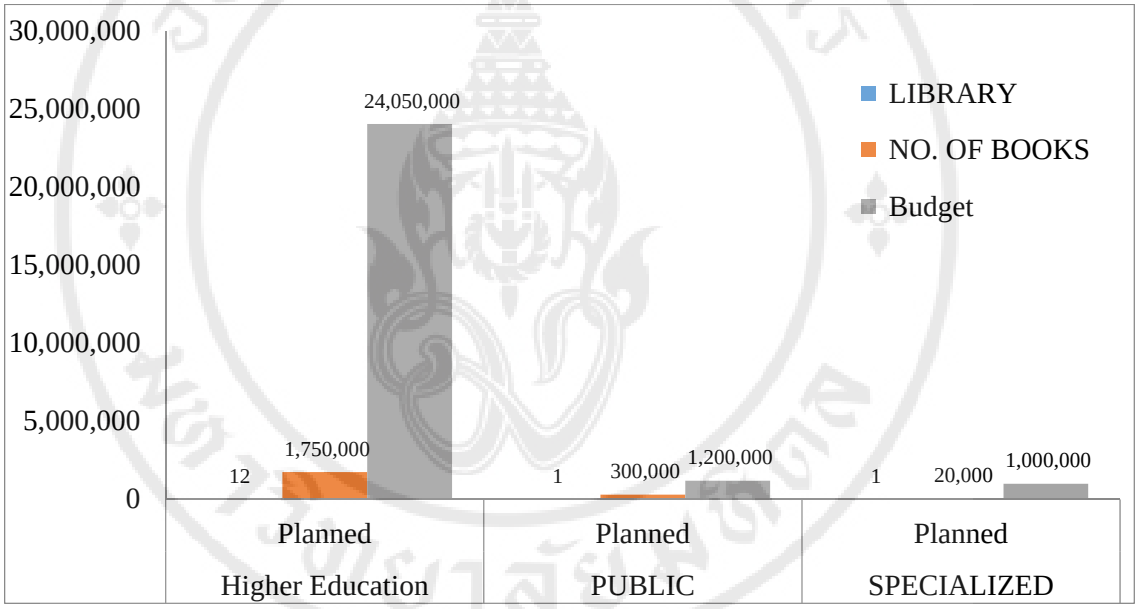

Figure 4.2 RFID Deployment Plan by Library Type.

There are 14 out of 49 responded libraries that already have some plans to deploy RFID components. Total budget that will be allocating for the installment amounts to 26 million baht for 2 million books. The 92% of which are 12 higher educational libraries.

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4.5 Data Exploration by High Frequency (HF) Libraries

As there are currently two different frequency deployments of RFID in Thailand libraries, it is interesting to see the distribution of both systems in Thailand. Table 4.5 provides high frequency (HF) system libraries in details and Figure 4.3 shows clearly contribution of each type, total budgets, and books tagged.

Table 4.5 Deployed HF RFID Budgets by Library Type.

TYPE OF LIBRARY	PROVINCE	HF	LIBRARY	Budget (THB)	NO. OF BOOKS
Higher Education	BKK	yes	10	44,100,000	1,685,000
	CHIANGMAI	yes	1	2,500,000	250,000
	CHONBURI	yes	1	3,000,000	100,000
	MAHASARAKHAM	yes	1	7,500,000	300,000
	NAKORNPATOM	yes	1	3,000,000	50,000
	NAKORNRACHASIMA	yes	2	12,000,000	500,000
	NAKORNSRITHAMMARAT	yes	1	1,500,000	150,000
	PATTALUNG	yes	1	5,000,000	200,000
	PATTANI	yes	1	2,500,000	150,000
	PITSANULOK	yes	1	6,000,000	150,000
	UBONRACHATHANI	yes	1	1,500,000	200,000
Higher Education Total			21	88,600,000	3,735,000
PUBLIC	BKK	yes	1	5,000,000	35,000
	CHACHOENSAO	yes	1	3,000,000	30,000
	PHUKET	yes	1	4,000,000	30,000
PUBLIC Total			3	12,000,000	95,000
SCHOOL	KARNCHANABURI	yes	1	3,000,000	45,000
	KHONKHAEN	yes	1	3,250,000	12,000

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Table 4.5 Deployed HF RFID Budgets by Library Type.(Cont.)

TYPE OF LIBRARY	PROVINCE	HF	LIBRARY	Budget (THB)	NO. OF BOOKS
	SURATTHANI	yes	1	3,000,000	50,000
SCHOOL Total			3	9,250,000	107,000
SPECIALIZED	BKK	yes	2	7,500,000	60,000
	CHAINGMAI	yes	1	1,500,000	15,000
SPECIALIZED Total			3	9,000,000	75,000
Grand Total			30	118,850,000	4,012,000

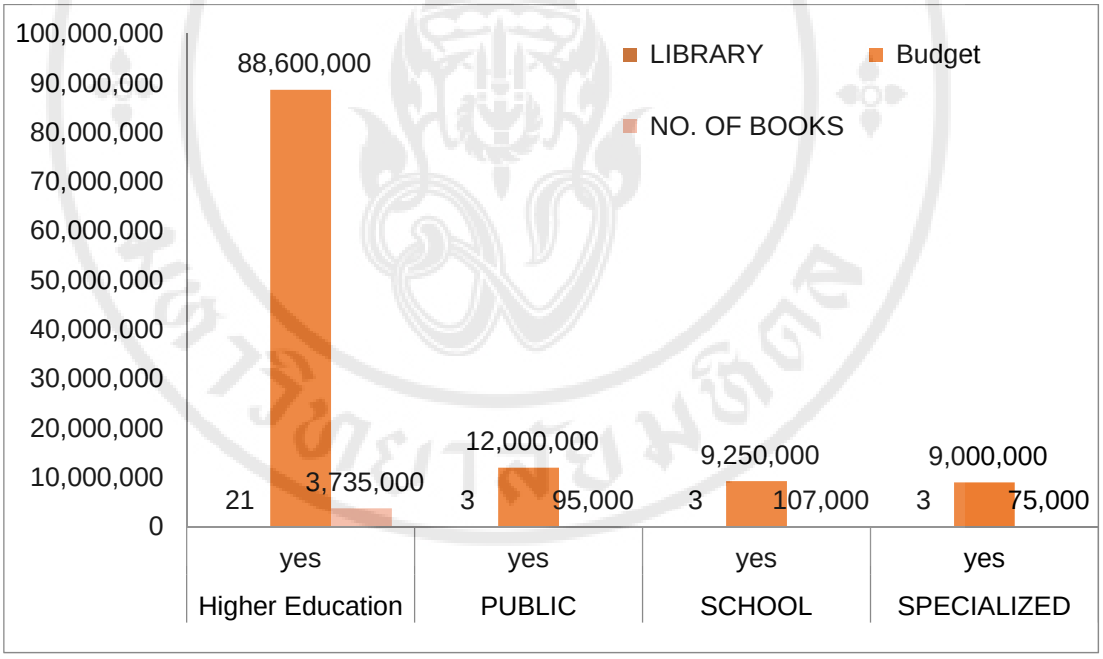

Figure 4.3 Total High Frequency (HF) Libraries.

There are 30 out of 35 libraries deploying HF RFID system with total budget of 118.8 million baht. The 21 HF libraries are of higher educational type, total 88.6 million baht allocated for 3.7 million books. 13 Libraries are in Bangkok which comprises one third of the total budgets.

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4.6 Data Exploration by Ultra High Frequency (UHF) Libraries

Ultra high frequency (UHF) libraries distribution can be seen in Table 4.6 and Figure 4.5.

Table 4.6 Total UHF Libraries.

TYPE OF LIBRARY	UHF	LIBRARY	Budget (THB)	NO. OF BOOKS
Higher Education	yes	5	26,100,000	1,010,000
SPECIALIZED	yes	1	2,000,000	30,000
TOTAL		6	28,100,000	1,040,000

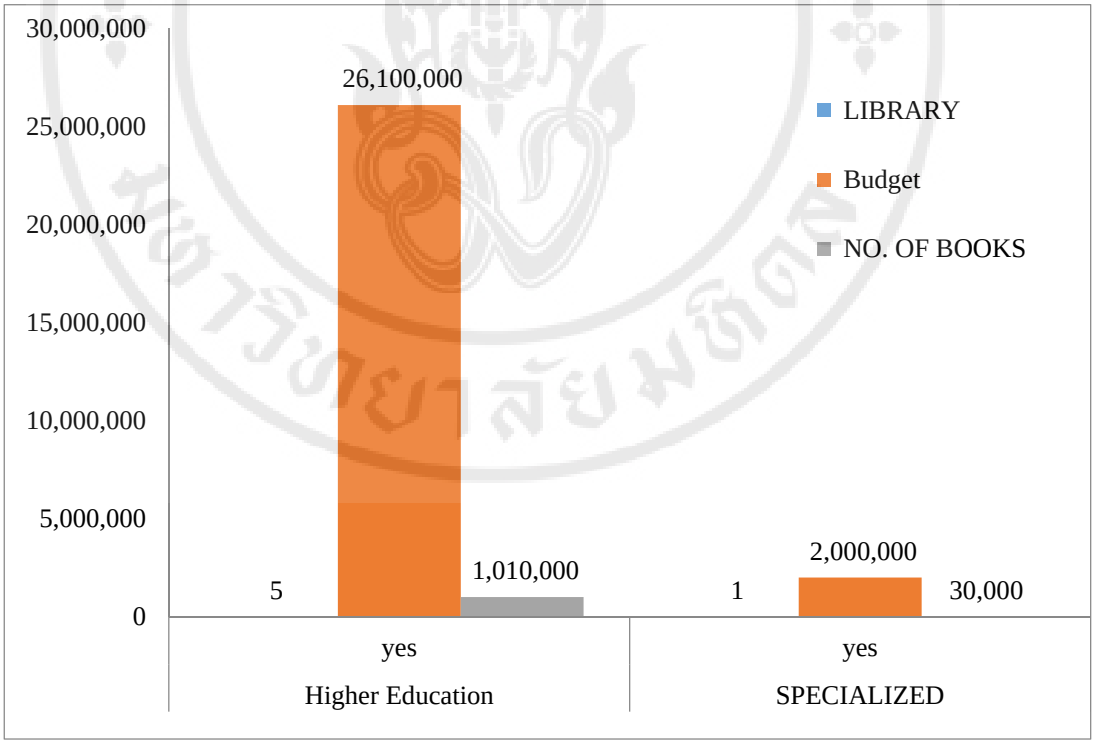

Figure 4.4 Total UHF Systems.

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There are 6 libraries deployed with UHF system, One specialized library and 5 higher educational. Total budget allocated is 28 million baht.

4.7 Data Exploration by Geographical Information System

The collected data in the previous section was processed and grouped using geographical information program, the outcome in various dimensions can be shown in Figures 4.5 - 4.7.

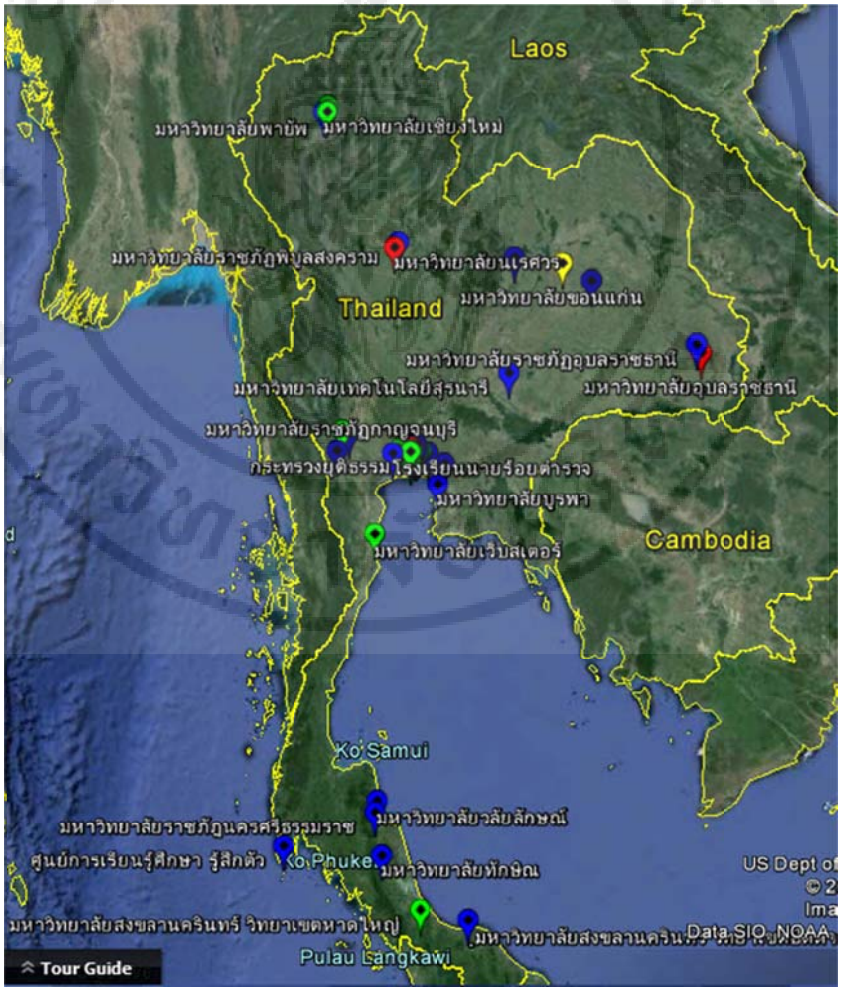

Figure 4.5 Geographical Information of RFID Libraries in Thailand Overview.

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Figure 4.5 shows the overview of distribution of RFID libraries in Thailand. Bullets in blue color indicate RFID HF library, red color with UHF, and green color with electromagnetic (EM) security systems. Figure 4.6 displays the overview of the distribution in different angle.

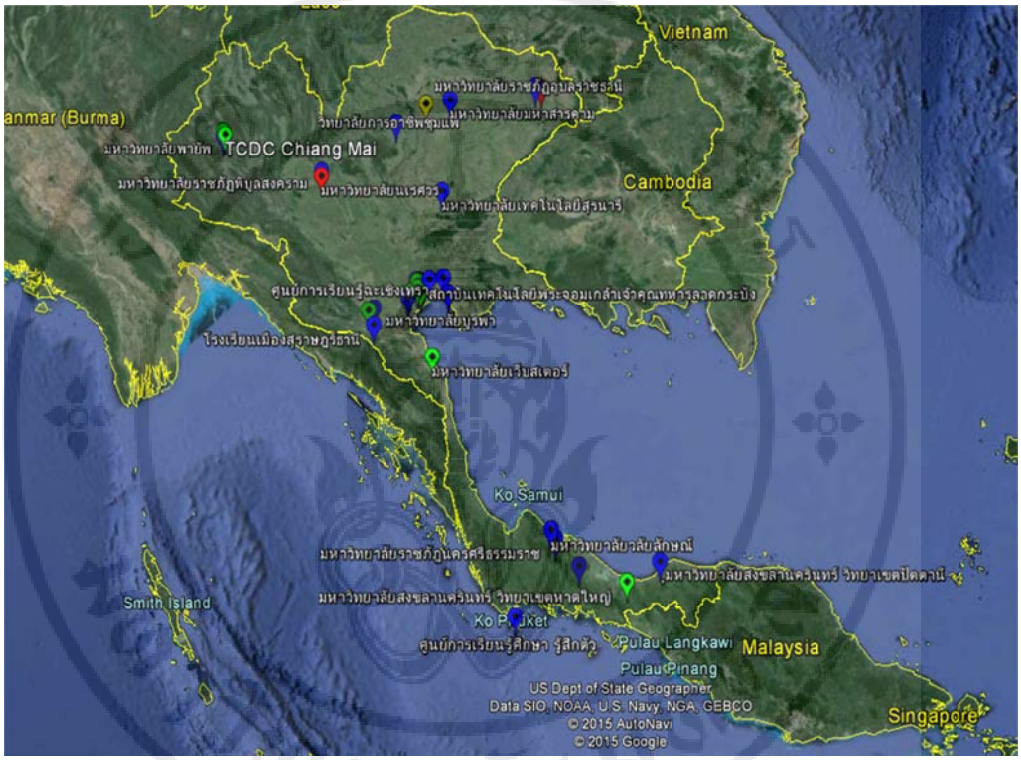

Figure 4.6 Geographical Information of RFID Libraries in Thailand Viewed in Different Angle.

By one easy click on the selected buttons, geographical information can offer broad picture of the dimension of interest, such as general distribution of the RFID deployment status of libraries throughout Thailand, as shown in Figures 4.5 - 4.6, to particular detail such as deployment status of libraries in Bangkok alone as shown in Figure 4.7. By clicking on Bangkok, all the information related to the interested dimension with focus on Bangkok alone is displayed simultaneously.

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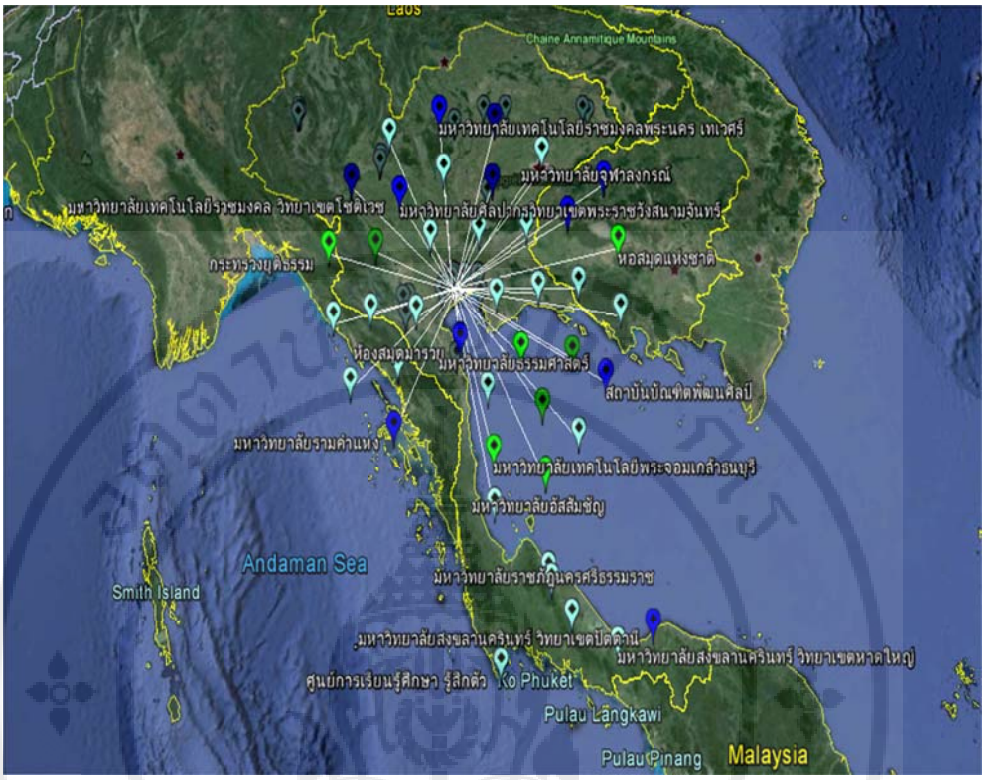

Figure 4.7 Geographical Information of RFID Libraries in Thailand by Region.

There are many advantages that geographical information dimension can offer.

Density of population in each interested region on interested dimension can be obtained. Moreover, type of RFID deployed by each library is also displayed. Other dimensions of information that could be of interest to the library management can also be clearly displayed in a very user-friendly manner, by clicking on the bullet representing the interested site.

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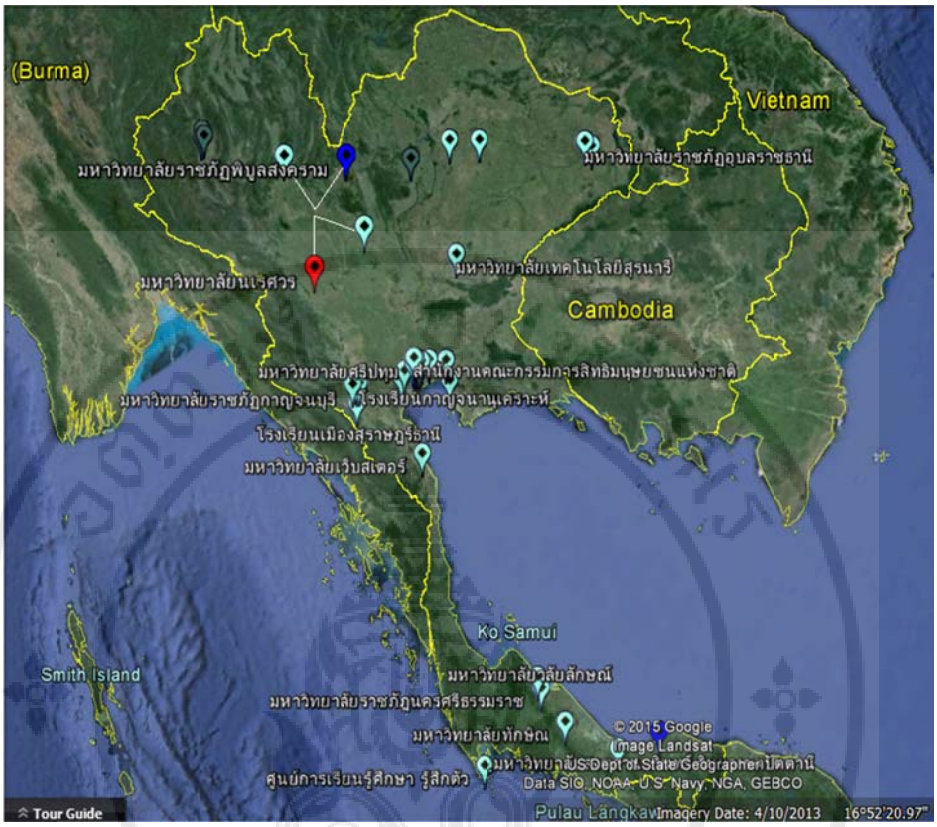

Figure 4.8 Geographical Information of RFID Libraries in Thailand by Type of System Deployment.

In summary, development of the business intelligence on RFID libraries in Thailand from pivot tables in with the information that librarians and management are interested, bar charts, geographical information that can be drilled down into detailed can support the decision making of the management by offer various aspects of information. Not only does it offer the useful information in various dimensions for library management, but it also provides the insight information for the RFID vendors to support in their strategic decision makings.

The resulted development is shown to the management of three libraries representing the favorable comments, especially for the ability to display the information in different dimensions on a simple click.

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CHAPTER V
CONCLUSION

This chapter provides summary of results of the study. Moreover, suggestions for the improvement of the future work are also provided.

5.1 Summary

Interesting information that most library management prefer to know relates to what their peer libraries do and how they do it. This paper aims to develop a business intelligence tool to provide such information to support the decision making of the library management in Thailand on implementing RFID for their libraries. Most frequently asked questions by the librarian and management are included in the survey which are distributed to libraries of all types throughout the country. Many libraries that have implemented RFID to enhance the library services to their patrons responded to the survey.

Data from the survey is inputted and processed by a business intelligence tool. Multidimensional pictures are obtained as the result and are shown to the five libraries to monitor the useful information result. All the library management confirm that the developed business intelligence tool provide quite significant information for them. The development is also shown to both local and international vendors in RFID industry. All reported the favorable comments on the result, especially for its ease of use and multidimensional information provided.

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5.2 Limitation and Suggestions

The developed tool could provide the better information if more feedback to the survey could be obtained. Moreover, since most respondents are from the higher educational libraries, the resulted outcome, hence, provides more picture on the university library type than others, particularly school library, that might in fact has more number of libraries. However, the study could be a basic tool for both libraries and vendors to contribute more detailed data and to create more dimensions for the tool in the future.

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