RFID ADOPTION IN LOGISTICS ACTIVITIES:
AN EXPLORATORY STUDY OF AGRIBUSINESS

KORAWIT FAKKHONG

MASTER OF BUSINESS ADMINISTRATION
IN
LOGISTICS AND SUPPLY CHAIN MANAGEMENT

SCHOOL OF MANAGEMENT
MAE FAH LUANG UNIVERSITY
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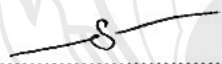# AN EXPLORATORY STUDY OF AGRIBUSINESS

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TO BE A PARTIAL FULFILLMENT OF THE REQUIREMENTS

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THESIS COMMITTEE

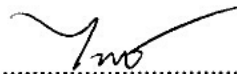..CHAIRPERSON

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ABSTRACT

Nowadays, 70 percent of food supply chain comes from an efficient improving technology and resulted in an important role of food supply chain management. The Thai SMEs agribusiness such as fresh fruits and vegetables adopt more appropriate supply chain technology to provide better service to their customers recently. The aim of this research was to understand the RFID technology adoption in Thai SMEs agribusiness of fresh fruits and vegetables and to understand factors that affect to RFID technology adoption in logistics management to improved business performance and business competency for Thai SMEs agribusiness of fresh fruits and vegetable is of vital important. A mixed research method is applied to this study which both qualitative and quantitative approaches were adopted semi-structured interview and questionnaires were used to answer research questions. Samples group are Thai SMEs agribusinesses of fresh fruits and vegetables in the northern part of Thailand. The finding of this study reveals that technology factor, organization factor, and environment factors are main factors that affect on RFID technology adoption in Thai SMEs

agribusiness of fresh fruits and vegetables. Moreover, expectations the RFID technology will be useful for people who are interested in fresh fruits and vegetables agribusiness.

Keywords: RFID technology/Logistics activities/Agribusiness/ Fresh fruits and vegetables

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CHAPTER 1

INTRODUCTION

This research is a study of the RFID adoption in logistics activities: an exploratory study of agribusiness. This chapter investigates the background of that to the adoption of RFID technology could contribute benefits in agribusinesses. The main research question is to find the factors that affect to RFID technology adoption in logistics management for agribusiness of fresh fruits and vegetables and outlines research objective, research question, and scope of study and includes the conceptual framework and expected outcome of study in the RFID adoption in logistics activities: an exploratory study of agribusiness.

1.1 Research Background

Nowadays, the number of global population is growing and the climate has been changing (Alexandratos & Bruinsma, 2012). There are about one million poverty people around the world and these number of population affect to agriculture products requirements according to The United Nations food and agriculture organization; FAO project (Simmons, 2010). The Food Economics and Consumer Choice Research forecasted that there would be more food requirements in the next 50 years required by the world population. This would be resulted by an increased in need of food capacity in 100 percent of today food production to meet customers' consumption and demand. Besides, 70 percent of food production in food supply chain comes from efficiency improving technology because 50 percent of worldwide food production requires appropriate management in food supply chain to serve the population requirement (Schmidhuber, 2010).
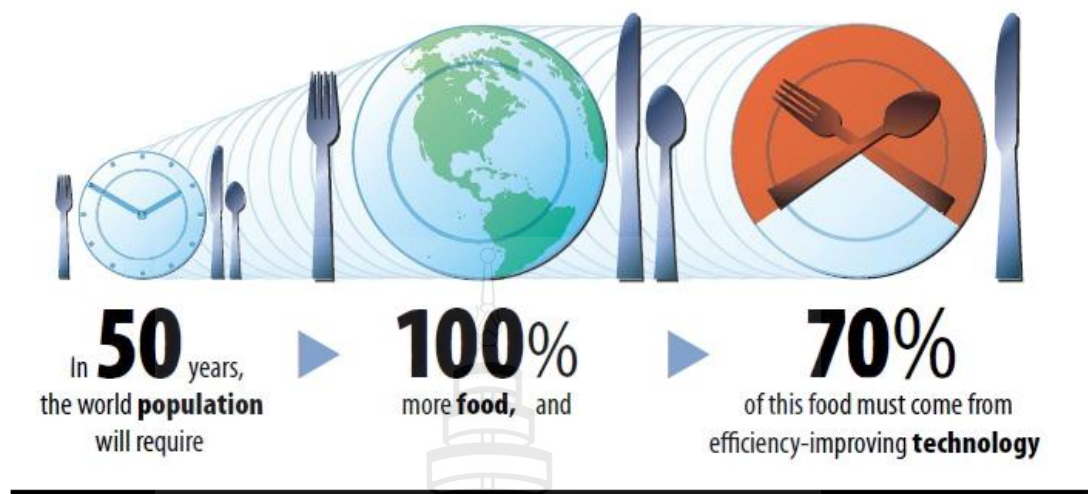
Source Schmidhuber (2010)

Figure 1.1 Situation of worldwide food production

Figure 1.1 demonstrates that there would be more food requirements in the next 50 years by the world population. This would be resulted by an increased in a need of food capacity in 100 percent of today food production to meet customers' consumption and demand. Besides, 70 percent of food production in food supply chain comes from efficiency improving technology such as RFID technology has been taken an important role in the food supply chain management to improve the logistics performance and support logistics activities.

Schmidhuber (2010) explains that there would be more food requirements in the next 50 years by the world population. The food produced today is lost, wasted or discarded as a result of inefficiency in the management of the food supply chain logistics management includes production process, transportation between manufacture and customers, packaging, warehouse management and inventory control (Schmidhuber, 2010), especially in agriculture foods industry, which include agribusiness of fresh fruits and vegetables. They should have quality control in the production processes, inventory management, transportation, traceability and many

others to protect contaminant or temperature control in processes. For example, the temperature control in transportation process for protecting fresh fruits and vegetables in agribusiness not to be rotten. Therefore, the production, transportation, warehouse management and inventory systems should consider important in maintenance and development to be more efficient (Bourlakis, Vlachos & Zeimpekis, 2011a). The packaging should be appropriated in transportation and the temperature control should be appropriated in transportation in order to reduce loss food product during the transportation between manufacture and customer or in production process of food supply chain management (Bourlakis, Vlachos, & Zeimpekis, 2011b).

Recent, a technology such as RFID technology has been taken an important role in the food supply chain management to improve the logistics performance and support logistics activities to reduce time, cost and risk. Moreover, technology is entered to support logistics activities, material handling and inventory management and many others. Recent, technology has been popular in the industry sector to facilitate their operations and function (Finkenzeller, 2010), which includes agribusiness such as RFID technology as one type of automatics identification technology.

Radio Frequency Identification Technology (RFID) as a one type of automatic identification technology (Finkenzeller, 2010), which RFID technology is one of the ten largest supporting systems in the 21th century (Bourlakis et al., 2011b). In recent years, automatic identification such as RFID technology has been popular in the industry and businesses to facilitate their operations, and functions include logistics system, purchasing processes, distribution management, manufacturing and material handling system. RFID technology aims to provide information concerned with people, animal, finish goods, raw materials and many other (Finkenzeller, 2010). Therefore, business sector usually adopt RFID technology to improve their business performance and support logistics activity in their supply chains.

Small and medium enterprises (SMEs) constitute a large portion of all businesses throughout the world (Erdem & Erdem, 2011), which in Thailand small and medium enterprises (SMEs) are initiated from policy by Thai government to boost the private sector in small business of Thailand, which Thai government tried to help and support new business especially the small and medium enterprises

(Mingmalairaks, 2011). This policy caused new businesses, which included agribusinesses of fresh fruits and vegetables and resulted in having high competitive environment afterward in the business sector. The consequences made business owners to seek out for tools to help their businesses to be able to compete with their competitors in the market. RFID technology were one tool and believed to be innovative that they adopt, and especially in the large industry sector. However, RFID technology is not still popular used and adopted amongst many small and medium enterprises in Thailand (Chavananikul, 2013) because the organizations worries on cost and knowledge of RFID technology to make they not dare to invest on RFID technology (Ngamsukkasamesri & Wanghatai, 2012). But also, technologies have been widely recognized as being critical factors in the supply chain because technology provided a contribution they can an improved the performance of both the individual organization and of the supply chain as well (Jin, 2006).

Therefore, this study focuses on the factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables, RFID technology that was adopted in logistics activities. Moreover, this research will give useful information for people who are interested in RFID technology adoption in agribusiness of fresh fruits and vegetables.

1.2 Research Objectives

This research is a study of the RFID adoption in logistics activities: an exploratory study of agribusiness. This research aims to achieve the following objectives;

1.2.1 To study the stylized facts of RFID technology adoption in Thai SMEs agribusiness of fresh fruits and vegetables;

1.2.2 To examine the determinants that affect to RFID technology adoption to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables.

1.3 Research Questions

To answer the objectives of this research, the research question was developed used to study for Thai SMEs agribusiness of fresh fruits and vegetables;

"What are factors that affect to RFID technology adoption in the logistics management to improved business performance and business competency for Thai SMEs agribusiness of fresh fruits and vegetables?"

The research question developed to support to understand factors that affect to RFID technology adoption for Thai SMEs agribusiness of fresh fruits and vegetables. The research question was used to gathering factors and knowledge required to develop a business to help Thai SMEs agribusiness of fresh fruits and vegetables improve their business, business competency, and business performance.

1.4 Scope of Study

This study focuses on RFID adoption in logistics activities: an exploratory study of agribusiness. The aim of this research is to understand factors that affect to RFID technology adoption in the logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables is vital important.

1.41 Population

Thai SMEs agribusiness of fresh fruits and vegetables in the northern part of Thailand

1.4.2 Time

Between February 2013 and September 2013

1.5 Expected Outcome

1.5.1 Business owner and people who are interested in this topic will get some useful information for their business based on RFID technology adoption in Thai SMEs agribusiness of fresh fruits and vegetables.

1.5.2 Business owner and people who are interested in the topic get some useful information for their business based on factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables.

1.5.3 Business owner and people who are interested getting to know about the guidelines of RFID technology adoption for Thai SMEs agribusiness of fresh fruits and vegetables.

1.6 Conceptual Framework
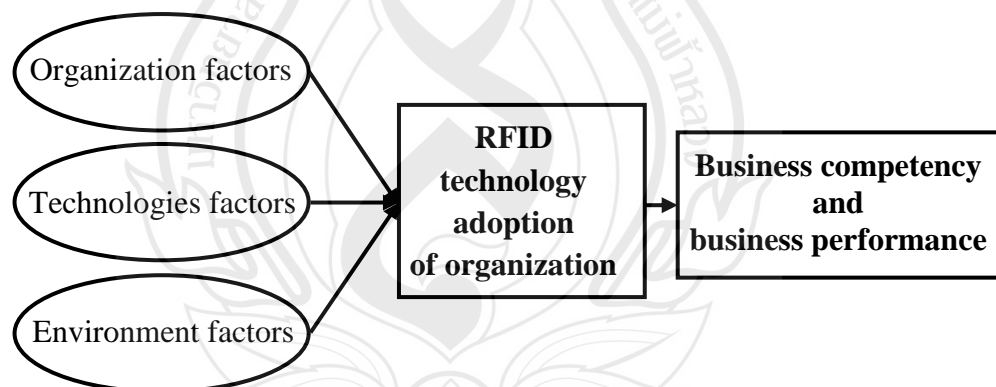
Figure 1.2 Conceptual Frameworks

Figure 1.2 demonstrates conceptual framework of this research, organization factors, technology factors, and environment factors are study to understand the factors that affect to RFID technology adoption for Thai SMEs agribusiness of fresh fruits and vegetables, which will develop into their business to improve business performance and business competency. The conceptual framework was adopted from

the OTE framework (Tornatzky, Fleischer & Chakrabarti, 1990), which are organization factors, technology factors, and environment factors used to examine the factors that affect to RFID technology adoption for Thai SMEs agribusiness of fresh fruits and vegetables.

1.7 Thesis Structure

Thesis structure can be follows are;

Chapter 2 Literature review provides a review of literature relate to RFID technology adoption in logistics management for Thai SMEs agribusiness of fresh fruits and vegetables. This chapter begins with supply chain includes agriculture supply chain, fresh produce supply chain, food supply chain management, the future of food supply chain, RFID technology the overall, potential of RFID technology in the agriculture food supply chain, RFID opportunities in agriculture food supply chain and business benefits, logistics activities, the OTE framework, and statistical processing of survey.

Chapter 3 Methodology provides a detailed description of the methodology used in this study, research procedures, population and sample, research tools. This chapter design describes the questionnaire development and explanation of hypotheses and research methods was used to analyze in this study.

Chapter 4 Results and discussion provides results of study follows are objective of study RFID adoption in logistics activities: an exploratory study of agribusiness. This chapter begins with demographics data respondents in this study, the RFID technology adoption and end with the factors that affect to RFID technology adoption in logistics management for agribusiness of fresh fruits and vegetables.

Chapter 5 Conclusion discusses the major findings of the research, the factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. The summary of research, limitations of the research and the suggestions for future research and end with conclusion.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of literature relate to RFID technology adoption in logistics management for Thai SMEs agribusiness of fresh fruits and vegetables. This chapter begins with supply chain includes agriculture supply chain, fresh produce supply chain, food supply chain management, the future of food supply chain, RFID technology the overall of RFID technology, potential of RFID technology in the agriculture food supply chain, RFID opportunities in agriculture food supply chain and business benefits, Logistics activities, the OTE framework, and statistical processing of survey.

2.2 Supply Chain Management

Supply Chain Management (SCM) has been around since 1982 (Cooper, Lambert & Pagh, 1997) the supply chain management are widespread and leads to many kinds of definitions. Supply chain management philosophy was applied to manage total flow of supply chain such as distribution channel of material, information, and finance from raw materials supplier to the consumers or end user. Supply chain management is the integration of business operations from producers or suppliers that provide products, services and information that add value for customers or end user. Roekel (2002) explains that the supply chain management may has many actors are in supply chain, which linked from "farm(s) to customer(s)" such supply chains may include growers, harvest process, packer, storage and warehouse

facilitators, transport facilitators, marketers, importers and exporters, distributors, wholesalers and retailers (Roekel, Willems & Boselie, 2002). Mentzer and DeWitt (2001), they explains definition supply chain management that is a set of organizations that pass material forward, organizations are involved in manufacturing a products and passing it in the hand of customers or end user in supply chain such as raw material and semi-components, products assembled, wholesalers, retailers, transportation companies, which these are members of supply chain and includes supply chain is a network of organization that are involved through upstream to downstream linkages, processes and activities that produce value in from products, services and information to serve customers requirement (Mentzer et al., 2001). Russell and Taylo (2008), they explains that the supply chain management are the activities, functions, facilities involved in the flow, transportation of finished goods and services from the supplier of materials to customers or end user and the main goals of each supply chain management should be satisfied end customers or the product end user, which to achieve this goal the companies needed to have about the partnerships in their supply chains include, suppliers, customers, and the product end users (Russell & Taylor-Iii, 2008).

La Londe and Masters (1994), they explains that the supply chain management are consists two or more organizations in a supply chain that enter into long term agreement to develop of trust and commitment to the relationship, the integration of logistics activities involved the share information of customer requirement and sales data that used to support logistics activities to develop their business performance and supply chain efficiency (La Londe & Masters, 1994). Mentzer and DeWitt (2001) also explains that the supply chain management is a concept that have main objective is to integrated and manage flow, control and to share information and management resources to reduce the waste in business processes used a total systems perspective across multiple functions and multiple tires of suppliers (Mentzer et al., 2001).

A supply chain consists of organizations are directly linked with one or more organizations or flows of products, services, and information. Douligeris and Tilipakis (2006), they explain that the supply chain management is a system that contains a variety of processes and activities from suppliers to customers. Basic concept of

supply chain management is based on how to deliver raw materials, services, and information or finished goods from suppliers to manufacturer, and distributions to customers or end user (Douligeris & Tilipakis, 2006). Same as Bartlett (2007) explains that the supply chain includes suppliers, partners, and customers working jointly on an activity or project together, which supply chain collaboration occurs when two or more organizations share the responsibility of exchanging information includes common planning, management, execution, and performance measurement information of the supply chain (Bartlett, Julien & Baines, 2007).

Supplier ⟷ Organization ⟷ Customer

Direct supply chain

Supplier's ⟷...⟷ Supplier ⟷ Organization ⟷ Customer ⟷...⟷ Customer's
supplier   customer

Extended supply chain

Third party
logistics supplier

Ultimate ⟷...⟷ Supplier ⟷ Organization ⟷ Customer ⟷...⟷ Ultimate
supplier   customer

Financial   Market
provider   research firm

Ultimate supply chain
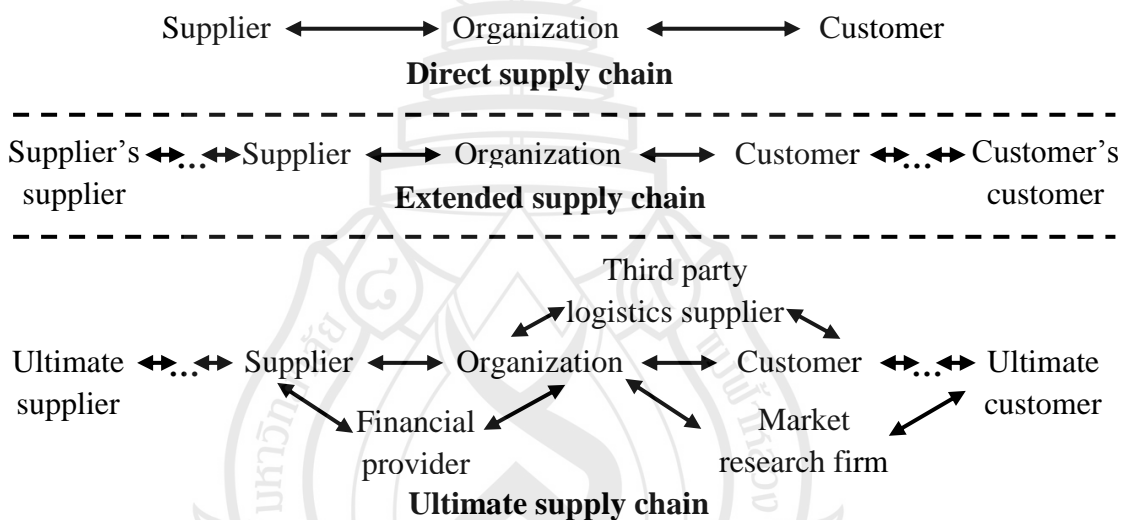
Source Mentzer et al. (2001)

Figure 2.1 Types of channel relationships of supply chain

Figure 2.1 demonstrates the types of channel relationship of supply chain, which can divided into three main categories includes direct supply chain, extended supply chain, and ultimate supply chain. Supply chain management is not only supplier, organization, and customer but includes those people involved in supply chain as well therefore supply chain management were talk about those player that have relationship together in supply chain (Mentzer et al., 2001).

2.2.1 Food Supply Chains

Food supply chain included food and drink together (Bourlakis & Weightman, 2004). Food supply chains are major portion of every national economic. The food supply can divided into agriculture sectors, horticulture, fisheries and aquaculture are the primary producers to processes the food into product ready for the table or future cooking (Eastham, Sharples & Ball, 2001). Food supply chain includes primary produce, farms and ranches product, raw food products, grains, fruits, vegetables, meats and dairy.

Harvest
Produce is picked during the cool hours of the day and shaded to protect it from the sun.

Distribution
Products are delivered to retail, wholesale and food service vendors. Products may also be sold direct to consumer

Picking
Some products receive minor treatments, such as waxing, trimming or spraying, prior to packing

Growing
Field, orchard and berry crops are grown from seed or stock.

Cooling / Storage
Decreasing the temperature of the product at the harvest process reduce the respiration level. Chilled temperatures are maintained throughout the supply chain to point of consumption.

Source Pullman and Wu (2012)

Figure 2.2 Fresh produce supply chain

Figure 2.2 demonstrates the supply chain for fresh products, which fruits and vegetables are perishable product (Pullman & Wu, 2012). The shelf life of product depends on the supply chain's ability and efficiency to transport fresh goods to consumer quickly, after the harvest process. Therefore, maximizing quality and value in the supply chain needs to have good coordination and collaboration between all

supply chain partners include farmers, supplier, workers, brokers, freight and shipping, buyers.

Thailand is one country that has high level of customers' consumption and demand for fresh products, which include fresh fruits and vegetables. Timmermans (2006) explains that in the fresh fruits and vegetables supply chain in Thailand, Thai consumers spend an increase proportion of consumption of fresh fruits and vegetables, which most products were sold in traditional markets and supermarkets such as 7-Eleven, Tesco, Makro, Carrefour and TOPS supermarket. Therefore, supply chain of fresh fruits and vegetables in Thailand is of vital important need to be developed to serve the customers' requirement, which was regularly increase in consumption (Timmermans, 2006).

2.2.2 The Food Supply Chain Management

In the past business practices about managing the problem of stocking shelves, restaurants by maintaining high level of all product in warehouse, store, in freezers and in storeroom. Supply chain management concept used to increased to replace traditional approaches to the buying, storing, and moving of materials and finished goods (Eastham, Sharples & Ball, 2001). The operations and supply chain management of food supply chain is a complex system. Therefore, businesses must confident that their food have high quality and safety, which there have many factors to an influence of an improvement and development of food supply chain follows are (Bourlakis & Weightman, 2004);

Firstly, quality was the significant degree of congruence between customer expectations because customers they need high quality and lower price, which quality assurances and control of processes has become an important tool of the supply chain management. Secondly, Technology has been taken an important role in the food supply chain management to improve the logistics performance and support logistics activities, which includes accurate weighing, volume of product such as barcode technology, electronic transplantation and, RFID technology these are technology that was adopted into food supply chain to improve their business performance . Thirdly, logistics are key business process that resulted increase customer satisfaction, efficiency and ability of productivity such as the process of strategically managing the

procurement, movement and storage of material, parts and finished goods (M. A. Bourlakis & Weightman, 2004). Finally, information technology were used support the movement of products and product information dissemination in the food supply chain to identification of products, location in retail warehouse and store and to record product movement such as electronic data interchange (EDI) used between organization and organization or organization and customer for electronic transmission of information aims to improve the production process, product quality, traceability and resource use.

2.2.3 The Future of the Food Supply Chain

Schmidhuber (2010) explains that there would be more food requirements in the next 50 years by the world population, which would be resulted by an increased in a need of food capacity to meet customers' consumption (Schmidhuber, 2010). The future the food chains will combine together, which our future the food supply chain will look different from to today. The pressures from price of raw material that still increasing, coupled with the difficulty of access to food, food security, food safety, environmental, organic production and trade policy and fair trade. This mean we must develop the food supply chain (production and consumption), which the food supply chain successfully comes from efficiency improving supply chain because consumers increased have to make decisions about that to purchase such as they used locally products and import products because the purchase the imported products often transporting of products over long distances or high cost and make them look to local products (Da Silva, 2009).

ASEAN Economic Community will begin in 2015, which Thailand will enhance the ASEAN Economic Community (AEC) in terms of easing the flows of goods, people, services and investments. The goals of AEC can divided into four main characteristics include (a) a single market and production base, (b) a highly competitive economic region, (c) a region of equitable economic development, and (d) a region fully integrated into the global economy (ASEAN.org, 2013). These result to business owner in Thai small and medium enterprises (SMEs) need to prepare the business that is important point in every way. The business management requires information on the organization's support. Therefore, this is one reason to

make business sector application the technology to drive their business move forward and including the information systems management of user groups, work processes and database system. Therefore, resulted to many firms and internal firm of agribusiness use high technology system to facilitate information gathering and exchange information internal organization or between organization and customers (Salin, 1998). RFID technology has been adopted in the supply chain management in industry and businesses sector to improve their business and support logistics activities, which include agribusiness.

2.3 RFID Technology for Agribusiness Supply Chain

RFID technology was firstly used around World War 2 it was used to identify friendly aircraft (Finkenzeller, 2010). In recent years, RFID technology was implemented in many supply chains and across industries to improve of their efficiency supply chains, which include agribusiness (Bottani & Rizzi, 2008). Agribusiness supply chain management was adopted RFID technology into their business to improve business performance and to support logistics activities in their business (Nambiar, 2009).

2.3.1 Overview of RFID Technology

Nowadays, automatic identification technology is popular tool and believed to be innovative that they adopt in many activities of the industry sector, logistics systems, purchasing, distribution, manufacturing and material handling system, which RFID technology aims to provide information concerned with people, animal, finish goods or materials, improve production process, product quality, traceability and resource used (Finkenzeller, 2010). Therefore, food industries tried to adopted RFID technology in their business to improve business performance and support logistics activity in agriculture foods supply chain.

RFID technology is a type of automatic identification technology or auto-ID (Finkenzeller, 2010) and RFID technology is one of the ten largest supporting systems in the 21st century (Bourlakis et al., 2011a). RFID technology was firstly used to

identify friendly aircraft during World War2. In the 1970 RFID technology were implemented for tracking animals, and in the 1980 for automatic toll collection (Landt, 2001). RFID technology also has been used for other applications includes library access, protection theft system in supermarkets and food traceability. Nevertheless, RFID technology were very successful in supply chain management when industry leaders such as Metro Group, Wal-Mart, and United State department of defense were adopted RFID tags to all their shipments (Li, Visich, Khumawala & Zhang, 2006).

RFID technology or automatic identification technology used radio signal to automatically and precisely identify track, and identify objects, items, or animal (Bourlakis et al., 2011b; Wamba, Bendavid, Lefebvre & Lefebvre, 2006), which include the capability to read multiple tags in one time, provide special identity data, and store data. RFID technology is a type of automatic identification technology, which auto-ID can be divided follows are (Finkenzeller, 2010);
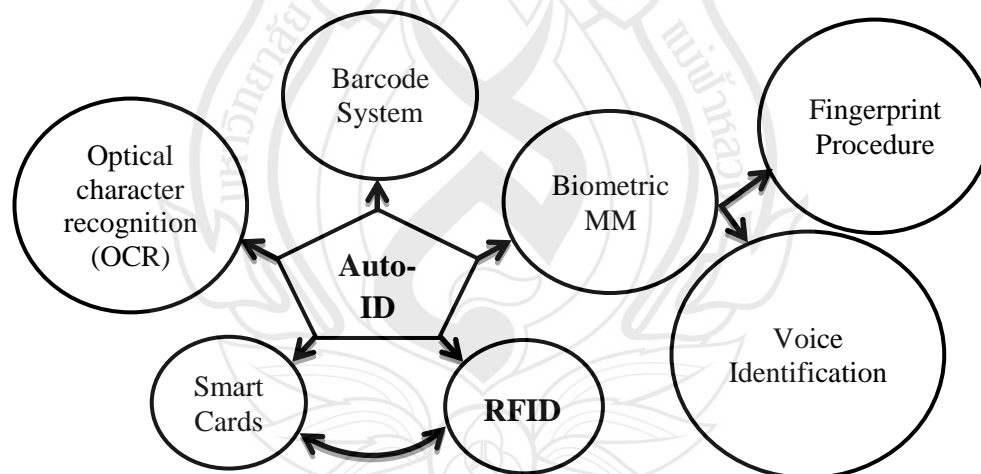
Source Finkenzeller (2010)

Figure 2.3 Overview of automatic identification technology; auto-ID

Figure 2.3 demonstrates the overview of automatic identification technology, which includes barcode technology, optical character recognition technology,

biometrics technology, smart card technology, voice identification, fingerprint technology, and RFID technology (Finkenzeller, 2010). RFID technology has been promoted and gets the awards because of its multiple competencies and includes the capability to read multiple tags in one time, provide special identity and storage data (Want, 1991).

RFID technology system consists three main components (Prater, Frazier, & Reyes, 2005). First, RFID tag or transponder consists of an integrated circuits and an antenna combined to form a transponder. Second, RFID reader is a scanning device that reliably reads the RFID tag and communicates the results to the middleware. Finally, host server equipment and computers equipment were used to process data that collected from RFID reader, filters data and transmits information to the different enterprise applications (Bourlakis et al., 2011b; Li et al., 2006).
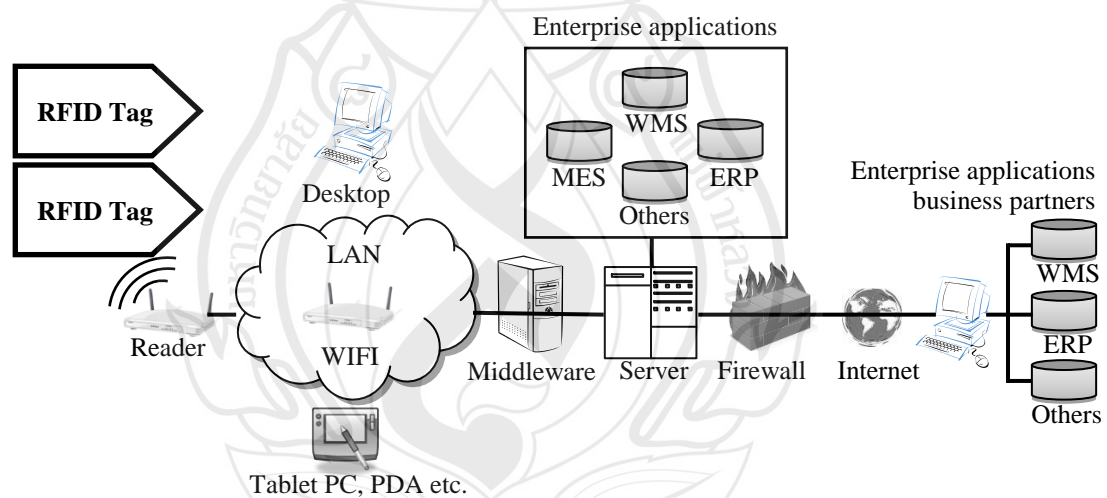
Source Bourlakis et al. (2011)

Figure 2.4 RFID technology systems

Figure 2.4 demonstrates the principles of RFID technology that used radio frequency waves to transfer data between a reader and a movable item to identify, categorize, and track (Bourlakis et al., 2011). RFID tag or transponder, containing

integrated circuits and an antenna, is embedded in or attached to a physical object. RFID reader called the interrogator and its antennas, which communicate with the RFID tag or transponder without requiring line of sign. The host server equipment comprising a middleware, was used to process data, filters data and transmits information to the different enterprise applications (Wamba et al., 2006).

2.3.2 Potential of RFID Technology in the Agriculture Food Supply Chain

Agriculture foods industry in worldwide, which was interested in a rising of problems of food supply chain including increased globalization and competition of food products, strict requirements on quality assurance, reliability in food provisioning and consumer trust sustainability (Schiefer, 2004). These are main reasons that make industries and stakeholders find the ways to prevent and manage this provision issue, which three main factors resulted to adopt technology into agriculture foods supply chain follows are (Bourlakis et al., 2011).

Firstly, the legislation by the government, which governments around the world were increased establishes draconian regulation in order to assure the safety of food products (Bourlakis et al., 2011a). In many countries build food traceability system to solve food quality problem from food safety that often occurred such as the European Union has opened a new approach involved strict supervision, control, and traceability of food product in their country (Chen, Chen, Yeh, Chen & Kuo, 2008). The farm securities in European countries begin using product origin labeling for food products include perishable agricultural (Bourlakis et al., 2011). Secondly, the consumer safety requirements are called for higher quality of food production in the food supply chain because they are increasingly aware that they have the right to receive information and select the products based on transparent information. Finally, the industries sector are key player in the food supply chain and also pushing the adoption of RFID technology such as McDonald's spends more than US$14 billion on farm product per year on traceability system from a supplier in order to promote consumer safety and keep consumer trust (Emma, 2005). The Metro group includes Wal-Mart and Tesco have requirement that an increasing number of their supplier to adopt RFID technology into their shipments (Bourlakis et al., 2011b). These are factors that affect to industry sector aware of the problem and make them find the

ways to prevent and manage with these issues such as adopt RFID technology into their business.

2.3.3 RFID Opportunities in the Agriculture Food Supply Chain

In food supply chain management producers, manufacturers, distribution, transportation, retailers, consumers and regulatory agencies are getting ready to adopt RFID technology within the objective to increase the quality of food products within the food supply chain and to increase facilities in their business such as internal traceability, product traceability (Bourlakis et al., 2011). RFID technology gave the opportunity to supply chain members identify, track, trace and manage in each individual product, which RFID technology provide the information in real time and business management flexibility (Wamba et al., 2006). RFID technology appears to be a good tool for adding competency into key business processes. These processes can be divided into several such as quality control processes, product traceability processes, warehouse and distribution management, inventory control, point of sale management processes (Bourlakis et al., 2011).

Upstream chain tracing

- Food source tracking
- Inventory management
- Environment monitoring
- Animal health monitoring

- Inventory management
- Environment monitoring
- Warehouse management
- Food quality management
- Product recall management

- Automated payment
- Automated-check-out
- Smart shopping application

Producer → Manufacturer → Distributor/Transporter → Retailer → Consumer

- Food source tracking
- W.I.P material tracking
- Environment monitoring
- Mobile asset management
- Product recall management

- Smart shelf
- Theft prevention
- Automated-check-out
- Inventory management

- Environment monitoring
- Food quality management
- Product recall management
- Product return management

Downstream chain tracing

Source Bourlakis et al. (2011)

Figure 2.5 An overview of RFID adoption in agriculture foods supply chain

Figure 2.5 demonstrates the RFID technology adoption in agriculture foods supply chain from upstream to downstream, start from producer, they produce raw material and delivery to manufacturer to produce finished goods in production processes, and distributor, transportation to retailer for serve consumers' requirement (Bourlakis et al., 2011b). For example, foods source tracking, inventory management, warehouse management, mobile asset management, food quality management, smart shelf and any other.

2.3.4 Business Performance

To days, information technology (IT) has becomes the most important enabler to organization activities including structure, operation, and management (Tzeng, Chen & Pai, 2008). RFID technology is one of the technologies that industries and businesses sector implementation to their business. RFID technology has brought new business opportunities to many information companies and improves accuracy of data and speed of data collection in supply chain. The accuracy is to reduction of human error in activity as well as better, prevention of theft and track expiration dates for foods more over. The speed is related to less handing required, easy to inventory count and multi object scanning, speed up store receiving, processing, and return processing. That result to supply chain efficiencies (Simchi-Levi & Philip Kaminsky, 2009). RFID business benefits include improved productivity, reduction cycle time, reduce rework, reduce business risk and control of assets and increased revenues

The RFID technology was recognized as a tool to develop the business performance and business competency because of its broad impact on the production, logistics, material handling, product tracking, inventory management, food safety and security, and customer service (Koh, Kim & Kim, 2006), which RFID technology that was adopted in the retail business can provide better customer service along with improvements in store management, fitting room, and customer satisfaction. RFID technology helped retail businesses to track stock gets more efficiency from product identity code, include the type, size, and color of the product.

RFID technology has many advantages that business owner includes supplier, manufacturer, and retailers and wholesalers were adopted RFID technology into their business. Koh and Kim (2006), they explains that the advantages of RFID technology,

which include the improved accuracy in inventory management, improved the performance in orders and inventory, reduced costs for logistical operation, improved efficiency of store and warehouse management, shorter retail cycle of designing, improved sales planning, improved customer service, and improved security (Koh, et al., 2006).

Retailers are interested and expected to be the main beneficiaries of RFID technology implementation to achieve greater speed and visibility into their supply chain and operational efficiency and store effectiveness. Kearney (2003) explains that the three main expected by retailers that were adopted RFID technology because they need to reduce inventory reduction in order cycle time and improved visibility, leading to better forecasts (Kearney, 2003). Secondly, store and warehouse labor reduction labor expenses are too high and RFID technology becomes one choice as to reduce the labor cost and final, reduction in out of stock. For example, implementation an RFID tagging system within a warehouse to aid traceability, improved order accuracy, reduce shipping error, labor cost and reduction of losses due to theft (Jones, Clarke-Hill, Hillier & Comfort, 2005). Shan Chiang Yu (2007) explains the advantages of RFID technology that is one tool has been popular in the business sector because they adopted RFID technology used to improve their business include reduce redundant work, reduce queues at the reception, increase satisfaction in customer service, increase internal security, reduce cost for storage management, tracking and checking automation, and high efficiency of the inventory arrangement (Yu, 2007). Smith (2005) explains that the benefits of RFID technology can reduce redundant work that associated with material handling and inventory management, such as RFID technology provided high efficiency monitor and control the product in warehouse management and also RFID technology can reduce cost, reduce theft within the supply chain of retailer. However, depend on organization decide that the benefits of RFID technology weighed with the risks such as cost, uncertain risk that may or may not be much (Smith, 2005). Wen Yao and Zang Li (2010), they explain that the benefits of RFID technology are not only reduced cost and improve efficiency by tracking product and people, but also reduce human error that to improve safety and save their lives, and reduce time. RFID technology can help business improve their competency by several approaches such as product tracking, monitoring system

to reduce equipment from being stolen, include reduced equipment rental, and improve staff productivity in their business (Yao, Chu & Li, 2010).

Jin Byoungho (2006) explains that the many companies adopted RFID technology used to provide information in real time and to reduce the growth of inventory level in production line, which they confirmed the fact that some suppliers invested RFID technology to improve both information and production capacity to reduce the inventory level (Jin, 2006). Andersen and Segars (2001), they explain that the information technology performance has a relationship with decision structure, which can conclude that information technology leads to a decentralized decision structure from increase internal communication resulted in higher performance (Andersen & Segars, 2001).

2.4 Logistics Management

The term logistics has become subject more widely recognized in public in the last 20 years (Langley, Gibson & Novack, 2008). Many media include television, radio, and print advertising have commended the importance of logistics. Esper Terry (2007) explains logistics that is one area in the organization that interacts with both upstream and downstream in the supply chain (Esper, Fugate & Davis-Sramek, 2007). Therefore, logistics are in a position to serve as facilitators. Tsseng and Yue (2005), they explains the definition of logistics is process of materials and products moving into, through, and out of organizations such as inbound logistics that cover the material movement that received from suppliers (Tseng, Yue & Taylor, 2005). Materials management is the movement of materials and/or goods between organization and suppliers, which the movement of materials and goods started from suppliers to the end of the production line and delivery to serve satisfy customers' requirement to improve business competitiveness and customer satisfaction (Tan, 2001).

Langley (2008) explains that the logistics management has become more widely recognized not only in the private sector but also in the government public and nonprofit sectors. In addition, an organization that provides services such as hospitals,

banks, hotels, and restaurants. These organizations have challenges in issues logistics management and they need to find the way that to improve their logistics performance (Langley et al., 2008). The Council of Supply Chain Management Professionals (CSCMP) explains that the logistics management is a part of the supply chain management includes planning, implements and controls materials and goods storage, and services and information. These are related from the point of origin to point of consumers to serve the customer requirement and customer satisfaction define by business owner and stakeholders such as the government or industry sector (CSCMP, 2007). Christopher (1999) explains that the logistics management is the process of managing that includes the procurement, product movement, materials and goods storage, parts and services that related to information flows within the organization such a way that make organization gets the maximize profits through lower cost and highly effective in order (Christopher, 1999).

2.4.1 Logistics Activities

Jeter (2013) explains that the logistics activities are key activities that provided facilitate the flow of materials and goods from supplier (point of origin) to customers (point of consumption). These activities are part of logistics process includes inventory management, material handling, order processing, demand forecast and planning, logistics communication, packaging, parts and services support, traffic and transportation (Jeter, 2013). Langley (2008) explains that the logistics are activities associated with logistics management and these activities relationships with logistics management, which includes inventory control, warehousing and storage, order fulfillment, demand forecast, materials handling, industrial packaging, production planning, facility location, parts and services support, procurement, customer services, transportation, return goods handling, and reverse logistic (Langley et al., 2008). Ivanaj and Franzil (2006), they explains that the logistics activities are the management and control of physical and information flow, which along with supply chain from the input to the output covered all operations of the stock, packaging, distribution, transportation to carry out to the customers' satisfaction (Ivanaj & Franzil, 2006). Christopher (1999) explains that the logistics activities can identified into 12 activities includes customer services, demand forecast, inventory

management, material handling, packaging, warehousing and store, traffic and transportation, parts and services support, reverse logistics, procurement, location selection, and order processing (Christopher, 1999). Stock and Lambert (2001), they explain that the logistics activities are internal and external activity and logistics activities are activities that support to the organization, which internal activity support and connect within organization for making the jobs run smoothly, external activity is activity between the organization with customers or organization with an organization. Logistics activities can be identified into 13 activities includes inventory management, warehouse management, material handling, customer service, demand forecast, logistics communication, order processing, packaging, parts and services, plans and warehouse site selection, procurement, transportation, and reverse logistics (Stock & Lambert, 2001).

Table 2.1 Logistics activities definitions

Logistics activities	Definitions
Customer service	Customer service involved the successful implementation of the logistics management in order to provide the highest level of customer satisfaction at the lowest possible total cost. (Stock & Lambert, 2001)
Demand forecasting	Demand forecast have involved the determination of the amount of product and service level that customers required in the future, which we should know the demand to prepare the proper amount of product and material. (Stock & Lambert, 2001)
Inventory management	Management of material or finished goods.(Langley, et al., 2008) Inventory management involved control the level of inventory that to achieve high customer service levels. (Stock & Lambert, 2001)

Table 2.1 (Continued)

Logistics activities	Definitions
Logistics communication	Logistics communication is linked to the organization includes communication internal and external of organization. (Stock & Lambert, 2001)
Material handling	Material handling is the movement or flow of raw materials and finished goods within a manufacturer or warehouse.(Langley et al., 2008)
Order processing	Order processing involved with filling and shipping customer order to fulfill customer's order or customer's requirement. (Langley et al., 2008)
Packaging	In logistics management, the package protects the product from damage that be happens from stored or transported, and proper packaging made it easier to store and move products to reduce materials handling costs. (Stock & Lambert, 2001)
Parts and service support	This activity is to provide services to customers after the sale, which involved providing replacement parts when product break down or damaged. The parts of spare are vital to the service and repair activity and logistics management need to make sure those parts are available when and where the customer needs them. (Stock & Lambert, 2001)
Plans and warehouse site selection	The activity involved the selection of location of plants and warehouses and includes facilities. (Stock & Lambert, 2001)
Warehousing and storage	Warehousing and storage activities involved the management of the space needed to carries or maintain inventories such materials and goods. (Stock & Lambert, 2001)

Table 2.1 (Continued)

Logistics activities	Definitions
Procurement	The process of purchasing materials and services to support the operational effectiveness of the organization's manufacturing, which include the selection of supply source locations, timing of purchases, price determination, quality control, and determination of the term purchase. (Stock & Lambert, 2001)
Reverse logistics	Reverse logistics involved the returned goods that cannot be transported, stored or handled as easily as original goods, and includes removal and disposal of waste materials from the production, distribution or packaging processes. (Langley et al., 2008)
Traffic and transportation	This activity involved management the movement of materials and goods and includes selecting the method of shipment, compliance with the regulation of various transports both domestic and international shipping requirements. (Stock & Lambert, 2001)

2.5 Organizational, Technological, and Environmental Framework (OTE Framework)

Tornatzky and Fleischer (1990) developed a framework that explored organizational, technological, and environmental factors in a specific context that referred to OTE framework (Tornatzky et al., 1990). These factors are used as the scope and framework for this research, which identified the context that influence the process by which the organization adopts and implements technological innovation, organizational context, technological context, and environment context.

Organizational context was defined in terms of several descriptive measures such as business size, organization structure, organization management styles and the quality of human resource. Technological context was defined in both the internal and external technologies relevant to the organization, which include existing technologies within the organization such as efficiency, information quality, and compatibility. Environmental context is the arena in which an organization conducts its business such as competitors, customers' requirement, access to resources supplied by others, and support from organization (Mingmalairaks, 2011; Tornatzky et al., 1990; Zhu, Kraemer & Xu, 2002).
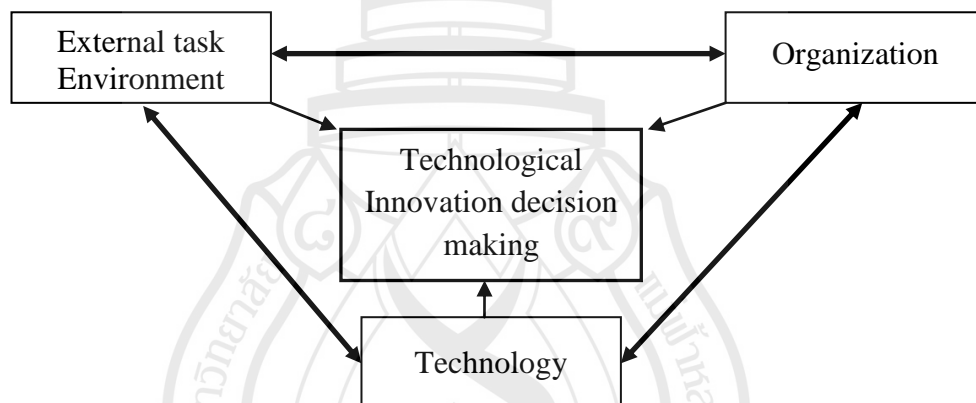
Source Mingmalairaks (2011) and Tornatzky et al. (1990)

Figure 2.6 OTE framework

Figure 2.6 demonstrated the three main of   a firm context that influence the process by which it adopts and implements technological innovations, which are include organizational, technological, and environmental context develop by (Tornatzky et al., 1990).
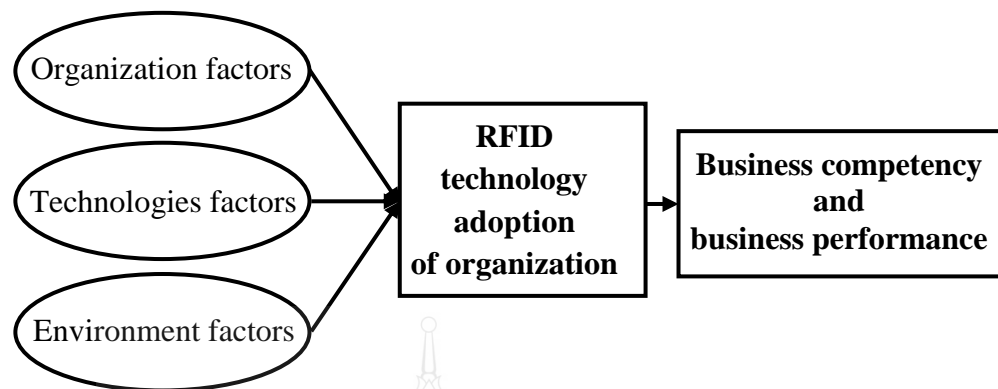
Figure 2.7 The conceptual framework of research

In this study, organization factors, technology factors, and environment factors were adopted to conceptual framework used to understand factors that affect to RFID technology adoption in the logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables.

2.5.1 Organization Factors

Tornatzky defined the organizational context in terms of several descriptive measures such business size, formalization, and complexity of organization, management styles, and the quality of human resource (Mingmalairaks, 2011; Tornatzky et al., 1990). The organization itself provides a rich source of structures and processes that facilitates the adoption of technologies and innovations, and the implementation of innovations. The results of all implementations in the organization are the result of both intentional and unintentional decisions and actions taken by organizational members.

Different organizations face different innovation opportunities. However, innovation in organizations can be exploited depending upon the degree of match between the innovation characteristics and the processes that are managed within the organization. Organization factors in this research include business size, management, and limitation of organization. Organizational factors refer to those variables that determine the organizational structure, and could be adjust or changed to suit its change environment. Hossain and Quaddus they explains that the generally,

organizations with more resources are more in a position to adopt RFID. Resources examined for RFID adoption includes financial, human, and technological resources of the organization and include Management attitude (management support), organizational readiness, and organizational cultural willingness (Hossain & Quaddus, 2011).

Wen and Fernando (2009), they explain that the organizations are increasingly required to adopt new technology into their business practices to improve business competency and competitiveness (Wen, Zailani & Fernando, 2009). Therefore, organization wide readiness is also an important factor for adoption of RFID technology according to a study by Patterson explains that the organization size should be a significant consideration in organization technology adoption. They found that larger organizations generally have extra capacity to adopt new technologies and to generate economies of scale from them and that larger organizations are generally more willing to adopt new technologies because they have capacity such as a financial resource (Patterson, Grimm & Corsi, 2003), which both of them focus on business size that affect to RFID technology adoption.

2.5.2 Technology Factors

Tornatzky explains that the technological context was defined in both the internal and external technologies relevant to the organization. The technology context includes current practices and equipment internal to the organization, (Zhu et al., 2002) as well as providing a pool available technology external to the organization. Technologies factors include in this research are efficiency, information quality, and compatibility of technology and organization. Technological factors that represent the perceived characteristics of the innovation (Tornatzky et al., 1990). Hossain and Quaddus (2011), they explains that the technological factors have a significant that affect on RFID adoption includes ease of use, compatibility, cost, and standard of technology (Hossain & Quaddus, 2011).

2.5.3 Environment Factors

Environmental factors that are usually beyond the control of the organizational management but are important factors in the functioning and decision making to adopt

new technology into the organization (Tornatzky et al., 1990). Environmental factors can be divided into external pressure, external support, and uncertainty. Hossain and Quaddus (2011), they explains that the environmental factors may come in different forms includes legislation, government and business mandate, market pressure, and competitor pressure which have an effect on RFID technology adoption (Hossain & Quaddus, 2011). Wen (2009) explains that the innovative organizational culture promoted adoption of new technology. Therefore, whether they are from internal or external to the organization, demands were always helping to promote adoption (Wen et al., 2009). Environmental factors have an impact on adoption. However, "innovation attributes" make RFID technology is suitable technology to meet the requirement of management in the supply chain.

Although specific factors that were identified in the three contexts which may different across different studies, the organization, technology, and environment framework has a strongest theoretical basis, consistent empirical support, and promise of applying to other IS innovation domains (Zhu et al., 2002). Therefore, this research adopted this theoretical framework and extended it to the RFID technology adoption, which used to understand factors that affect to RFID technology adoption in logistics management to improved business performance in Thai SMEs agribusiness of fresh fruits and vegetables.

2.6 Statistical Processing of Survey Data

While qualitative data were analyzed to gain a general understanding of findings by using thematic coding and narrative method was used to explain what happened consequently, quantitative research focuses on measuring and analyzing to identify factors that affect to RFID adoption in logistics activities to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. In this study, two different sets of econometric models were applied in processing the survey data.

2.6.1 Paired Samples t-test

The Paired sample t-test is an example of a repeated measures design. The different between "between groups" designs and a "repeated measures" design is an important one (Crawford, Howell & Garthwaite, 1998). Paired-sample t-test is known as a dependent t - test, repeated measures t-test or within subjects t-test, which a Paired-sample t-test is used to analyze paired scores, specifically that want to see if there is a difference between paired scores (Samuels, Witmer & Schaffner, 2012).

Statistics, for each variable mean, sample size, standard deviation, and standard error of the mean for each pair of variables correlation, average difference in means, t test, and confidence interval for mean difference (can specify the confidence level) standard deviation and standard error of the mean difference (Crawford et al., 1998).

In this study paired-sample t-test was used to test questions in each major factor to identify strong questions that affect to other relevant major factors and affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables.

2.6.2 Binary Logistic Regression

Logistic regression analyses both models binomial and binary logistic regression, and multiple logistic regression. Binary logistic regression is normally used when the dependent variable is dichotomous and the independent variables are either continuous or categorical variables. Logistic regression is best used when the dependent variable is not dichotomous and is comprised of more than two cases; a multinomial logistic regression can be worked. Referred to logit regression, multinomial logistic regression these have very similar results with binary logistic regression (Anderson, 1982). Logistic regression analysis examines the influence of various factors on a dichotomous outcome by estimating the probability of the event's occurrence. The examining the relationship between one or more independent variables and the log odds of the dichotomous outcome by calculating changes in the log odds of the dependent as opposed to the dependent variable itself. The log odds ratio is the ratio of two odds and it is a summary measure of the relationship between

two variables. The log odds ratio in logistic regression provides a most simplistic description of the probabilistic relationship of the variables and the outcome in comparison to a linear regression by which linear relationships and more rich information can be drawn (King, 2008).

Logistic model was considered the presence of a qualitative classifier, which logistic regression was accepted quantitative, binary or categorical predictors and code the latter two in various ways. A simple model includes a selection of variable types the criterion variable is traditional versus nontraditional business size, respondents (Nandy, Helle, Liski & Liski, 2010). Binary logistic regression was adopted when we want to look at a dependence structure, with a dependent variable and a set of explanatory variables one or more, can use the logistic regression framework, which multiple linear regression may be used to investigate the relationship between a continuous (interval scale) dependent variable, such as income, blood pressure or examination score (Hilbe, 2009).

Logistic model =

$$\ln(ODDS) = \ln\left(\frac{\hat{Y}}{1-\hat{Y}}\right) = a + bX$$

$\hat{Y}$ is the predicted probability of the event which is coded with 1 (continue the research) rather than with 0 (stop the research).

The theoretical concept of the logistic model was adopted with a list of factors to identify factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. The identified factors include organizational, technological, and environmental factors. They had significant numbers and correlation numbers to answer questions of study.

2.7 Conclusion

In this chapter provided a reviewed of literature relate to RFID technology adoption in logistics management includes supply chain management, logistics activities which were used to understand the RFID technology that was adopted in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables includes what are the logistics activities that adopted RFID technology into their business, reasons that Thai SMEs agribusiness of fresh fruits and vegetables adopted RFID technology to their business.

Also, in this chapter was provided the OTE framework that explored organizational, technological, and environmental factors in a specific context, that referred to OTE framework (Tornatzky et al., 1990), which this theoretical framework used to understand factors that affect to RFID technology adoption in logistics management to an improved business performance and business competency for Thai SMEs in agribusiness of fresh fruits and vegetables. The following chapters (Chapter1, Chapter4, and Chapter 5) place the study within the findings regarding to the factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables.

Finally, this chapter was provided statistical processing of survey data includes firstly, paired sample t-test, which used to test questions in each major factor to identify strong questions that affect to other relevant major factors and affect to RFID technology adoption. Secondly, logistic regression used to analyze quantitative data to identify factors that affect to RFID technology adoption in logistics management to an improved business performance and business competency for Thai SMEs in agribusiness of fresh fruits and vegetables.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This study is about the RFID adoption in logistics activities: an exploratory study of agribusiness, which this chapter provides the research methodology that used in this study, research procedures, questionnaire design, and outlines the data analysis of research the RFID adoption in logistics activities: an exploratory study of agribusiness.

3.2 Research Methodology

A mixed research method is applied to this study used to answer the research questions. Both qualitative and quantitative data were collected. This research was conduct by using questionnaire to answer questions about the RFID technology adoption in Thai SMEs agribusiness of fresh fruits and vegetables. Qualitative data was used to analyze RFID technology adoption in logistics activities of agribusiness of fresh fruits and vegetables. Quantitative data was used to analyze the factors that affect to RFID technology adoption in the logistics management in Thai SMEs agribusiness of fresh fruits and vegetables. Sample of this study people are Thai SMEs agribusiness of fresh fruits and vegetables in the northern part of Thailand.

3.2.1 Qualitative Research Method

Qualitative research was used for collection of a variety of empirical materials case study, introspection, artifacts, life story, interview, observation, personal experience, culture texts and productions, historical, interactional, and visual texts. Denzin and Lincoln (2000), they explains that the qualitative research can described by using multiple and gender images, scientist, naturalist, field worker, journalist, social critic, artist, performer, jazz musician, filmmaker, quilt maker, essayist (Denzin & Lincoln, 2000). King and Keohane (1994), they explains that the qualitative research covers a widely of approaches but by definition these methodology not depend on numerical measurements (King, Keohane & Verba, 1994) such as tended of work that focus on one or a small number of cases to use in-deep interviews or depth analysis of historical data, and method that comprehensive account of some event or unit. The qualitative research is a method rather than a particular set of techniques, and its appropriateness derives from the nature of the social phenomena to be explored (Morgan & Smircich, 1980). Amaratunga and Baldry (2002), they explain that the qualitative research was conducted through an intense and/or prolonged contact with a "field" or life situation. These situations are typically "banal" or normal, reflective of the everyday life of individuals, groups, societies, and organizations, people, objects, and situations (Amaratunga, Baldry, Sarshar & Newton, 2002). Hoepfl (1997) explains that the qualitative research means any type of research that produces findings not arrived from statistical method or other means of quantification (Hoepfl, 1997). Creswell (2009) explains that the qualitative research is the traditional methods that were used for experiments, or the empiricist paradigm. The qualitative research comes from an empiricist tradition established by such authorities as Comte, Mill, Durkheim, Newton, and Lock (Creswell, 2009). Hopkins (2008) explains that the qualitative research is designs are either descriptive (subjects usually measured once) or experimental (subjects measured before and after a treatment) (Hopkins, 2008).

3.2.2 Quantitative Research Method

Amaratunga and Baldry (2002), they explains that the quantitative research that is characterized by the assumption that human behavior can be explained by "social facts" which can be investigated by methodologies that utilize "the deductive logic of the natural science" quantitative research is strong in measuring variables such as a quantitative assumption regarding construction process capability (Amaratunga, et al., 2002). Creswell (2009) explains that the quantitative research is part of the constructive approach or naturalistic, the interpretative approach, or the post positive or postmodern perspective and the quantitative researcher views reality as "objective", "out there" independent of the researcher, which something can be measured objectively by using a questionnaire or an instrument (Creswell, 2009), and a quantitative approach is one in the methodology that investigator primarily used for developing knowledge, which include cause and effect think, reduction to specific variables and hypotheses and questions, use of measurement and observation, and the test of theories and collects data on predetermined instruments that yield statistical data (Creswell, 2013). A survey design provides a quantitative or numeric description of some fraction of the population the sample through the data collection process of asking questions of people. This data collection, in turn, enables a researcher to generalize the findings from a sample of responses to a population (Creswell, 2009). Hopkins (2008) explains that the quantitative research aim to determine the relationship between one thing (an independent variable) and another (a dependent variable) in a population of research (Hopkins, 2008), and quantitative research used number such as percentages or statistical coefficients to describe and answer research question (Neuman, 2007).

Therefore, a mixed research method is applied to this study which both qualitative and quantitative approaches were adopted by using questionnaire to answer questions of study, which a mixed methods approach pragmatic knowledge claims, collection of both quantitative and qualitative data sequentially on the assumption that collect diverse types of data best provides an understand of a research problem (Creswell, 2013). A qualitative approach is being use to understand the RFID technology adopted in their business and what are logistics activities they adopt RFID technology, and provide the main reason the make they adopt RFID technology in

Thai SMEs agribusiness of fresh fruits and vegetables. A quantitative approach is being use to understand the factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. Questionnaire has used to collect data to gain more data of RFID technology adoption and include factors that affect to RFID technology adoption in logistics management to improved business performance and business competency for Thai SMEs agribusiness of fresh fruits and vegetables.

3.3 Data Collection Procedures

Qualitative and quantitative research, there are different research methods available to collect and analyzed information, which the choice of research method that the researcher was used to collect data and specific research methods also imply different skills, assumptions and research practices (Creswell, 2009). The objectives of this research aim to understand RFID technology adoption and factors that affect to RFID technology adoption in logistics management to improved business performance and business competency for Thai SMEs agribusiness of fresh fruits and vegetables.

3.3.1 Method of Data Collection

A review of literature and encourage multiple methods of data collection procedures, in order to increase the rigor and credibility, offering triangulation amongst the collected data, which data collection method was described follows are;

3.3.1.1 Questionnaire, open question and close question were to obtain data of sample group, what are the factors that affect to RFID technology adoption in logistics management to improved business performance and business competency and use to understand RFID technology adopt in Thai SMEs agribusiness of fresh fruits and vegetables.

3.3.1.2 Secondary data, the collection of document were collected from white Papers, articles and Journals. Source of information is reliability related supply

chain, agribusiness supply chain of fresh fruits and vegetables, logistics, logistics activities, RFID technology, adoption of RFID technology in agribusiness, and paper that related with this research.

Questionnaires were developed in different ways to be use with many different data-gathering media such as online-questionnaire. The questionnaire can be left with subjects to complete themselves and to gain more data that use to answer research questions (Brace, 1904). This study used a questionnaire to gain more data from sample group Thai SMEs agribusiness of fresh fruits and vegetables in the northern part of Thailand to answer research questions in this study. The questionnaire was to provide a standardized interview across all subjects, which that all respondents are asked the questions that are appropriate to them, and so that, when those questions asked, they always asked in the same way, which asking the questions in the same way to different people is key to most survey research, imagine what would happen in the same question were asked differently of different respondents. It would be impossible for the survey researcher to interpret the answers (Oppenheim, 2000).

The information was collected by using a questionnaire made by the researcher, and online-questionnaire and paper base was used in data collection. This method was used as it allowed the researcher to probe on issues identified in the questionnaire. Most questionnaires were in the form of and use close questions of, the following questions, "What type of your business? (Retailer, dealer, import-export, modern trade)", "What are logistics activities did you adopt RFID technology in your business? (Customer service, inventory management, warehousing management, transportation, procurement, and other more)", and "What are main reasons that make you adopt RFID technology? (Clearer information, reduces cost, reduce time, serve customers' requirement, material handling, and other more)" and include question that use to ask for factors that affect to RFID technology adoption in logistics management to improved business performance and business competency for agribusiness of fresh fruits and vegetables, following questions, "The readiness of the organization is one factor to making decision to adopt RFID technology? (Highest, high, medium, low, and lowest)", and "Technology is one factor related to made your business succeed? (Highest, high, medium, low, and lowest)"

The other source of data were collected form secondary data, which include collecting publicly available information such as books the supply chain management, books the RFID technology, and books the logistics management and include are white papers, conference, articles and journals papers relating to supply chain, food supply chain, logistics management, logistics activities, RFID technology, OTE frameworks, and others papers that involved with this research.

3.3.2 Population and Sample

Population of this research comprised Thai SMEs agribusiness of fresh fruits and vegetables in the northern part of Thailand area 1 and area 2 includes Chiang Mai, Chiang Rai, Phrae, Mae Hong Son, Phayao and Lampang, which have 209 businesses of Thai SMEs agribusiness of fresh fruits and vegetables (OSMEP, 2013). The office of small and medium enterprises promotion has classified numbers of businesses by size and type of legal organization classified by economic activity from province.

Samples in this research were people from Thai SMEs agribusinesses of fresh fruits and vegetables, sample of research was used the random sample using the formula of Taro Yamane (Yamane, 1963), tolerance 0.05 and confidence level of 95 percent by using quota sampling for the sample of research for quantitative data and to answer objective of study in the objective of study, RFID technology adoption, the factors that affect to RFID technology adoption in the logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables, by using questionnaires, which target 100 copy.

3.4 Questionnaire Design

Questionnaire must clearest from the research objectives and what information areas the questionnaire needs to cover. This is principal information such product, behavioral patterns, attitudes, satisfaction with the service, response to concept, and other more (Oppenheim, 2000). Brace (1904) explains that the main questionnaire, the researcher must consider the order in which the topics and questions are presented to the respondents. As a rule, it is better to work from the most general topics through to

the most specific, therefore the interview might in start with questions about the respondent demographics, before proceeding through to specific questions that want to gain more information to react to a research question (Brace, 1904). There are two reasons for questionnaire design. Firstly, the questions about the specific product or brand of interest were asked first, and then the respondents would be aware the question researcher's interest and this would bias their answers to the more general questions that come later. The respondents' consciousness of the product or brand in question will tend to lead to it being over-represented as a response to any questions. This includes questions about consumption of products or brand in the market generally and lead to overestimation of consumption of the brand of interest. Secondly, starting with general questions allows the respondents to think about their behavior in the market before getting into the detail.

Any questions in an interview and questionnaire can classified in a number of different ways, open or closed, depending whether or not the answer can come only from a finite number of possible response, spontaneous or prompted, depending on whether respondents are asked to reply in their own words or given a number of options from which to choose a response, and open-ended or pre-coded, depending on whether the answer is recorded verbatim or against one or more of a number of predetermines answer (Brace, 1904).

This research focuses on the RFID technology adoption in logistics activities and the factors that affect to RFID technology adoption in the logistics management for Thai SMEs agribusiness of fresh fruits and vegetables. Therefore, this research has design the questionnaire into two parts, qualitative and quantitative data.
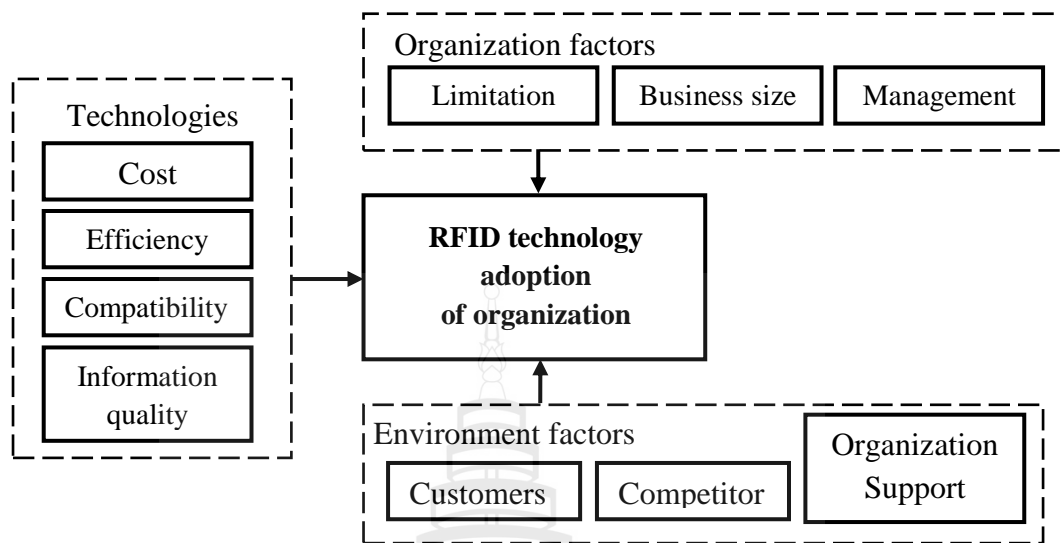
Figure 3.1 Explanatory factors

Figure 3.1 Explanatory factors, the three main factors were identified in conceptual framework that affect to RFID technology adoption in the logistics management to improved business performance and business competency for Thai SMEs agribusiness of fresh fruits and vegetables. The questionnaire was developed from the factors that were identified can follows are;

Firstly, organization factors refer to the organizational context in terms of several descriptive measures such business size, formalization, and complexity of organization, management styles, and the quality of human resource (Tornatzky et al., 1990). Organization factors include organization management styles, organization limitation, business size and management.

Secondly, technologies factors refer to the technological context describes both the internal and external technologies relevant to the organization. The technology context includes current practices and equipment internal to the organization (Zhu et al., 2002).Technology factors can be related to the cost, efficiency, information quality and optimal with organization (Petter, DeLone, & McLean, 2008)

Finally, environment factors refer to those variables that are usually beyond the control of the organizational management but are important in functioning and decision making behavior (Tornatzky, et al., 1990). Therefore, environment factors include external pressure, external support, and uncertainty can follows are organization support; the support from organization, equipment support, customer's requirement, and competitor pressure.

3.5 Data Analysis

The process of data analysis is technique helped the researcher to summaries the large amount of data and to understand the effect of a number of factors on the final outcome, which data analysis technique also helped the researcher to minimize the confounding effects naturally in most data collection processes. In addition data analysis technique enabled the researcher to assess the effects of alternative future scenarios (Sachan & Datta, 2005). Var Vectors (1998) explains that the multivariate data are data with many variables numbering from minimum of two variables to millions such as data usually control variables or factors and/or responses, which most system and processes are characterized by multivariate data and multivariate data analysis techniques can be used to model factors and responses and find the relationship from multivariate data, information extracted from multivariate data are usually very helpful in understanding characteristics of systems and processes and are useful in solving problems (Var, 1998). Narrative method has been studied from a variety of perspectives, which narratives can be understood to organize a sequence of events into a whole so that the significant of each events can be understood through its relation to that whole (Elliott, 2005). Data derived in data collection process were interpreted in both qualitative and quantitative approaches and they were analyzed information in this research.

Firstly, qualitative data were analyzed to gain a general understanding of database, RFID technology adoption that was adopted in their business in Thai SMEs agribusiness of fresh fruits and vegetables to answer questions of study.

Secondly, quantitative data was analyzed in part of the factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables to answer questions of study.

Qualitative data were analyzed, the findings of this study were used to gain a general understanding of finding by using thematic coding and narrative method was used to explain what happened consequently. Themes include type of business, business size, respondents, and major product of their business and used to identify the RFID technology adoption in their business, logistics activities that was adopted RFID technology, the reasons that they adopted RFID technology into their business and include type of RFID tag that use in their business Thai SME agribusiness of fresh fruits and vegetables. Thorne (2000) has summarized the cognitive processes involved in qualitative research in a way that can help us to better understand how the researcher's cognitive processes interact with qualitative data to bring about findings and generate new knowledge (Thorne, 2000). Catherine Pope (2000) explains that the qualitative research used analytical categories to describe and explain social phenomena, which analyzing qualitative data is not a simple or quick task, which "good qualitative analysis is able to document its claim to reflect some of the truth of a phenomenon by reference to systematically gathered data" (Pope, Ziebland & Mays, 2000).

The second part is quantitative data were used to identify factors that affect to RFID technology adoption. The study used the Statistical Package for the Social Science (SPSS) program to analyzed quantitative data. Firstly paired samples t-test was used to test questions in each major factor to identify strong questions that affect to other relevant major factors and affect to RFID technology adoption. Secondly, binary logistic analysis was used to identify factors that affect to RFID technology adoption. Identified factors include organizational, technological, and environmental factors. They had significant numbers and correlation numbers to answer questions of study. The first and major step in analyze quantitative data included coding data techniques to screen various common process problems, then each factor in the work system framework was identified into meaningful categories, which the researcher had to identify and describe themes, patterns and concepts, then organized them into

meaningful categories to be able to understand and explained these themes, patterns or concepts into a meaningful format (Riessman, 2003). This study focus on qualitative data, it is worthwhile to spend a moment in the estimation process for quantitative data, which quantitative data were used to analyze to find the answer to identify factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. Regression model was used to explain the frequency of events such as numbers of RFID technology adoption, factors that affect to RFID technology adoption. Regression analyzes is among the most commonly used methods of statistical analyze, which regression analyze is to describe the relationship of a response with explanatory variables, which regression include linear models for a measured response, logistic model for binary responses (Liang & Zeger, 1993).
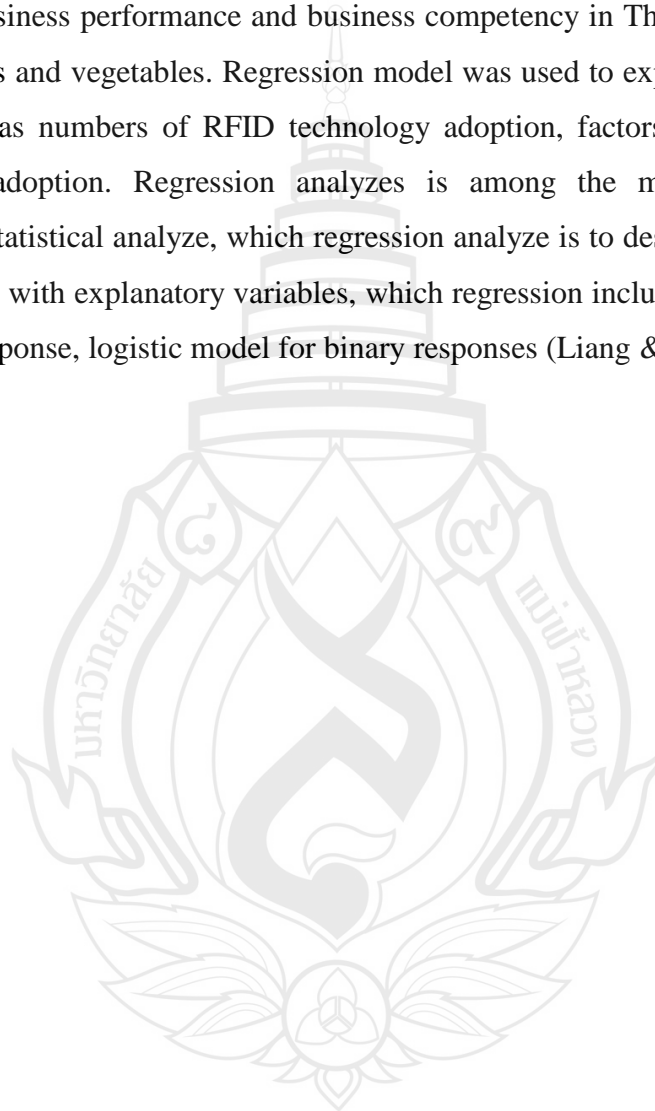
CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter provides results of study follows are objective of study RFID adoption in logistics activities: an exploratory study of agribusiness. This chapter begins with demographics data respondents in this study, the RFID technology adoption and end with the factors that affect to RFID technology adoption in logistics management for agribusiness of fresh fruits and vegetables.

Also, in this chapter were describes data that the researcher collected from 30 respondents' businesses in This SMEs agribusiness of fresh fruits and vegetables in the northern part of Thailand, which can divided into 4 main sections includes overview data, RFID technology that was adopted, and factors that affect to RFID technology in Thai SMEs agribusiness of fresh fruits and vegetables and end with the conclusion.

Follows research objectives are;

4.1.1 To study the stylized facts of RFID technology adoption in Thai SMEs agribusiness of fresh fruits and vegetables;

4.1.2 To examine the determinants that affect to RFID technology adoption to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables.

4.2 Stylized Facts of SMEs

This section reported the demographics of the respondents and statistical descriptions of the study, which used to understand of general data include are type of business, business size, product of their business, logistics activities and reasons that they adopted RFID technology to their business.

Table 4.1 Participant's demographics

	Number of respondents (n=30)	Percentage %
Type of business		
Retailer-Wholesalers	18	60.00
Import-Export	8	26.67
Dealer	2	6.67
Modern trade	1	3.33
Others	1	3.33
Status		
Owner	14	46.67
Staffs/User	14	46.67
Others	2	6.67
Type of products		
Fresh fruits	12	40.00
Fresh vegetables	10	33.33
Fresh fruits and vegetables	8	26.67
Others	0	0.00

Figure 4.1 demonstrates the demographics data of the respondents' businesses. These are 30 businesses respondents from Thai SMEs agribusiness of fresh fruits and vegetables in the northern part of Thailand, which were 60% from retailer-

wholesalers, 6.67% from dealer, 26.67% from import-export companies, 3.33% from modern trade, and another 3.33% from agriculturist group in Samoeng, Chiang Mai province.

Amongst respondents' business 40% are from fresh fruits businesses, 33.33% are from fresh vegetables businesses, and 26.67 are from both fresh fruits and vegetables businesses, which half of respondents' business contribute 46.67% business owner, 46.67% staffs and include user in their business, and another 6.67% are leader of agriculturist group at Samoeng, Chiang Mai province.

Table 4.2 Classification of business size

	Number of respondents (n=30)	Percentage %
Capital investment*		
<50 million bath	19	63.33
51-200 million bath	4	13.33
>200 million bath	4	13.33
Others	3	10.00
Labor		
<50 labors	21	70.00
51-200 labors	5	16.67
>200 labors	4	13.33
Others	0	0.00
Work experience		
<5 years	9	30.00
5-6 years	13	43.33
>15 years	8	26.67
Others	0	0.00

Note. <50 million bath mean small business, 51-200million bath mean medium business, and >200 million bath mean large business according to the office of small and medium enterprises promotion (OSMEP, 2013).

Figure 4.2 demonstrates the demographics of respondents. These are 30 businesses respondent from Thai SMEs agribusiness of fresh fruits and vegetables in the northern part of Thailand, which the sample data was collected 63.33% from small businesses, 13.33% from medium businesses, and 13.33% from large businesses. Thai SMEs agribusiness of fresh fruits and vegetables mostly has labor or staff less number, which 70% has less than 50 labors, 16.67% has between 51-200 labors, and 13.33% has over than 200 labors. The sample data of this study were have work experience in field agribusiness of fresh fruits and vegetables 30% has work experience less than 5 years, 43.33% has work experience between 5-6 years, and 26.67% has work experience over than 15 years.

4.3 RFID Technology in Thai SMEs Agribusiness of Fresh Fruits and Vegetables
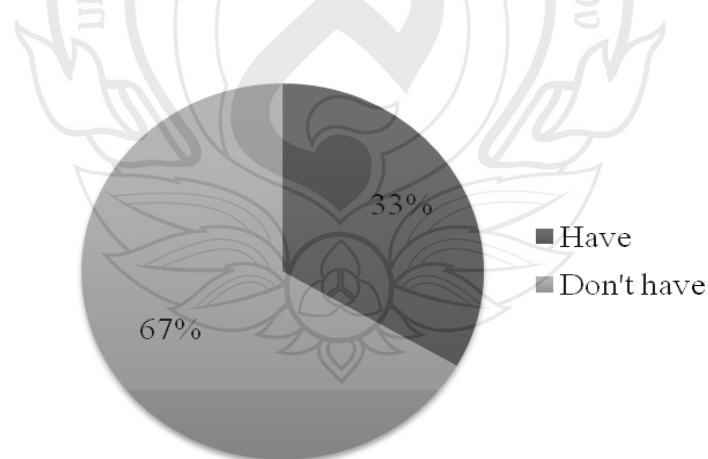
Figure 4.1 Number of business has adopted RFID technology

Figure 4.1 demonstrates the number of businesses that adopted RFID technology into their businesses from 30 respondents' businesses in Thai SMEs agribusiness of fresh fruits and vegetables in the northern part of Thailand. These

were 33% of respondents adopted RFID technology whilst others 67% have not yet decided to adopt RFID technology into their business operations.

Table 4.3 Business size and RFID technology adoption

		Business size				Total
		Small business	**Medium business**	**Large business**	**Other**	
Adopt	Count	3	4	3	0	10
		15.79%	100%	75%	0%	33.33%
Not adopt	Count	16	0	1	3	20
		84.21	0	25	100	66.67%
Total	**Count**	**19**	**4**	**4**	**3**	**30**
		100%	**100%**	**100%**	**100%**	**100%**

This study revealed the business that different size affects to RFID technology adoption. Table 4.3 demonstrates the number of businesses that adopted RFID technology was depended on business size. There are small business was adopted RFID technology at 15.79% of the number of respondents, medium business was adopted RFID technology at 100% of the number of respondents, and large business was adopted RFID technology at 75% of the number of respondents.

Table 4.4 Type of business and RFID technology adoption

		Type of business					Total
		Retailer Wholesaler	Import Export	Modern trade	Dealer	Other	
Adopt	Count	5	4	1	0	0	10
		27.78%	50%	100%	0%	0%	33.33%
Not adopt	Count	13	4	0	2	1	20
		72.22%	50%	0%	100%	100%	66.67%
Total	**Count**	**18**	**8**	**1**	**2**	**1**	**30**
		100%	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4.4 demonstrates the type of business that adopted RFID technology in Thai SMEs agribusiness of fresh fruits and vegetables. There are retailers and wholesalers were adopted RFID technology at 27.78% of the number of respondents, import and export was adopted RFID technology at 50% of the number of respondents, and modern trade was adopted RFID technology at 100% of the number of respondents.
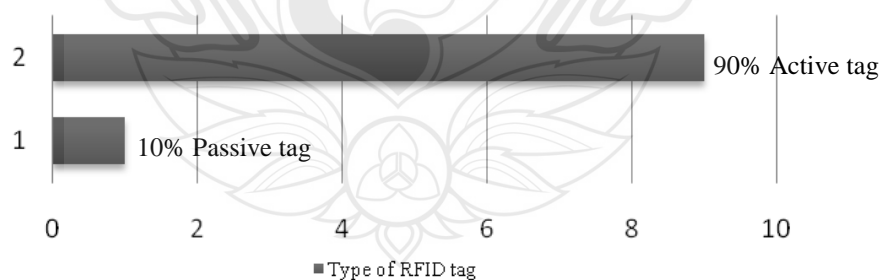
Figure 4.2 Types of RFID tag

Figure 4.2 demonstrates the types of RFID tag that was adopted in Thai SMEs agribusiness of fresh fruits and vegetables most are active tag, which was accounted

for 90% of respondent's businesses. Others 10% are considered as passive tag, which both active and passive tags are being used in agribusiness.
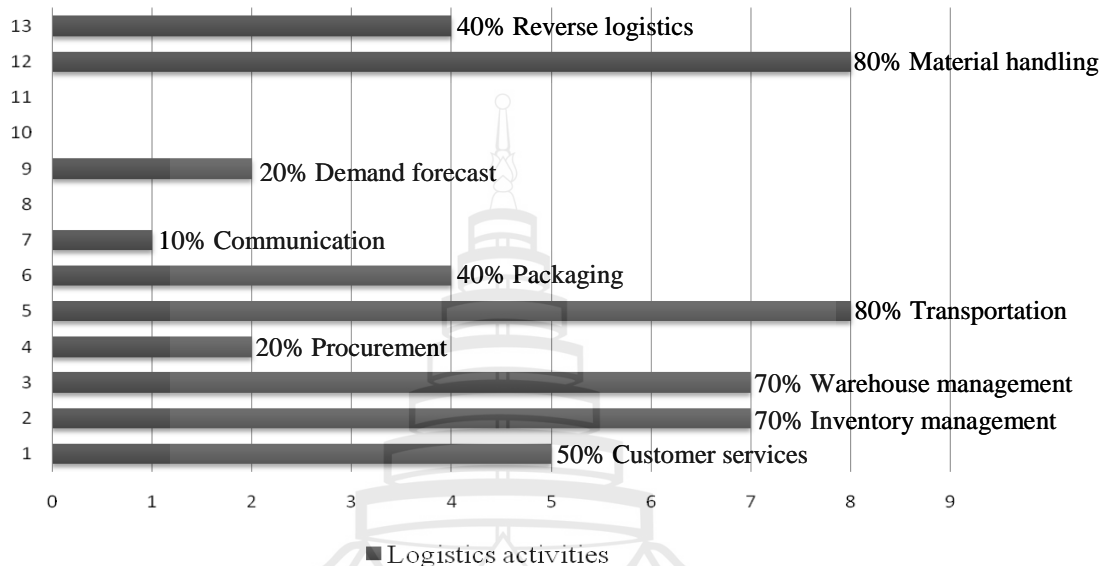
Figure 4.3 Logistics activities that adopted RFID technology

Figure 4.3 demonstrates the logistics activities found that adopted and used RFID technology in Thai SMEs agribusiness of fresh fruits and vegetables. The logistics activity that mostly seen adopted RFID technology, which can be divided about four groups. Firstly, 80% were used in material handling and in transportation. Secondly, 70% were used in warehouse management and inventory management. Thirdly, 50% used in customer services, 40% used in packaging and reverse logistics. Finally, 20% used in procurement and demand forecast; and other 10% used communication process respectively.

This finding has showed the most logistics activities that was adopted and used RFID technology was because they were aware of the important of technology. The other reason was because the agribusiness of fresh fruits and vegetables are perishable product, which the shelf life of product depends on the supply chain's ability and efficiency to transport fresh goods to consumer quickly, after the harvest process. Therefore, they were focuses on logistics activities that make their products

delivery to customers as quickly as possible, which include are material handling, transportation, inventory management, and warehouse and storage management.
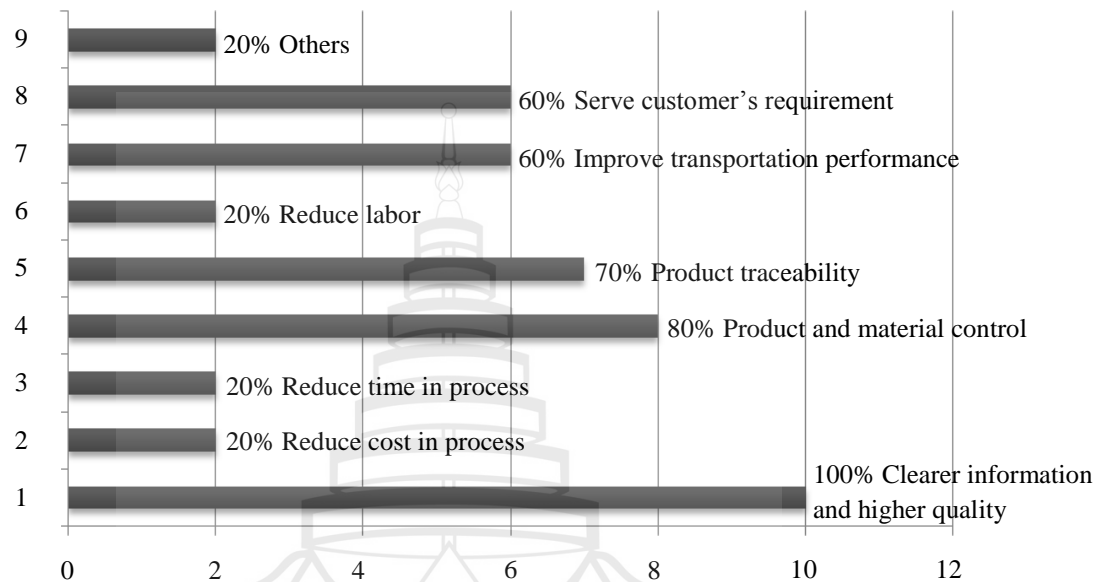
Figure 4.4 Reasons that business owner adopted RFID technology

Figure 4.4 demonstrates the reasons that adopted business owner adopted RFID technology into their business. There were many reasons that agribusiness of fresh fruits and vegetables businesses adopt the RFID technology. Firstly, 100% it was because the RFID technology provided a clearer information and higher quality. Secondly, it was found that 80% the RFID technology facilitate the product and material handling process. Thirdly, it was found that 70% product traceability. Fourthly, it was found that 60% improve transportation performance. Fifthly, it was found that 60% serve customer's requirement. Sixthly, it was found that 20% reduce cost and time in process. Lastly, it was found that 20% referred as they were from others reason.

4.4 Factors That Affect to RFID Technology in Thai SMEs Agribusiness of Fresh Fruits and Vegetables

Refer to conceptual framework, which used the OTE framework that includes organization, technology, and environment factors. This theoretical framework was used to understand factors that affect to RFID technology adoption in logistics management to improved business performance and business competency for Thai SMEs agribusiness of fresh fruits and vegetables.
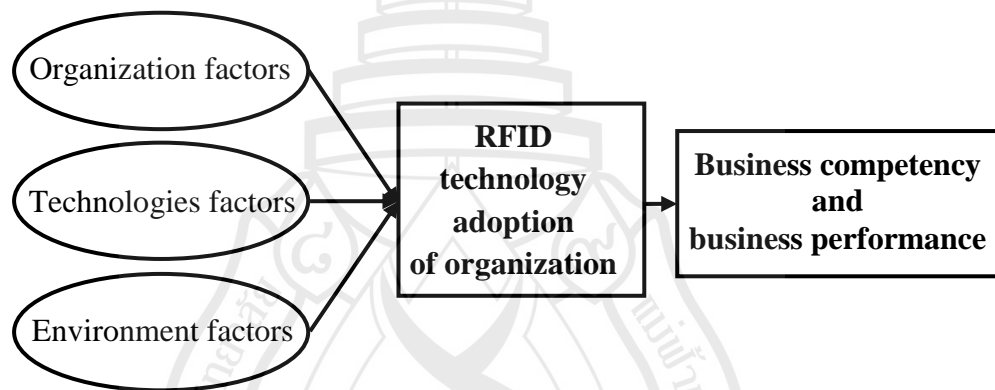
Figure 4.5 Conceptual Frameworks

Referred to the OTE framework includes are organization factors, technology factors, and environment factors. This theoretical framework was used to developed conceptual framework. Figure 4.5 demonstrates the conceptual framework that used in this study, which were organization, technology, and environment factors. This study aims to understand factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables.

4.4.1 Organization Factors

Table 4.5 Paired samples correlation of organization factors with RFID adoption

|		N	Correlation	Significant
Pair 1	RFID adoption & O1	30	0.471	0.009
Pair 2	RFID adoption & O2	30	0.563	0.001
Pair 3	RFID adoption & O3	30	0.542	0.002
Pair 4	RFID adoption & O4	30	0.555	0.001
Pair 5	RFID adoption & O5	30	0.463	0.010
Pair 6	RFID adoption & O6	30	0.293	0.116
Pair 7	RFID adoption & O7	30	0.463	0.010
Pair 8	RFID adoption & O8	30	0.493	0.006
Pair 9	RFID adoption & O9	30	0.431	0.017
Pair 10	RFID adoption & O10	30	0.537	0.002
Pair 11	RFID adoption & O11	30	0.528	0.003

Table 4.5 demonstrates the results of analyzed of the organization factors with RFID adoption, which used to find the factors that have strong relationship with RFID adoption by used significant number, those factors that significant number over than 0.05 were reject (sig > 0.05 = reject) but those factors that significant number less than 0.05 were accept (sig < 0.05 = accept). The organization factors rejected O6 was significantly at 0.116 and was correlated at 0.293 with RFID technology adoption of organization. Therefore the organization factors accepted are O1 was significant at 0.009 and was correlated at 0.471, O2 was significant at 0.001 and was correlated at 0.563, O3 was significant at 0.002 and was correlated at 0.542, O4 was significant at 0.001 and was correlated at 0.555, O5 was significant at 0.010 and was correlated at 0.463, O7 was significant at 0.010 and was correlated at 0.463, O8 was significant at 0.006 and was correlated at 0.493, O9 was significant at 0.017 and was correlated at 0.431, O10 was significant at 0.002 and was correlated at 0.537, and O11 was

significant at 0.003 and was correlated at 0.528 with RFID technology adoption of organization.
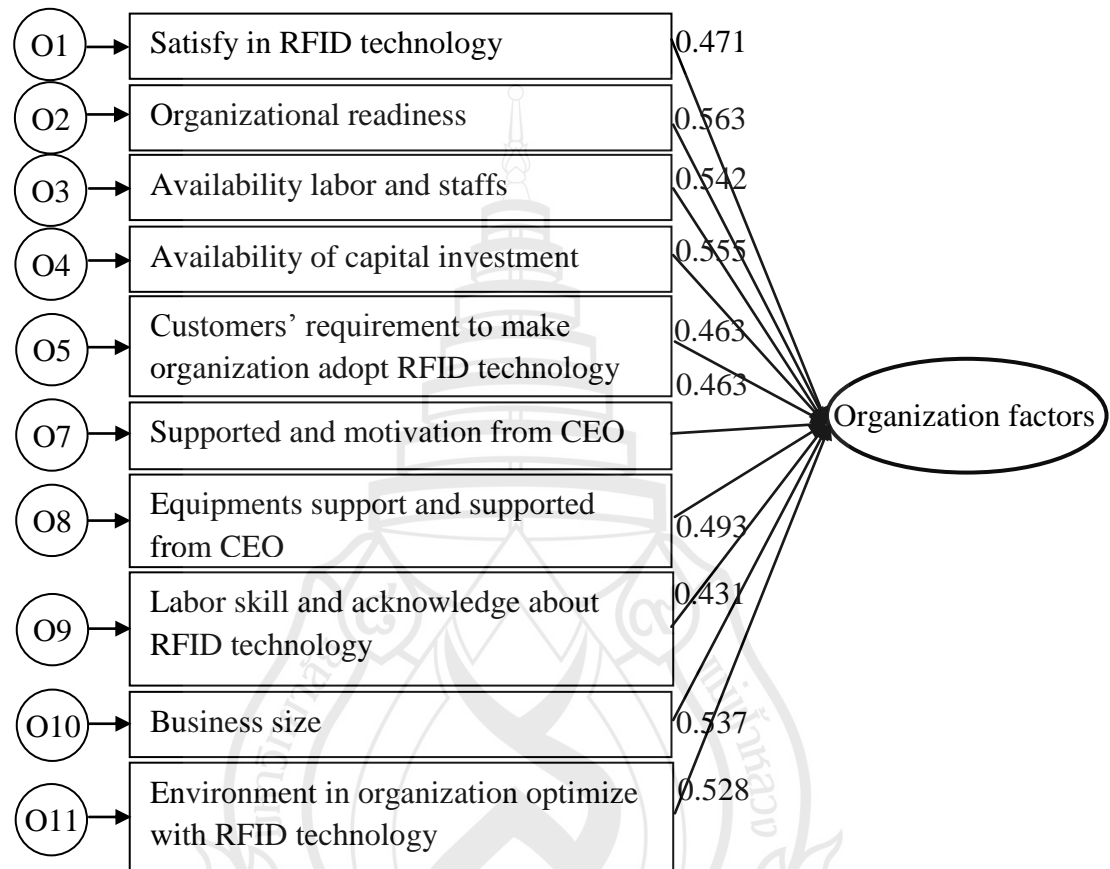
Figure 4.6 Questions that were accept in parts of organization factors

The questions that represented a good fit for organization factors, which used to gain more information in organization factors that affect to RFID technology adoption that were accepted from Figure 4.6, which include satisfy in RFID technology was correlated at 0.471, organizational readiness to adopt RFID technology was correlated at 0.563, the availability labor and staffs was correlated at 0.542, the availability of capital investment was correlated at 0.555, customers' requirement to make organization adopt RFID technology was correlated at 0.463, supported and motivation from CEO was correlated at 0.463, equipments support and

supported from CEO was correlated at 0.493, labor skill and acknowledge about RFID technology was correlated at 0.431, business size was correlated at 0.537, and environment in organization optimize with RFID technology was correlated at 0.528.

4.4.2 Technology Factors

Table 4.6 Paired samples correlation of technology factors with RFID adoption

		N	Correlation	Significant
Pair 1	RFID adoption & T1	30	0.336	0.070
Pair 2	RFID adoption & T2	30	0.378	0.040
Pair 3	RFID adoption & T3	30	0.279	0.135
Pair 4	RFID adoption & T4	30	0.511	0.004
Pair 5	RFID adoption & T5	30	0.205	0.276
Pair 6	RFID adoption & T6	30	0.467	0.009
Pair 7	RFID adoption & T7	30	0.534	0.002
Pair 8	RFID adoption & T8	30	0.497	0.005
Pair 9	RFID adoption & T9	30	0.451	0.012
Pair 10	RFID adoption & T10	30	0.388	0.034
Pair 11	RFID adoption & T11	30	0.279	0.136
Pair 12	RFID adoption & T12	30	0.304	0.103
Pair 13	RFID adoption & T13	30	0.353	0.055
Pair 14	RFID adoption & T14	30	0.488	0.006
Pair 15	RFID adoption & T15	30	0.312	0.094
Pair 16	RFID adoption & T16	30	0.185	0.327
Pair 17	RFID adoption & T17	30	0.563	0.001
Pair 18	RFID adoption & T18	30	0.537	0.002

Table 4.6 demonstrates the results of analyzed of the technology factors with RFID adoption, which used to find the factors that have strong relationship with RFID

adoption by used significant number, those factors that significant number over than 0.05 were reject (sig > 0.05 = reject) but those factors that significant number less than 0.05 were accept (sig < 0.05 = accept). The technology factors rejected T1 was significant at 0.070 and was correlated at 0.336, T3 was significant at 0.135 and was correlated at 0.279, T5 was significant at 0.276 and was correlated at 0.205, T11 was significant at 0.136 and was correlated at 0.279, T12 was significant at 0.103 and was correlated at 0.304, T13 was significant at 0.055 and was correlated at 0.353, T15 was significant at 0.094 and was correlated at 0.312, and T16 was significant at 0.327 and was correlated at 0.185 with RFID technology adoption of organization. Therefore the technology factors accepted are T2 was significant at 0.040 and was correlated at 0.379, T4 was significant at 0.004 and was correlated at 0.511, T6 was significant at 0.009 and was correlated at 0.467, T7 was significant at 0.002 and was correlated at 0.534, T8 was significant at 0.005 and was correlated at 0.497, T9 was significant at 0.012 and was correlated at 0.451, T10 was significant at 0.034 and was correlated at 0.388, T14 was significant at 0.006 and was correlated at 0.488, T17 was significant at 0.001 and was correlated at 0.563, and T18 was significant at 0.002 and was correlated at 0.537 with RFID technology adoption of organization.
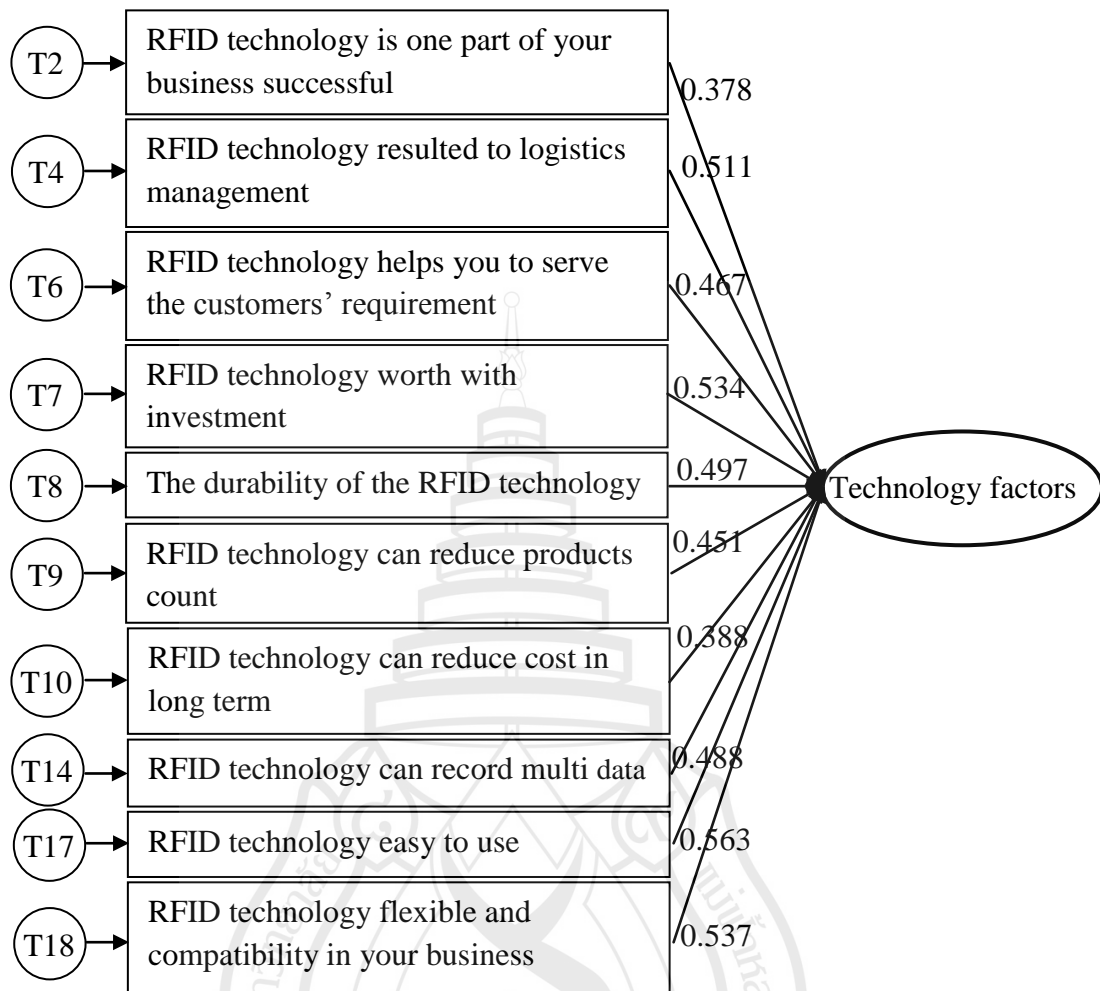
Figure 4.7 Questions that were accept in parts of technology factors

The questions that represented a good fit for technology factors, which used to gain more information in organization factors that affect to RFID technology adoption that were accepted from Figure 4.6, which include are RFID technology is one part of your business successful was correlated at 0.378, RFID technology resulted to logistics management was correlated at 0.511, RFID technology help you to serve the customers' requirement was correlated at 0.467, RFID technology worth with investment was correlated at 0.534, the durability of the RFID technology was correlated at 0.497, RFID technology can reduce products count was correlated at 0.451, RFID technology can reduce cost in long term was correlated at 0.388, RFID technology can record multi data was correlated at 0.488, RFID technology easy to

use was correlated at 0.563, and RFID technology flexible and compatibility in your business was correlated at 0.537.

4.4.3 Environment Factors

Table 4.7 Paired samples correlation of environment factors with RFID adoption

		N	Correlation	Significant
Pair 1	RFID adoption & E1	30	0.419	0.021
Pair 2	RFID adoption & E2	30	0.514	0.004
Pair 3	RFID adoption & E3	30	0.378	0.040
Pair 4	RFID adoption & E4	30	0.143	0.450
Pair 5	RFID adoption & E5	30	0.331	0.074
Pair 6	RFID adoption & E6	30	0.437	0.016
Pair 7	RFID adoption & E7	30	0.313	0.092
Pair 8	RFID adoption & E8	30	0.477	0.008
Pair 9	RFID adoption & E9	30	0.474	0.008
Pair 10	RFID adoption & E10	30	0.503	0.005
Pair 11	RFID adoption & E11	30	0.377	0.040

Table 4.7 demonstrates the results of analyzed of the environment factors with RFID adoption, which used to find the factors that have strong relationship with RFID adoption by used significant number, those factors that significant number over than 0.05 were reject (sig > 0.05 = reject) but those factors that significant number less than 0.05 were accept (sig < 0.05 = accept). The environment factors rejected E4 was significant at 0.450 and was correlated at 0.143, E5 was significant at 0.074 and was correlated at 0.331, and E7 was significant at 0.092 and was correlated at 0.313 with RFID technology adoption of organization. Therefore the environment factors accepted are E1 was significant at 0.021 and was correlated at 0.419, E2 was significant at 0.004 and was correlated at 0.514, E3 was significant at 0.040 and was

correlated at 0.378, E6 was significant at 0.016 and was correlated at 0.437, E8 was significant at 0.008 and was correlated at 0.477, E9 was significant at 0.008 and was correlated at 0.474, E10 was significant at 0.005 and was correlated at 0.503, and E11 was significant at 0.040 and was correlated at 0.377 with RFID technology adoption of organization.

E1	Availability of old systems facilitate to adopt RFID technology	0.419
E2	Customers need to see your business adopt RFID technology	0.514
E3	The investment return in long term	0.378
E6	The impulsion from market and competitors	0.437
E8	The impulsion from customers' requirement	0.477
E9	Organization has procedures how to use RFID technology	0.474
E10	Organization support equipment in their operations	0.503
E11	Organization provide training on how to use RFID technology	0.377

Figure 4.8 Questions that were accept in parts of environment factors

The questions that represented a good fit for environment factors, which used to gain more information in organization factors that affect to RFID technology adoption that were accepted from Figure 4.8, which include are the availability of old systems facilitate to adopt RFID technology was correlated at 0.419, customers need to see your business adopt RFID technology was correlated at 0.514, the investment return in long term was correlated at 0.378, the impulsion from market and

competitors was correlated at 0.437, the impulsion from customers' requirement was correlated at 0.477, organization has procedures how to use RFID technology was correlated at 0.474, organization support equipment in their business was correlated at 0.503, and organization provide training on how to use RFID technology was correlated at 0.377

Figure 4.9 Questions that high correlate with RFID technology adoption

The three factors that high correlated in each of main factors, which researcher selected from questions that high correlated with RFID technology adoption included are O2= organizational readiness was correlated at 0.563, O3=availability labor and staffs was correlated at 0.542, O4= availability of capital investment was correlated at
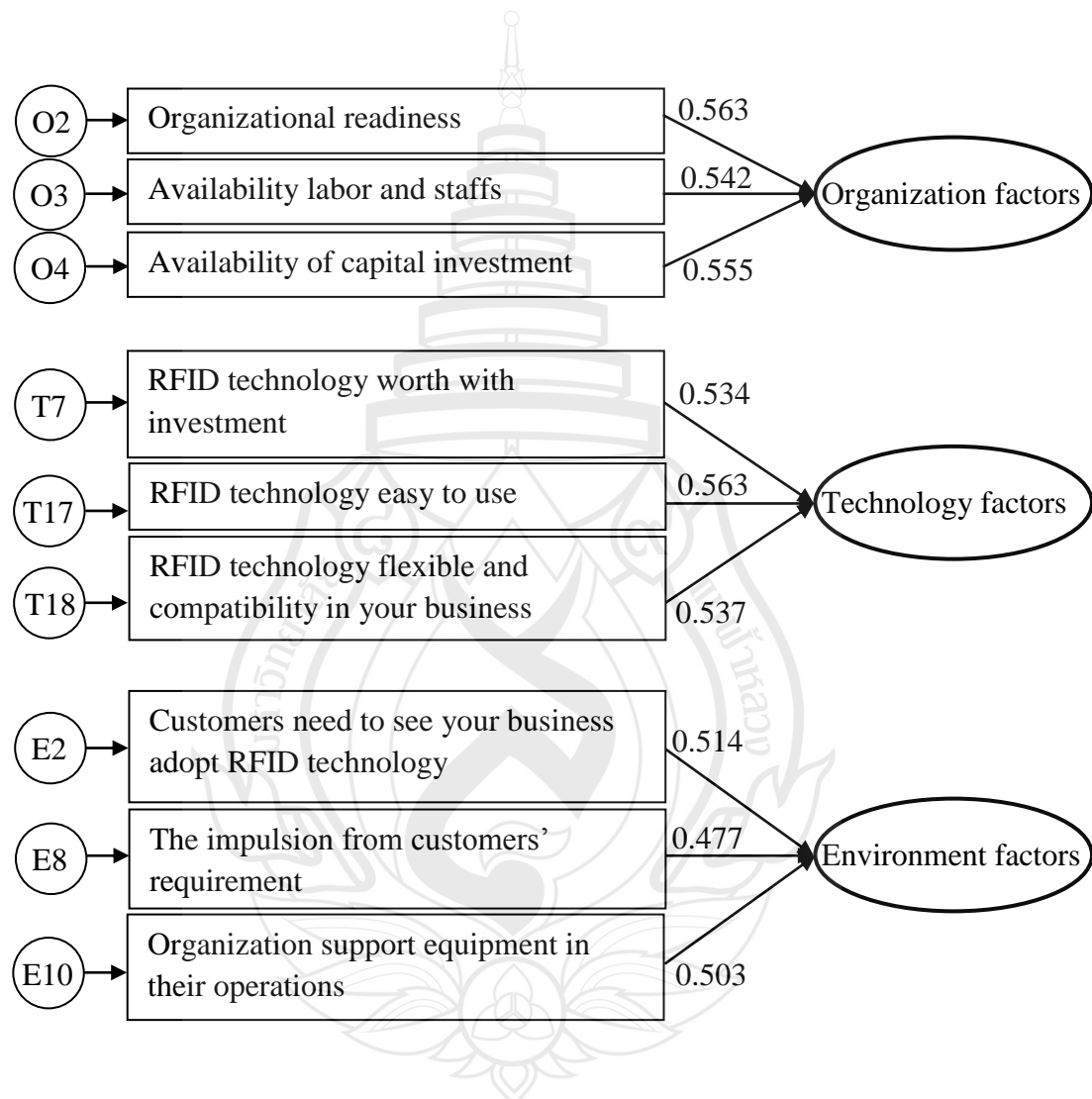
0.555, T4= RFID technology resulted to logistics management was correlated at 0.511, T17= RFID technology easy to use was correlated at 0.563, T18= RFID technology flexible and compatibility in your business was correlated at 0.537, E2= Customers need to see your business adopt RFID technology was correlated at 0.514, E8= The impulsion from customers' requirement was correlated at 0.477, and E10= organization support equipment in their operations was correlated at 0.503. These are three main questions that affect to RFID technology adoption.

4.4.4 OTE Framework

Table 4.8 Omnibus tests of model coefficients

		Chi-square	df	Sig.
Step 1	Step	14.002	3	0.003
	Block	14.002	3	0.003
	Model	14.002	3	0.003

Note. Significant at 0.05

Table 4.8 demonstrates the Omnibus tests of model coefficients, which gave an indication of whether or not the model with independent factors fits data better. This Table showed the significant in the final column (Model) on this table, and significant was at 0.003, which significant is less than 0.05 that mean this model with the three factors fits better than a model with no predictors.

Table 4.9 Model summary

Step	-2 log likelihood	Cox & Snell R square	Nagelkerke R square
1	24.169[a*]	0.373	0.519

Note. a estimation terminated at iteration number 6 because parameter estimates

changed by less than 0.001

Table 4.9 demonstrates the model summary that provided with the Pseudo R square statistics. These are two measures, Cox & Snell and Nagelkerke R square. Both used a somewhat different formula, but both are equally valid, which these numbers indicate modest improvement in fit over the baseline model (0-0.1 would indicate poor improvement in fit, 0.1-0.3 modest improvement, 0.3-0.5 moderate improvement and more than 0.5 strong improvements), which this table was showed the Cox and Snell was at 0.373 and Nagelkerke R square was at 0.519 is strong improvement.

Table 4.10 Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Org	2.192	1.994	1.208	1	0.272	8.950
	Tec	1.953	1.948	1.005	1	0.316	7.047
	Env	-1.045	2.187	0.413	1	0.520	0.245
	Constant	-11.137	4.807	5.367	1	0.021	0.000

Note. a variable(s) entered on step 1: Org, Tec, Env

Table 4.10 demonstrates the variables in the equation revealed the coefficient B of three factors includes organization, technology, and environment factors, which use to predicting the dependent variable from the independent variable. The organization factor was coefficient B at 2.192, technology factors was coefficient B at 1.953, and environment factors was coefficient B at -1.045, which can created the prediction equation is "$\log(p/1-p) = -11.137 + 2.192*Org + 1.953*Tec - 1.045*Env$". This estimate provides the relationship between the independent variables and the dependent variable that mean an increase of factors by one unit. The significant predictive power for the factors organization factors was significant at 0.272, technology factors was significant at 0.316, and environment was significant at 0.520. These three factors rejected because was the significant over than 0.05.

Table 4.11 Paired samples statistics

	Mean	N	Std. Deviation	Std. Error mean
Pair 1 RFID adoption	0.3300	30	0.47900	0.0880
Org	3.3433	30	0.90656	0.1655
Pair 2 RFID adoption	0.3300	30	0.47900	0.0880
Tec	3.7000	30	0.75184	0.1376
Pair 3 RFID adoption	0.3300	30	0.47900	0.0880
Env	3.3250	30	0.89032	0.1625

Table 4.11 demonstrates the paired samples statistics revealed the number of respondents was 30, mean of RFID technology was 0.3300, organization factors was 3.3433, technology factors was 3.7000, and environment factors was 3.3250, standard deviation of RFID technology was 0.47900, organization factors was 0.90656, technology factors was 0.75184, and environment factors was 0.89032, and standard error of the mean for each factor, which the RFID technology was 0.0880, organization factors was 0.1655, technology factors was 0.1376, and environment factors was 0.1625

Table 4.12 Paired samples correlations

	N	Correlation	Sig.
Pair 1 RFID adoption & Org	30	0.592	0.001
Pair 2 RFID adoption & Tec	30	0.572	0.001
Pair 3 RFID adoption & Env	30	0.525	0.003

Note. Significant at 0.05

Figure 4.12 demonstrates the paired samples correlations between each of the factors with RFID adoption, which revealed the number of respondents was 30. The organization factors was at 0.592 correlations and was significant at 0.001, technology factors was correlated at 0.572 and was significant at 0.001, and environment factors was correlated at 0.525 and was significant at 0.003 with RFID adoption.
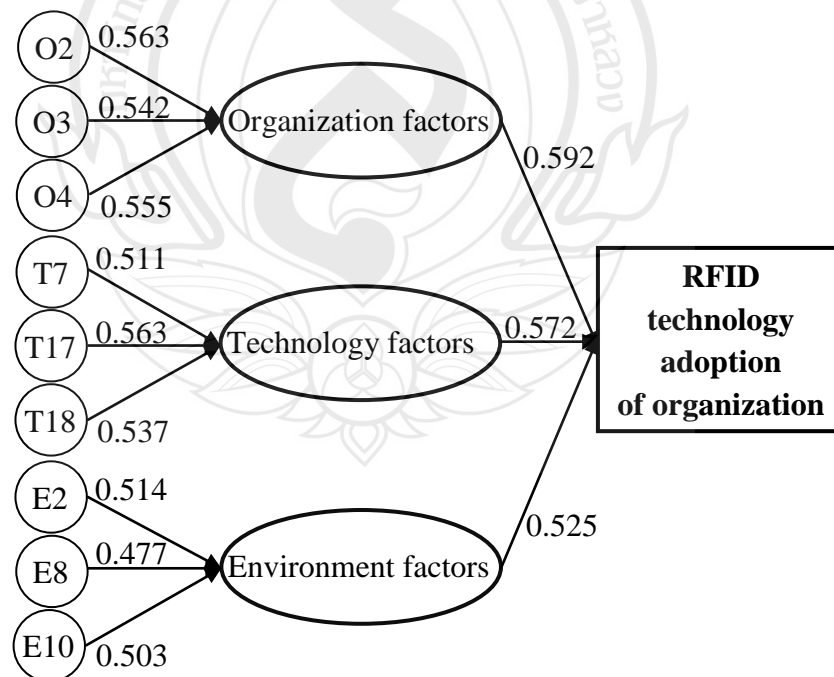
Figure 4.10 Organization, technology, and environment factors

These are factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. Figure 4.9 revealed, firstly organizational factors was at 0.592 correlations and has 0.001 significantly the strongest relationships with RFID technology adoption of organization resulted that it was 0.563 from organization readiness to adopt RFID technology, 0.555 from the availability of capital investment, and 0.542 from the availability labor and staff. Secondly, the technological factor was correlated at 0.572 and was significantly at 0.001 with RFID technology adoption of organization, which resulted 0.534 from RFID technology efficiency worth the capital invested, 0.563 from RFID technology easy to use, and 0.537 from compatibility and flexible of RFID technology with organization. Lastly the environment factor was correlated at 0.525, and was significant at 0.003 with RFID technology adoption of organization, which resulted that 0.514 was from customers and competitors in the market, 0.503 was from organization support, and 0.477 was from customers, requirement to know the product information.

4.5 Conclusion

The qualitative results were demonstrates the qualitative analysis. Qualitative data were analyzed to gain a general understanding of findings by using thematic coding and narrative method was used to explain what happened consequently. The qualitative analysis started with the demographic statistics of the sample, which included type of business, respondents status, major product of their business, business size, number of business and RFID tag that was adopted RFID technology, logistics activities that was adopted RFID technology, and reasons that they adopted RFID technology. Once analyzing the demographic statistics, data was undertaken to gain a general understanding of Thai SMEs agribusiness of fresh fruits and vegetables and to identify logistics activities that was adopted RFID technology and reasons that they adopted RFID technology into their business.

The quantitative results were demonstrates the factors that affect to RFID technology adoption. The Statistical Package for the Social Science (SPSS) program was used to analyze quantitative data to identify factors that affect to RFID technology adoption. The quantitative analysis started with the paired samples t-test was used to test questions in each major factor to identify strong questions that affect to other relevant major factors and affect to RFID technology adoption of three main factors, which was showed in Figure 4.9 (Chapter 4) three main questions that high correlation with RFID technology adoption. Secondly, binary logistic analysis and paired samples t-test was used to identify factors that affect to RFID technology adoption. The identified factors include organizational, technological, and environmental factors. They had significant numbers and correlation numbers to answer questions of study, which organization factors was the strongest relationships factors that affect to RFID technology adoption of organization. The OTE framework provided data that was not only organization factors, but also included technology and environment factors that affected to RFID technology adoption was showed in Figure 4.10 (Chapter 4) organization, technology, and environment factors.

CHAPTER 5

CONCLUSION

5.1 Introduction

This chapter discusses the major findings of the research, the factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. The summary of research, limitations of the research and suggestions for future research and end with conclusion.

The objective of this research was to understand factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. The research objectives of this research were;

5.1.1 To study the stylized facts of RFID technology adoption in Thai SMEs agribusiness of fresh fruits and vegetables;

5.1.2 To examine the determinants that affect to RFID technology adoption to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables.

5.2 RFID Technology in Thai SMEs Agribusiness of Fresh Fruits and Vegetables

This study revealed the number of businesses that adopted RFID technology into their businesses. There was 33% of respondents adopted RFID technology whilst

others 67% have not yet decided to adopt RFID technology into their business operations. The finding of this study revealed consistent with a research background that RFID technology is one popular tool and innovative that they adopted, especially in the large industry sector. However, RFID technology is not still popular used and adopted amongst many small and medium enterprises but this study revealed that the small and medium enterprises they interesting in RFID technology. Among the respondents were 30 respondents business that researcher were collected has business that interested in RFID technology were at 73.33 percent of respondents business but were 26.67 percent they not interest yet in RFID technology. The considered to be a good trend that small and medium enterprises agribusiness of fresh fruits and vegetables interested on RFID technology adoption into their business to improve their business performance and business competency and its business process efficiency.

The finding of this study revealed that the type of RFID tag that was adopted in Thai SMEs agribusiness of fresh fruits and vegetables most are active tag, which was accounted for 90% of respondent's business, and others 10% were considered as passive tag. Passive tag uses only gives information such as traceability and tacking, passive tags obtain operating power generated from the RFID reader, it smaller and lighter than active tags but has a shorter communication range and requires a high powered reader. Active tags normally seen adopted in shopping mall they adopted RFID tag with their products that expensive and need to have RFID tag to protect all these time, active tag have an internal battery to power them, which active tags generally can transmit their data over a longer distance, the tag itself is larger than a passive tag, and has a limited operational lifespan (Ruiz García & Lunadei, 2010).

Referred to literature argues that an logistics activities are internal and external activity and logistics activities are activities support to organization, which internal activity support and connect within organization for make the jobs run smoothly, external activity is activity between the organization with customers or organization with organization (Stock & Lambert, 2001). This study was adopted logistics activities 13 activities used to understand the logistics activities that was adopted RFID technology includes customer service, demand forecast, inventory management,

logistics communication, material handling, order processing, packaging, parts and services, plans and warehouse site selection, procurement, reverse logistics, transportation, and warehouse management. This study revealed that the most logistics activities that business adopted RFID technology into their businesses, which the logistics activities found that adopted and used RFID technology in Thai SMEs agribusiness of fresh fruits and vegetables. The logistics activity that mostly seen adopted RFID technology are 80% used in material handling; 80% in transportation; 70% used in warehouse management and inventory management; 50% used in customer services; 40% used in packaging and reverse logistics; 20% used in procurement and demand forecast; and other 10% used communication process respectively. Some executives suggest that information technology is the single, most important factor to logistics and supply chain management improvement (Dawe, 1994), while 34% of logistics executives rank technology as the most important factor in improving logistics capabilities (Patterson et al., 2003).

This study revealed that the reasons that business adopted RFID technology into their businesses, which the reasons that adopted business owner adopted RFID technology into their business. There were many reasons that agribusiness of fresh fruits and vegetables businesses adopt the RFID technology. Firstly, 100% it was because the RFID technology provided a clearer information and higher quality. Secondly, it was found that 80% the RFID technology facilitate the product and material handling process. Thirdly, it was found that 70% product traceability. Fourthly, it was found that 60% improve transportation performance. Fifthly, it was found that 60% serve customer's requirement. Sixthly, it was found that 20% reduce cost and time in process. Lastly, it was found that 20% referred as they were from others reason, which the most vital important reason that business adopted RFID technology into their business was because they were aware of the important of technology. The other reason was because the agribusiness of fresh fruits and vegetables business adopted the RFID technology wanted to improve their business performance and business competency. These reasons consistent with the literature argues that RFID technology can improved accuracy in management inventory, reduced cost for logistical operation, and improved customer service (Koh et al.,

2006), and RFID technology also can improved efficiency of product traceability by tracking, reduced human error, and reduced cost, time, and risk (Yao et al., 2010).

5.3 Factors That Affect to RFID Technology in Thai SMEs Agribusiness of Fresh Fruits and Vegetables

Referred to research objective was to examine the determinants that affect to RFID technology adoption to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. This study was adopted the OTE framework which included organization, technology, and environment factors. This theoretical framework used to understand factors that affect to RFID technology in Thai SMEs agribusiness of fresh fruits and vegetables. This study revealed that not only organization factors were major factors for its adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables, but the adoption also includes technological and environmental factors. Therefore, Thai SMEs agribusiness of fresh fruits and vegetables and those who are interested in RFID technology should realize and consider that, an organizational factor is not only one factor to consider. They need to consider to technological factors, the positive attitude towards technology and environmental factors include are customer's requirement, impulsion from the competitors in the market, and supported from the organization. These are main factors that Thai SMEs agribusiness of fresh fruits and vegetables and include who are interested RFID technology should be give significant when to seek out for tools to help their businesses.

5.3.1 Organization Factors

Referred to organization context was defined in terms of several descriptive measures such as business size, organization structure, organization management styles, and the quality of human resource (Tornatzky et al., 1990). A variety of organizational factors have been suggested to technology adoption, which business size has been one of the most researched variables, organization-wide readiness is

also an important factor for adoption of RFID technology, and the financial and technology resources to invest in new technologies the larger organizations are generally more willing to adopt new technologies because they have financial resource (Patterson et al., 2003). Different organizations face different innovation opportunities. The organizations with more resources are more in a position to adopt RFID, which resources examined for RFID adoption includes financial, human, and technological resources of the organization and include Management attitude (Hossain & Quaddus, 2011).

This study revealed that the questions that represented a good fit for organization factors, which used to gain more information in organization factors that affect to RFID technology adoption that were accepted from Figure 4.6 (Chapter 4) , which include satisfy in RFID technology was correlated at 0.471, organizational readiness to adopt RFID technology was correlated at 0.563, the availability labor and staffs was correlated at 0.542, the availability of capital investment was correlated at 0.555, customers' requirement to make organization adopt RFID technology was correlated at 0.463, supported and motivation from CEO was correlated at 0.463, equipments support and supported from CEO was correlated at 0.493, labor skill and acknowledge about RFID technology was correlated at 0.431, business size was correlated at 0.537, and environment in organization optimize with RFID technology was correlated at 0.528.

5.3.2 Technology Factors

Referred to technology context described both the internal and external technologies relevant to the organization, which includes existing technologies within the organization such as efficiency, information quality, and compatibility (Tornatzky et al., 1990). The technological factors have a significant effect on RFID adoption. The relevant technological factor for RFID adoption includes ease of use, compatibility, cost, and standard of technology (Hossain & Quaddus, 2011).

This study revealed that the questions that represented a good fit for technology factors, which used to gain more information in organization factors that affect to RFID technology adoption that were accepted from Figure 4.7 (Chapter 4), which include are RFID technology is one part of your business successful was

correlated at 0.378, RFID technology resulted to logistics management was correlated at 0.511, RFID technology help you to serve the customers' requirement was correlated at 0.467, RFID technology worth with investment was correlated at 0.534, the durability of the RFID technology was correlated at 0.497, RFID technology can reduce products count was correlated at 0.451, RFID technology can reduce cost in long term was correlated at 0.388, RFID technology can record multi data was correlated at 0.488, RFID technology easy to use was correlated at 0.563, and RFID technology flexible and compatibility in your business was correlated at 0.537.

5.3.3 Environment Factors

Referred to environment context was explained in the arena in which an organization conducts its business such as competitors, customers' requirement, access to resources supplied by others, and support from organization. Environment factors can be decomposed into external pressure, external support, and uncertainty. The environment pressure may come in different forms including legislation, government and business mandate, market pressure, and competitor pressure which have affect on RFID technology adoption (Hossain & Quaddus, 2011). Environmental conditions can have the impact on technology adoption 'innovation attributes' make RFID technology a suitable technology to meet the demands of the supply chain (Zhu et al., 2002).

This study revealed that the questions that represented a good fit for environment factors, which used to gain more information in organization factors that affect to RFID technology adoption that were accepted from Figure 4.9, which include are the availability of old systems facilitate to adopt RFID technology was correlated at 0.419, customers need to see your business adopt RFID technology was correlated at 0.514, the investment return in long term was correlated at 0.378, the impulsion from market and competitors was correlated at 0.437, the impulsion from customers' requirement was correlated at 0.477, organization has procedures how to use RFID technology was correlated at 0.474, organization support equipment in their business was correlated at 0.503, and organization provide training on how to use RFID technology was correlated at 0.377

5.3.4 OTE Framework

Refer to the OTE framework, which includes organization, technology, and environment factors. This theoretical framework is used to understand factors that affect to RFID technology adoption in logistics management to an improved business performance and business competency for Thai SMEs in agribusiness of fresh fruits and vegetables. This study revealed that the factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. Figure 4.6 revealed, firstly organizational factors was at 0.592 correlations and has 0.001 significantly the strongest relationships with RFID technology adoption of organization resulted that it was 0.563 from organization readiness to adopt RFID technology, 0.555 from the availability of capital investment, and 0.542 from the availability labor and staff. Secondly, the technological factor was correlated at 0.572 and was significantly at 0.001 with RFID technology adoption of organization, which resulted 0.534 from RFID technology efficiency worth the capital invested, 0.563 from RFID technology easy to use, and 0.537 from compatibility and flexible of RFID technology with organization. Lastly the environment factor was correlated at 0.525, and was significant at 0.003 with RFID technology adoption of organization, which resulted that 0.514 was from customers and competitors in the market, 0.503 was from organization support, and 0.477 was from customers, requirement to know the product information.

5.4 Summary

This research focused on an RFID technology that was adopted and factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. Referred to research background RFID technology is one popular tool to help and believed to be innovative that they adopt, especially in the large industry sector but RFID technology is not still popular used and adopted amongst many small and medium enterprises because the organizations worries on

cost and knowledge of RFID technology to make they not dare to invest on RFID technology. But also technologies are widely recognized that are critical factors in the supply chain because technology can improve the performance in their business in supply chain (Jin, 2006). This study revealed the qualitative data were analyzed to gain more a general understanding, which included type of business, business size, major product of their business, logistics activities that was adopted RFID technology, reasons that they adopted RFID technology. The quantitative data were used to identify factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. The research began with the development of a conceptual framework, which was adopted the OTE framework includes organization, technology, and environment factors used to understand factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables. The literature review was then used would guide the data collection process. The main research question is

"What are factors that affect to RFID technology adoption in the logistics management to improved business performance and business competency for Thai SMEs agribusiness of fresh fruits and vegetables?"

The study shown the data derived in data collection process was interpreted in both qualitative and quantitative approaches and they were analyzed information from the data collection (Chapter 3). The qualitative data were analyzed to gain a general understanding of findings by using thematic coding and narrative method was used to explain what happened consequently. Themes included type of business, business size, major product of their business, logistics activities that was adopted RFID technology, reasons that they adopted RFID technology. The quantitative data were used to identify factors that affect to RFID technology adoption. The study used the Statistical Package for the Social Science (SPSS) program to analyzed quantitative data. Firstly paired samples t-test was used to test questions in each major factor to identify strong questions that affect to other relevant major factors and affect to RFID technology adoption. Secondly, binary logistic analysis was used to identify factors that affect to RFID technology adoption. The identified factors include organizational,

technological, and environmental factors. They had significant numbers and correlation numbers to answer questions of study.

5.5 Limitations of The Research

Every research has some certain limitations and limitation can alter the outcomes of the research. In this research, the first limitation was a respondent's questionnaire, this study was conducted in Thai SMEs agribusiness of fresh fruits and vegetables in the northern part of Thailand, which this research collected less and small number of return respondents might be resulted to the outcomes in this study is not accurate.

Second, the respondents (the business owner, managers, and staffs) were concerned about providing information that might be accessed and used by their competitors such as sometime data about logistics activities or products that was adopted RFID technology. Face difficulty in accessing business information.

Third, the some respondents (the business owner, managers, and staffs) they are not really clear understand what is RFID technology, which resulted data that was collected some data not correct because actually in their business has adopted RFID technology but they are do not really clear understand that is RFID technology, which resulted to outcomes of research.

Finally, although particular limitations were identified into this research but these limitations have not affect to main study of this research.

5.6 Future Research

This research explored the most vital important reason that business adopted RFID technology into their businesses and RFID technology that was adopted to an improved performance and to support in logistics activities, which include factors that affect to RFID technology adoption in logistics management. The OTE framework were adopted to conceptual framework used to understand factors that affect to RFID

technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables.

Therefore, future research should further investigate the performance of RFID technology that was adopted in Thai SMEs agribusiness of fresh fruits and vegetables to give more information to businesses owner or people who are interested in RFID technology adoption to improve their business performance and business competency.

Secondly, the OTE framework provided the three main factors include are organizational, technological, and environmental factors that affect to RFID adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables, which in businesses sector might have many factors that we need to consider. Future research might explore factors that affect to RFID technology adoption and adopted the OTE framework used for provided main factors and maybe explore other factors that affect to RFID technology adoption such as instructor factors, product factors, and external factors.

Thirdly, this research influence as a basic understanding for further research that explores factors that affect to RFID adoption in logistics management to improved business performance and business competency in Thai SMEs in other businesses sector, using the OTE framework, which includes organization, technology, and environment factors. There are still some industries in Thailand such as the Thai SMEs agribusiness of frozen foods, and SMEs agribusiness of dried fruit, which this methodology adopted in those businesses, should enable them to better understand their issues and see ways to resolve them.

Finally, business performance management along the food supply chain is an interesting area that needs to be explored future. The efficiency food supply chain not only technology that was adopted but food supply chain need to consider in other parts to improve business performance such as suppliers' relationship management, organizations collaboration that lead to efficiency supply chain.

5.7 Conclusion

The conclusion of this study will be mention the background of this study that the 70 percent of food production in food supply chain come from efficiency improving technology because 50 percent of worldwide food production requires appropriate management in food supply chain (Schmidhuber, 2010). In recent years, a technology such as RFID technology has been taken an important role in the food supply chain management to improve the logistics performance and support logistics activities to reduce cost, time, and risk. Various technologies have been popular use in the industry sector and business to facilitate their operation and functions (Finkenzeller, 2010), which includes agribusiness of fresh fruits and vegetables. Small and medium enterprises (SMEs) initiated from policy by Thai government to boost the private sectors in small business of Thailand (Mingmalairaks, 2011), which this policy caused new business and included agribusiness of fresh fruits and vegetables resulted in having high competitive environment afterward in business sector. The consequences made business owner to seek out for tools to help their business to be able to compete with their competitors in the market. RFID technology is one popular tool to help and believed to be innovative that they adopt, especially in the large industry sector. However, RFID technology is not still popular used and adopted amongst many small and medium enterprises. But also, technology are widely recognized as being critical factors in the supply chain because of the contribution they can make to improve the performance of both the individual organization and of the supply chain as a whole (Jin, 2006). Therefore, this research sought to find the factors that affect to RFID technology adoption, which OTE framework was used to understand factors that affect to RFID technology adoption in logistics management to improved business performance and business competency in Thai SMEs agribusiness of fresh fruits and vegetables.

This study has showed the most vital important reason that business adopted RFID technology into their businesses was because they were aware of the importance of technology. The other reason was because the agribusiness of fresh fruits and vegetables businesses adopted the RFID technology wanted to improve

their business performance and business competency and its business process efficiency. The OTE framework was used to understand and identify significant factors that affect to adopt the RFID technology. The findings of this study revealed that not only organization factors were major factors for its adoption, but the adoption also includes technological and environmental factors.

Therefore, Thai SMEs in agribusiness of fresh fruits and vegetables and those who are interested RFID technology should realize that, positive attitude towards technology should be developed amongst employees and staff members within the organization to promote their understanding and the benefit of the implementation of technology within an organization. The organization should prepare their people to be ready for a new change and ensure that the readiness, for new technology is available, capital investment is ready to take place, and the level of labor and staff readiness for technological improvement has to be viable. These are factors that affect on RFID technology in logistics management to an improve business performance and business competency for Thai SMEs in agribusiness of fresh fruits and vegetables.
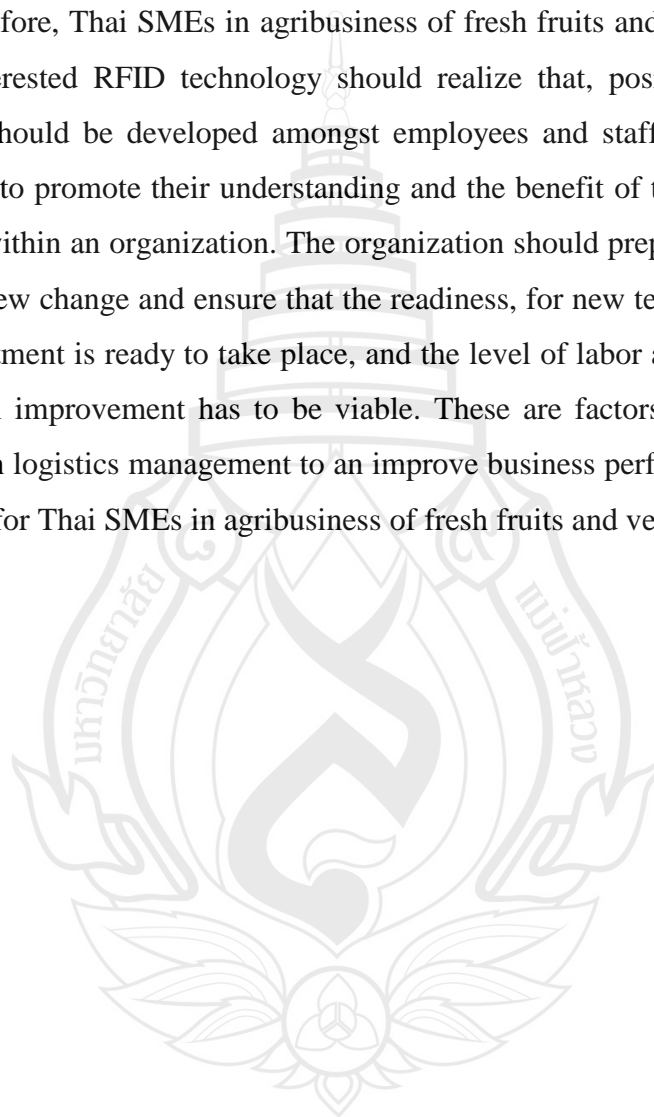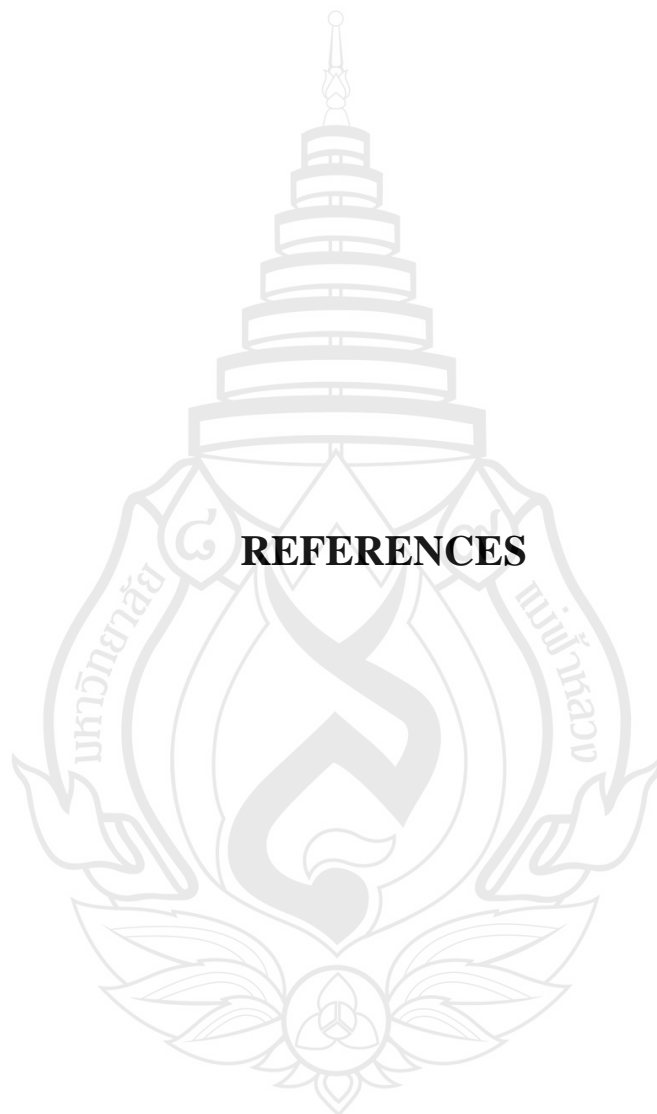
REFERENCES

REFERENCES

Alexandratos, N., & Bruinsma, J. (2012). *World agriculture towards 2030/2050: the 2012* revision: ESA Working paper.

Amaratunga, D., Baldry, D., Sarshar, M., & Newton, R. (2002). Quantitative and qualitative research in the built environment: application of "mixed" research approach. *Work Study, 51*(1), 17-31.

Andersen, T. J., & Segars, A. H. (2001). The impact of IT on decision structure and firm performance: evidence from the textile and apparel industry. *Information & Management, 39*(2), 85-100.

Anderson, J. (1982). Logistic regression. *Handbook of Statistics. North-Holland, New York*, 169-191.

ASEAN.org. (2013). ASEAN Economic Community, Retrieved July 19, 2013, from http://www.asean.org/communities

Bartlett, P. A., Julien, D. M., & Baines, T. S. (2007). Improving supply chain performance through improved visibility. *The International Journal of Logistics Management,, 18*(2), 294-313.

Bottani, E., & Rizzi, A. (2008). Economical assessment of the impact of RFID technology and EPC system on the fast-moving consumer goods supply chain. *International Journal of Production Economics, 112*(2), 548-569.

Bourlakis, M., Vlachos, I., & Zeimpekis, V. (2011a). Retail technologies in the agrifood chain. *Intelligent Agrifood Chains and Networks*, 27-38.

Bourlakis, M., Vlachos, I. P., & Zeimpekis, V. (2011b). *Intelligent agrifood chains and networks*: Retrieved March 17, 2013, from Wiley Online Library.

Bourlakis, M. A., & Weightman, P. W. (2004). *Food supply chain management*: Retrieved March 20, 2013, from Wiley Online Library.

Brace, I. (1904). *Questionnaire design: How to plan, structure, and write survey material for effective market research* (Vol. 1): London: Kogan Page Ltd.

Chavananikul, V. (2013). Food traceability in Thailand. *RFID Institute of Thailand*.

Chen, R. S., Chen, C., Yeh, K., Chen, Y., & Kuo, C. (2008). Using RFID technology in food produce traceability. *WSEAS Transactions on Information Science and Applications, 5*(11), 1551-1560.

Christopher, M. (1999). Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Service Financial Times. London: Pitman Publishing.

Cooper, M. C., Lambert, D. M., & Pagh, J. D. (1997). Supply chain management: more than a new name for logistics. *International Journal of Logistics Management, The, 8*(1), 1-14.

Crawford, J., Howell, D. C., & Garthwaite, P. H. (1998). Payne and Jones revisited: estimating the abnormality of test score differences using a modified paired samples t test. *Journal of Clinical and Experimental Neuropsychology, 20*(6), 898-905.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*: United States of America: Sage.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*: United States of America: Sage.

CSCMP. (2007). Council of Supply Chain Management Professionals.

Da Silva, C. A. (2009). *Agro-industries for development*: United States of America: CABI.

Dawe, R. L. (1994). An investigation of the pace and determination of information technology use in the manufacturing materials logistics system: a case study of Northern California's electronics manufacturers. *Journal of Business logistics, 1994 (1), 229-259.*

Denzin, N. K., & Lincoln, Y. S. (2000). The discipline and practice of qualitative research. *Handbook of Qualitative Research, 2*, 1-28.

Douligeris, C., & Tilipakis, N. (2006). A knowledge management paradigm in the supply chain. *EuroMed Journal of Business, 1*(1), 66-83.

Eastham, J., Sharples, L., & Ball, S. (2001). *Food Supply Chain Management*: United Kingdom: Routledge.

Elliott, J. (2005). *Using narrative in social research: Qualitative and quantitative approaches*: United States of America: Sage.

Emma, N. (2005). Food and Livestock Traceability–Forecasts, Needs, and Best Practices. *IDTechEx Technique Report*.

Erdem, F., & Erdem, S. (2011). Functional strategies and practices of small and medium-sized family businesses. *International Journal of Islamic and Middle Eastern Finance and Management, 4*(2), 174-185.

Esper, T. L., Fugate, B. S., & Davis-Sramek, B. (2007). Logistics learning capability: sustaining the competitive advantage gained through logistics leverage. *Journal of Business Logistics, 28*(2), 57-82.

Finkenzeller, K. (2010). *RFID handbook: fundamentals and applications in contactless smart cards, radio frequency identification and near-field communication*: United Kingdom: Wiley.

Hilbe, J. M. (2009). *Logistic regression models*: United States of America: CRC Press Boca Raton.

Hoepfl, M. C. (Ed.). (1997). *Choosing qualitative research: A primer for technology education researchers*: United States: Electronic Journals.

Hopkins, W. G. (2008) *Quantitative research design*. New Zealand: University of Otago.

Hossain, M. A., & Quaddus, M. (2011). The adoption and continued usage intention of RFID: an integrated framework. *Information Technology & People, 24*(3), 236-256.

Ivanaj, V., & Franzil, Y. M. (2006). *Outsourcing logistics activities: a transaction cost economics perspective.* Paper presented at the XVeme Conference Internationale de Management Strategique, Annecy (Geneve. 13-16 Juin 2006).

Jeter. (2013). Key Logistics Activities. (Logistics in the Economiy and organization).

Jin, B. (2006). Performance implications of information technology implementation in an apparel supply chain. *Supply Chain Management: An International Journal, 11*(4), 309-316.

Jones, P., Clarke-Hill, C., Hillier, D., & Comfort, D. (2005). The benefits, challenges and impacts of radio frequency identification technology (RFID) for retailers in the UK. *Marketing Intelligence & Planning, 23*(4), 395-402.

Kearney, A. (2003). Meeting the retail RFID mandate—A discussion of the issues facing CPG companies. *http://www. rfidconsultation. eu/docs/ficheiros/ATK_Meeting_the_Retail_RFID_Mandate. pdf. Last access, 31*, 2009.

King, G., Keohane, R. O., & Verba, S. (1994). *Designing social inquiry: Scientific inference in qualitative research*: Princeton University Press.

King, J. E. (2008). Binary logistic regression. *Best practices in quantitative methods*, 358-384.

Koh, C. E., Kim, H. J., & Kim, E. Y. (2006). The impact of RFID in retail industry: issues and critical success factors. *Journal of Shopping Center Research, 13*(1), 101-117.

La Londe, B. J., & Masters, J. M. (1994). Emerging logistics strategies: blueprints for the next century. *International Journal of Physical Distribution & Logistics Management, 24*(7), 35-47.

Landt, J. (2001). Shrouds of Time: The history of RFID.

Langley, C. J., Gibson, B. J., & Novack, R. A. (2008). *Supply chain management: a logistics perspective*: Cengage Learning.

Li, S., Visich, J. K., Khumawala, B. M., & Zhang, C. (2006). Radio frequency identification technology: applications, technical challenges and strategies. *Sensor Review, 26*(3), 193-202.

Liang, K.-Y., & Zeger, S. L. (1993). Regression analysis for correlated data. *Annual review of public health, 14*(1), 43-68.

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2001). Defining supply chain management. *Journal of Business logistics, 22*(2), 1-25.

Mingmalairaks, P. (2011). *Innovation Adoption in Thai SMEs.* RMIT University.

Morgan, G., & Smircich, L. (1980). The case for qualitative research. *Academy of management review, 5*(4), 491-500.

Nambiar, A. N. (2009). *RFID technology: A review of its applications.* Paper presented at the Proceedings of the world congress on engineering and computer science.

Nandy, K., Helle, S., Liski, A., & Liski, E. (2010). Optimal Designs for Binary Logistic Regression with a Qualitative Classifier with Independent Levels. *Communications in Statistics-Simulation and Computation, 39*(10), 1962-1977.

Neuman, L. W. (2007). *Social Research Methods, 6/E*: Pearson Education India.

Ngamsukkasamesri, W., & Wanghatai, S. (2012). RFID Solution for Transportation Management. *RFID Institute of Thailand*.

Oppenheim, A. N. (2000). *Questionnaire design, interviewing and attitude measurement*: Continuum International Publishing Group.

OSMEP. (2013). ASEAN to bring information technology to support the management of industrial SMEs in the South. (ASEAN to bring information technology to support the management of industrial SMEs in the South).

Patterson, K. A., Grimm, C. M., & Corsi, T. M. (2003). Adopting new technologies for supply chain management. *Transportation Research Part E: Logistics and Transportation Review, 39*(2), 95-121.

Petter, S., DeLone, W., & McLean, E. (2008). Measuring information systems success: models, dimensions, measures, and interrelationships. *European Journal of Information Systems, 17*(3), 236-263.

Pope, C., Ziebland, S., & Mays, N. (2000). Qualitative research in health care: Analysing qualitative data. *BMJ: British Medical Journal, 320*(7227), 114.

Prater, E., Frazier, G. V., & Reyes, P. M. (2005). Future impacts of RFID on e-supply chains in grocery retailing. *Supply Chain Management: An International Journal, 10*(2), 134-142.

Pullman, M., & Wu, Z. (2012). *Food supply chain management: Economic, social and environmental perspectives*: Routledge.

Riessman, C. K. (2003). Analysis of personal narratives. *Inside interviewing: New lenses, new concerns*, 331-346.

Ruiz García, L., & Lunadei, L. (2010). Monitoring cold chain logistics by means of RFID.

Russell, R. S., & Taylor-Iii, B. W. (2008). *Operations management along the supply chain*: Wiley. com.

Sachan, A., & Datta, S. (2005). Review of supply chain management and logistics research. *International Journal of Physical Distribution & Logistics Management, 35*(9), 664-705.

Salin, V. (1998). Information technology in agri-food supply chains. *The International Food and Agribusiness Management Review, 1*(3), 329-334.

Samuels, M. L., Witmer, J. A., & Schaffner, A. (2012). *Statistics for the life sciences*: Pearson Education.

Schiefer, G. (2004). New technologies and their impact on the agri-food sector: an economists view. *Computers and Electronics in Agriculture, 43*(2), 163-172.

Schmidhuber, J. (2010). World Agriculture: Towards 2015/2030. *Rome: Food and Agriculture Organization*.

Simchi-Levi, D. S.-L., & Philip Kaminsky, E. (2009). Designing and Managing The Supply Chain: Concepts, Strategies, and Case Studies-3/E.

Simmons, J. (2010). *Food economics and consumer choice.* Paper presented at the Proceedings Four-State Dairy Nutrition & Management Conference. Dubuque, Iowa.

Smith, A. D. (2005). Exploring the inherent benefits of RFID and automated self-serve checkouts in a B2C environment. *International Journal of Business Information Systems, 1*(1), 149-181.

Stock, J. R., & Lambert, D. M. (2001). Strategic logistics management.

Tan, K. C. (2001). A framework of supply chain management literature. *European Journal of Purchasing & Supply Management, 7*(1), 39-48.

Thorne, S. (2000). Data analysis in qualitative research. *Evidence Based Nursing, 3*(3), 68-70.

Timmermans, A. (2006). Agri-supply chain management.

Tornatzky, L. G., Fleischer, M., & Chakrabarti, A. K. (1990). *The processes of technological innovation* (Vol. 273): Lexington Books Lexington, MA.

Tseng, Y.-y., Yue, W. L., & Taylor, M. A. (2005). *The role of transportation in logistics chain*.

Tzeng, S.-F., Chen, W.-H., & Pai, F.-Y. (2008). Evaluating the business value of RFID: evidence from five case studies. *International Journal of Production Economics, 112*(2), 601-613.

Van Roekel, J., Willems, S., & Boselie, D. M. (2002). *Agri-Supply Chain Management to Stimulate Cross-Border Trade in Developing Countries and Emerging Economies*: World bank.

Var, I. (1998). Multivariate data analysis. *vectors, 8*, 6.

Wamba, F. S., Bendavid, Y., Lefebvre, L. A., & Lefebvre, E. (2006). RFID technology and the EPC network as enablers of mobile business: a case study in a retail supply chain. *International journal of networking and virtual organisations, 3*(4), 450-462.

Want, R. (1991). RFID: A key to automating everything. *Scientific American, 10*.

Wen, L., Zailani, S., & Fernando, Y. (2009). Determinants of RFID adoption in supply chain among manufacturing companies in China: a discriminant analysis. *Journal of technology management & innovation, 4*(1), 22-32.

Yamane, T. (1963). *Mathematics for economists: an elementary survey*: Prentice-Hall.

Yao, W., Chu, C.-H., & Li, Z. (2010). *The use of RFID in healthcare: Benefits and barriers.* Paper presented at the RFID-Technology and Applications (RFID-TA), 2010 IEEE International Conference on.

Yu, S.-C. (2007). RFID implementation and benefits in libraries. *Electronic Library, The, 25*(1), 54-64.

Zhu, K., Kraemer, K. L., & Xu, S. (2002). A cross-country study of electronic business adoption using the technology-organization-environment framework.

APPENDIX

APPENDIX A

SURVEY

A1 Letter of ask for permission for the survey questionnaire (Thai)

เรื่อง   ขอความอนุเคราะห์เก็บข้อมูลแบบสอบถามเพื่อการวิจัย

เรียน   ผู้จัดการ / เจ้าของสถานประกอบการ

        เนื่องด้วย นายกรวิทย์ ฟักคง นักศึกษาระดับปริญญามหาบัณฑิต สาขาวิชาการจัดการ โลจิสติกส์และซัพพลายเชน สำนักวิชาการจัดการ มหาวิทยาลัยแม่ฟ้าหลวง   ง ได้รับอนุมัติให้ทำวิทยานิพนธ์ เรื่อง "กลยุทธ์การเลือกใช้เทคโนโลยีอาร์เอฟ ไอดี (RFID) ในกิจกรรมโลจิสติกส์สำหรับผู้ประกอบการธุรกิจเกษตรผักและผลไม้สดในธุรกิจขนาดเล็กและขนาดกลาง   " (RFID STRATEGIC IN LOGISTICS ACTIVITIES FOR AGRIBUSINESS OF FRESH FRUITS AND VEGETABLE IN THAI SMEs)" โดยมีวัตถุประสงค์ในการศึกษาถึงกลยุทธ์และปัจจัยการเลื อกใช้งานเทคโนโลยี RFID ในธุรกิจเกษตรผักและผลไม้สดของธุรกิจเกษตรขนาดเล็กและขนาดใหญ่ โดยมีท่านอาจารย์ ดร.สุเทพ นิ่มสาย เป็นอาจารย์ที่ปรึกษาวิทยานิพนธ์

        ในการนี้ นักศึกษามีความจำเป็นที่จะต้องทำการเก็บรวบรวมข้อมูลเพื่อใช้ในการศึกษาวิจัย จึงใคร่ขอความอนุ   เคราะห์ท่าน ในการกรอกข้อมูลที่เกี่ยวกับการดำเนินธุรกิจของสถานประกอบการของท่าน

        จึงเรียนมาเพื่อโปรดพิจารณา และ ขอขอบพระคุณเป็นอย่างสูงมา ณ โอกาสนี้

                                ขอแสดงความนับถือ

                                (ดร.สุเทพ นิ่มสาย)
                ประธานกรรมการบริหารหลักสูตรบริหารธุรกิจมหาบัณฑิต
                        สาขาการจัดการ โลจิสติกส์และซัพพายเชน

A2 Questionnaire (Thai)

MAE FAH LUANG UNIVERSITY

แบบสำรวจเรื่องกลยุทธ์การเลือกใช้เทคโนโลยีอาร์เอฟไอดี (RFID) สำหรับผู้ประกอบการธุรกิจเกษตรผักและผลไม้สดในธุรกิจขนาดเล็กและขนาดกลาง

วัตถุประสงค์แบบสำรวจนี้ จัดทำขึ้นเพื่อใช้ในการรวบรวมข้อมูลสำหรับงานวิจัยภายใต้หัวข้องานวิจัย "กลยุทธ์การเลือกใช้เทคโนโลยีอาร์เอฟไอดี (RFID) ในกิจกรรมโลจิสติกส์สำหรับผู้ประกอบการธุรกิจเกษตรผักและผลไม้สดในธุรกิจขนาดเล็กและขนาดกลาง" (RFID STRATEGY IN LOGISTICS ACTIVITIES FOR THAI SMEs AGRIBUSINESS OF FRESH FRUITS AND VEGETABLE) โดยมีวัตถุประสงค์ในการศึกษาถึงกลยุทธ์และปัจจัยการเลือกใช้งานเทคโนโลยี RFID ในธุรกิจเกษตรผักและผลไม้สดของธุรกิจเกษตรขนาดเล็กและขนาดใหญ่ ข้าพเจ้าขอขอบพระคุณยิ่งที่ท่านได้สละเวลาให้ข้อมูล ที่เป็นประโยชน์ต่องานวิจัยและจะเป็นประโยชน์อย่างมากต่อการพัฒนาประสิทธิภาพของการจัดการประสิทธิภาพภายในธุรกิจเกษตรผักและผลไม้สดของไทยในอนาคต การสำรวจข้อมูลในครั้งนี้เป็นส่วนหนึ่งของการทำโครงการวิจัยชั้นปีสุดท้ายของนิสิตระดับมหาบัณฑิต สาขาการจัดการโลจิสติกส์และซัพพลายเชน สำนักวิชาการจัดการมหาวิทยาลัยแม่ฟ้าหลวง โดยแบบสำรวจในครั้งนี้แบ่งออกเป็น 5 ส่วน ดังต่อไปนี้

ตัวอย่างของเทคโนโลยี RFID ที่มีการประยุกต์ใช้งานในธุรกิจเกษตร

กรณีการประยุกต์ใช้งานเทคโนโลยี RFID ในธุรกิจพืชผักสดจากโครงการหลวง โดยการติด Tag กับตะกร้าใหญ่แล้วกระจายสู่ตะกร้าเล็กเพื่อทำการตัดแต่ง แล้วนำสู่สายพานและบรรจุเป็นแพ็คย่อยซึ่งจะถูกเปลี่ยนเป็นบาร์โค้ด (Barcode) ข้อมูลทั้งหมดจะถูกเก็บไว้ในเซิร์ฟเวอร์จึงสามารถตรวจสอบย้อนกลับ (Traceability) ได้ตั้งแต่ จุดผลิต ซึ่งจะมีส่วนช่วยประหยัดต้นทุนค่าแรงงานที่ต้องใช้ในการจดข้อมูลสินค้าและลดความผิดพลาดที่เกิดจากคนหรือ Human Error

ส่วนที่ 1 ข้อมูลทั่วไปของสถานประกอบการ (ร้านค้า / บริษัท)

1.1 ประเภทของสถานประกอบการ (ร้านค้า / บริษัท)

❑ ธุรกิจค้าส่ง-ปลีกภายในประเทศ ❑ ร้านค้าสมัยใหม่ (Modern trade)

❑ ตัวแทนจำหน่าย ❑ อื่นๆ (โปรดระบุ).................................

❑ ธุรกิจนำเข้า - ส่งออก

1.2 สถานะภาพของผู้ตอบแบบสอบถาม

❑ เจ้าของกิจการ ❑ อื่นๆ (โปรดระบุ).................................

❑ พนักงาน / ผู้ใช้งาน

1.3 ประเภทของสินค้าที่จัดจำหน่ายหรือรับซื้อ

❑ ผักและผลไม้สด ❑ ผลไม้สด

❑ ผักสด ❑ อื่นๆ (โปรดระบุ).................................

1.4 เงินทุนจดทะเบียน

❑ ต่ำกว่า 50 ล้านบาท ❑ มากกว่า 200 ล้านบาท

❑ 51-200 ล้านบาท ❑ อื่นๆ (โปรดระบุ).................................

1.5 จำนวนพนักงานของสถานประกอบการ (ร้านค้า / บริษัท)

❑ ต่ำกว่า 50 คน ❑ มากกว่า 200 คน

❑ 51-200 คน ❑ อื่นๆ (โปรดระบุ).................................

1.6 ระยะเวลาในการดำเนินงานและประสบการณ์ของสถานประกอบการ (ร้านค้า / บริษัท)

❑ ต่ำกว่า 5 ปี ❑ มากกว่า 15 ปี

❑ 6-15 ปี ❑ อื่นๆ (โปรดระบุ).................................

ส่วนที่ 2 ข้อมูลเกี่ยวกับการประยุกต์ใช้งานเทคโนโลยี RFIDในสถานประกอบการ (ร้านค้า / บริษัท)

2.1 สถานประกอบการ (ร้านค้า / บริษัท) ของท่านมีการนำเทคโนโลยี RFID มาใช้งานหรือไม่

    ❑ มี (ระยะเวลาที่ใช้งาน...................ปี)   ❑ ไม่มี (ไม่มีข้ามไปทำข้อ 2.5)

2.2 สถานประกอบการ (ร้านค้า / บริษัท) ของท่านนำเทคโนโลยี RFID มาใช้ในกิจกรรมอะไรบ้างใน การดำเนินงาน (ตอบได้มากกว่า 1 ช่อง)

❑ กิจกรรมการบริการลูกค้า	❑ กิจกรรมการจัดการคำสั่งซื้อของลูกค้า
❑ กิจกรรมบริการสินค้าคงคลัง	❑ กิจกรรมการคาดการณ์ความต้องการ
❑ กิจกรรมการบริหารคลังสินค้า	❑ กิจกรรมสนับสนุนการบริการและอะไหล่
❑ กิจกรรมการจัดซื้อ	❑ กิจกรรมการเลือกทำเลที่ตั้งโรงงานธุรกิจ
❑ กิจกรรมการขนส่ง	❑ กิจกรรมการเคลื่อนย้ายวัตถุดิบและสินค้า
❑ กิจกรรมบรรจุภัณฑ์	❑ กิจกรรมย้อนกลับของวัตถุดิบหรือสินค้า
❑ กิจกรรมการติดต่อสื่อสาร	❑ อื่นๆ (โปรดระบุ)...................................

2.3 อะไรที่เป็นเหตุผลหลักที่ท่านทำเทคโนโลยี RFID มาใช้ในธุรกิจของท่าน (ตอบได้มากกว่า 1)

❑ เพื่อข้อมูลที่ชัดเจนและมีคุณภาพ	❑ เพื่อการตรวจสอบย้อนกลับของสินค้า
❑ เพื่อลดต้นทุนในการดำเนินงาน	❑ เพื่อลดการจ้างงานในกิจกรรมที่ไม่จำเป็น
❑ เพื่อลดระยะเวลาในการดำเนินงาน	❑ เพื่อเพิ่มประสิทธิภาพในการขนส่ง
❑ เพื่อความสะดวกในการควบคุมสินค้า	❑ เพื่อตอบสนองความต้องการของลูกค้า
	❑ อื่นๆ (โปรดระบุ)...................................

2.4 สถานประกอบการ (ร้านค้า / บริษัท) ของท่านนำเทคโนโลยี RFID ประเภทใดมาประยุกต์ใช้ งาน

    ❑ RFID Tag แบบ Passive   ❑ RFID Tag แบบ Active

    ❑ RFID Tag แบบ Semi-active/Semi-passive   ❑ อื่นๆ (โปรดระบุ)......................

2.5 สถานประกอบการ (ร้านค้า / บริษัท) ของท่านมีการนำเทคโนโลยีอื่นๆ มาใช้หรือไม่ (กรุณาโปรด ระบุ)

....

....

ส่วนที่ 3 ข้อมูลปัจจัยด้านองค์กรที่ส่งผลต่อการตัดสินใจในการนำเทคโนโลยี RFID มาใช้

ปัจจัยด้านองค์กร	ระดับของความสำคัญ				
	5 มากที่สุด	4 มาก	3 ปานกลาง	2 น้อย	1 น้อยที่สุด
1. ท่านมีความพึงพอใจต่อการใช้เทคโนโลยี RFID ในการดำเนินงาน					
2. ความพร้อมขององค์กร (ร้านค้าหรือบริษัท) ในการนำเทคโนโลยี RFID มาใช้งาน					
3. ความพร้อมของตัวบุคลากร (พนักงาน), ความรู้ความเชียวชาญในการนำเทคโนโลยี RFID มาประยุกต์ใช้งาน					
4. ความพร้อมด้านเงินทุนในการลงทุนติดตั้งเทคโนโลยี RFID ในร้านค้าหรือบริษัท					
5. ความพร้อมในสายการผลิตหรือการดำเนินงานของสินค้าในร้านค้าหรือบริษัท					
6. ผู้บริหารเล็งเห็นประโยชน์จากการใช้งานเทคโนโลยี RFID					
7. ผู้บริหารคอยสนับสนุนและกระตุ้นให้มีการใช้งานเทคโนโลยี RFID					
8. ผู้บริหารจัดเตรียมความช่วยเหลือ และสิ่งอำนวยความสะดวกที่จำเป็นในการใช้เทคโนโลยี RFID					
9. พนักงานมีความรู้และความชำนาญในการใช้งานเทคโนโลยี RFID					
10. ขนาดองค์กรเหมาะสมที่ใช้เทคโนโลยี RFID ในการดำเนินงาน					
11. สภาพแวดล้อมขององค์กรช่วยให้การทำงานของเทคโนโลยี RFID มีประสิทธิภาพ					

ส่วนที่ 4 ข้อมูลด้านปัจจัยด้านเทคโนโลยีที่ส่งผลต่อการตัดสินใจในการนำเทคโนโลยี RFID มาใช้

ปัจจัยด้านเทคโนโลยี	ระดับของความสำคัญ				
	5 มากที่สุด	4 มาก	3 ปานกลาง	2 น้อย	1 น้อยที่สุด
1. เทคโนโลยี RFID ช่วยให้การดำเนินธุรกิจสะดวกขึ้น					
2. เทคโนโลยี RFID เป็นปัจจัยหนึ่งที่มีส่วนต่อความสำเร็จในธุรกิจ					
3. เทคโนโลยี RFID มีส่วนทำให้พนักงานปฏิบัติงานได้อย่างมีประสิทธิภาพมากขึ้น					
4. เทคโนโลยี RFID มีผลดีต่อการบริหารจัดการกิจกรรมโลจิสติกส์					
5. เทคโนโลยี RFID สามารถรองรับกับความต้องการหรือการเปลี่ยนแปลงที่จะเกิดขึ้นได้ภายในองค์กร (บริษัท) เพื่อให้เข้ากับเหตุการณ์ได้					
6. เทคโนโลยี RFID มีส่วนต่อการช่วยธุรกิจในการตอบสนองความต้องการของลูกค้า					
7. ประสิทธิภาพของเทคโนโลยี RFID คุ้มกับที่ลงทุนติดตั้งในร้านค้าหรือบริษัท					
8. ความทนทานของเทคโนโลยี RFID ในทุกสภาวะการทำงาน					
9. เทคโนโลยี RFID สามารถช่วยประหยัดหรือลดระยะเวลาในการตรวจสอบสินค้า					
10. เทคโนโลยี RFID สามารถช่วยลดต้นทุนการดำเนินงานในระยะยาว					
11. ความสามารถในการอ่านสินค้าได้พร้อมๆกันหลายๆชิ้น					
12. ข้อมูลจากเทคโนโลยี RFID มีความน่าเชื่อถือ					
13. เทคโนโลยี RFID มีประสิทธิภาพมากกว่าบาร์โค้ด					
14. ความสามารถในการบันทึกข้อมูลที่หลากหลาย					
15. ข้อมูลจากเทคโนโลยี RFID สามารถช่วยให้ลูกค้ามีความเชื่อมั่นและรับรู้ถึงสินค้าของท่านมากขึ้น					
16. ราคาต้นทุนและค่าซ่อมแซมของเทคโนโลยี RFID					
17. เทคโนโลยี RFID ง่ายต่อการใช้งาน					
18. เทคโนโลยี RFID ยืดหยุ่นสามารถปรับแต่งให้เหมาะสมกับองค์กร					

ส่วนที่ 5 ข้อมูลปัจจัยด้านสิ่งแวดล้อมที่ส่งผลต่อการตัดสินใจในการนำเทคโนโลยี RFID มาใช้

ปัจจัยจากสิ่งแวดล้อมภายในและภายนอก	ระดับของความสำคัญ				
	5 มากที่สุด	4 มาก	3 ปานกลาง	2 น้อย	1 น้อยที่สุด
1. ความพร้อมของระบบงานแบบเดิมที่ เอื้ออำนวยต่อการนำเทคโนโลยี RFID มาประยุกต์ใช้งาน					
2. ลูกค้ามีความต้องการที่จะให้ร้านค้าหรือบริษัทของท่านนำเทคโนโลยี RFID มาใช้งาน					
3. ผลตอบแทนในระยะยาวจากการลงทุนเลือกใช้งานเทคโนโลยี RFID					
4. การคำนึงถึงสิ่งแวดล้อมเช่น ลดการใช้กระดาษ, ลดการใช้พลังงานจาก การทำงานซ้ำซ้อน					
5. แรงผลักดันจากภาคธุรกิจระหว่างคู่ค้าในธุรกิจของท่าน					
6. แรงผลักดันจากทางด้านตลาดร่วมถึงการแข่งขันที่สูงขึ้น					
7. แรกผลักดันจากคู่แข่งทางธุรกิจในตลาด					
8. แรกผลักดันจากความต้องการของลูกค้าที่ต้องการ ได้รับข้อมูลเกี่ยวกับสินค้ามากขึ้นและชัดเจน					
9. องค์กรมีขั้นตอนและวิธีการใช้งานเทคโนโลยี RFID ที่เข้าใจและชัดเจนให้กับพนักงาน					
10. องค์กรมีเครื่องมือในการอำนวยความสะดวกในการใช้งานเทคโนโลยี RFID ในการดำเนินงาน					
11. องค์กรมีการจัดอบรมให้ความรู้เกี่ยวกับการใช้งานเทคโนโลยี					

APPENDIX B

STATISTIC TABLE

Table B1 T-test of organization factors with RFID technology adoption

	t-test for equality of means				
	t	df	Sig. (2tailed)	Mean difference	Std. Error difference
O1	-2.828	28	0.009	-0.900	0.318
	-2.825	18.05	0.011	-0.900	0.319
O2	-3.604	28	0.001	-1.200	0.333
	-4.368	27.07	0.000	-1.200	0.281
O3	-3.411	28	0.002	-1.200	0.352
	-4.107	27.60	0.000	-1.200	0.292
O4	-3.532	28	0.001	-1.600	0.453
	-4.292	27.81	0.000	-1.600	0.373
O5	-2.763	28	0.010	-1.050	0.380
	-3.243	26.71	0.003	-1.050	0.324
O6	-1.624	28	0.116	-0.500	0.308
	-1.874	25.94	0.072	-0.500	0.267
O7	-2.763	28	0.010	-0.900	0.326
	-3.512	27.67	0.002	-0.900	0.256
O8	-2.996	28	0.006	-1.000	0.334
	-3.826	27.52	0.001	-1.000	0.261
O9	-2.528	28	0.017	-1.000	0.396
	-2.762	22.87	0.011	-1.000	0.362
O10	-3.366	28	0.002	-1.250	0.371
	-3.920	26.38	0.001	-1.250	0.319
O11	-3.287	28	0.003	-1.100	0.335
	-3.899	27.13	0.001	-1.100	0.282

Table B2 T-test of technology factors with RFID technology adoption

| | t-test for equality of means | | | | |
	t	df	Sig. (2tailed)	Mean difference	Std. Error difference
T1	-1.887	28	0.070	-0.550	0.291
	-2.476	26.29	0.020	-0.550	0.222
T2	-2.158	28	0.040	-0.750	0.348
	-2.502	26.16	0.019	-0.750	0.300
T3	-1.539	28	0.135	-0.500	0.325
	-1.636	21.31	0.116	-0.500	0.306
T4	-3.144	28	0.004	-0.900	0.286
	-3.630	25.97	0.001	-0.900	0.248
T5	-1.110	28	0.276	-0.350	0.315
	-1.243	24.28	0.226	-0.350	0.282
T6	-2.792	28	0.009	-0.900	0.322
	-3.028	22.46	0.006	-0.900	0.297
T7	-3.338	28	0.002	-1.150	0.344
	-4.101	27.96	0.000	-1.150	0.280
T8	-3.034	28	0.005	-0.850	0.280
	-3.955	26.65	0.001	-0.850	0.215
T9	-2.675	28	0.012	-0.800	0.299
	-2.792	20.30	0.011	-0.800	0.287
T10	-2.231	28	0.034	-0.650	0.291
	-2.524	24.90	0.018	-0.650	0.257
T11	-1.535	28	0.136	-0.500	0.326
	-1.584	19.69	0.129	-0.500	0.316
T12	-1.687	28	0.103	-0.600	0.356
	-1.903	24.71	0.069	-0.600	0.315
T13	-1.999	28	0.055	-0.700	0.350
	-2.505	27.93	0.018	-0.700	0.279
T14	-2.956	28	0.006	-0.900	0.304
	-3.484	26.89	0.002	-0.900	0.258
T15	-1.736	28	0.094	-0.600	0.346
	-1.963	24.85	0.061	-0.600	0.306
T16	-0.997	28	0.327	-0.300	0.301
	-1.202	27.64	0.240	-0.300	0.250
T17	-3.603	28	0.001	-1.050	0.291
	-4.078	24.90	0.000	-1.050	0.257
T18	-3.367	28	0.002	-1.050	0.312
	-3.753	24.04	0.001	-1.050	0.280

Table B3 T-test of organization factors with RFID technology adoption

	t-test for equality of means				
	t	**df**	**Sig. (2tailed)**	**Mean difference**	**Std. Error difference**
E1	-2.445	28	0.021	-0.900	0.368
	-2.447	18.15	0.025	-0.900	0.368
E2	-3.173	28	0.004	-1.200	0.378
	-3.589	24.87	0.001	-1.200	0.334
E3	-2.158	28	0.040	-0.750	0.348
	-2.502	26.16	0.19	-0.750	0.300
E4	-0.766	28	0.450	-0.300	0.391
	-0.758	17.58	0.459	-0.300	0.396
E5	-1.854	28	0.074	-0.700	0.377
	-2.208	27.26	0.036	-0.700	0.317
E6	-2.570	28	0.016	0.900	0.350
	-3.221	27.93	0.003	-0.900	0.279
E7	-1.747	28	0.092	-0.650	0.372
	-2.136	27.91	0.042	-0.650	0.304
E8	-2.872	28	0.008	-1.050	0.366
	-3.272	25.27	0.003	-1.050	0.321
E9	-2.849	28	0.008	-1.050	0.369
	-3.367	26.99	0.002	-1.050	0.312
E10	-3.081	28	0.005	-1.100	0.357
	-3.604	26.58	0.001	-1.100	0.305
E11	-2.155	28	0.040	-0.850	0.394
	-2.343	22.62	0.028	-0.850	0.363

Table B4 T-test of three main factors with RFID technology adoption

RFID technology adoption		N	Mean	Std. Deviation	Std. Error Mean
Organization factors	Have	10	4.0900	0.44083	0.13940
	Don't have	20	2.9700	0.84983	0.19003
Technology factors	Have	10	4.3000	0.38873	0.12293
	Don't have	20	3.4000	0.71525	0.15993
Environment factors	Have	10	3.9750	0.26874	0.08498
	Don't have	20	3.0000	0.91766	0.20520

Table B5 T-test for equality of means

	t-test for equality of means				
	t	df	Sig. (2tailed)	Mean difference	Std. Error difference
Organization factors	3.890	28	0.001	1.12000	0.28789
	4.752	27.89	0.000	1.12000	0.23568
Technology factors	3.694	28	0.001	0.90000	0.24363
	4.462	27.68	0.000	0.90000	0.20172
Environment factors	3.265	28	0.003	0.97500	0.29866
	4.390	24.55	0.000	0.97500	0.22210

APPENDIX C

CONFERENCE PAPER

RFID STRATEGY IN LOGISTICS ACTIVITIES FOR THAI SMEs AGRIBUSINESS OF FRESH FRUITS AND VEGETABLES

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Abstract

Nowadays, 70 percent of food supply chain comes from an efficient improving technology and resulted in an important role of food supply chain management. The Thai SMEs agribusiness such as fresh fruits and vegetables adopt more appropriate supply chain technology to provide better service to their customers recently. The aim of this research was to understand the RFID technology adoption in Thai SMEs agribusiness of fresh fruits and vegetables and to understand factors that affect to RFID technology adoption in logistics management to improved business performance and business competency for Thai SMEs agribusiness of fresh fruits and vegetable is of vital important. A mixed research method is applied to this study which both qualitative and quantitative approaches were adopted semi-structured interview and questionnaires were used to answer questions of study. Sample group are Thai SMEs agribusinesses of fresh fruits and vegetables in the northern part of Thailand. The finding of this study reveals that technology factor, organization factor, and environment

factors are main factors that affect on RFID technology adoption in Thai SMEs agribusiness of fresh fruits and vegetables. Moreover, expectations the RFID technology will be useful for people who are interested in fresh fruits and vegetables agribusiness.

*Keywords***:** RFID technology, Logistics activities, Agribusiness, Fresh fruits and vegetables

Introduction

Nowadays, the global number of population is growing and the climate has been changing [1]. There are about one billion poverty people around the world and these numbers of population affect to agriculture products requirements [2]. The Food Economic and Consumer Choice Research forecasted that there would be more food requirements in the next 50 years required by the world population. This would be resulted by an increased in a need of food capacity in 100 percent of today food productions to meet customers' consumption and demand. Besides, 70 percent of food production in food supply chain comes from efficiency improving technology because 50 percent of worldwide food production requires appropriate management in food supply chain [3].

Recent, a technology such as RFID technology has been taken an important role in the food supply chain management to improve the logistics performance and support logistics activities to reduce time, cost and risk. Various technologies such as information technology and RFID technology as a one type of automatics

identification technology, which include food sector, have been popular used in the industry and businesses to facilitate their operations and functions [4]. RFID technology has been adopted in the supply chain management, automotive, tracking animal, and the protection theft system, material handling in inventory and includes food traceability. Food safety in industry sectors and small and medium enterprises refer to agriculture foods industry worldwide, which was interested in a rising of problems of food supply chain including increased globalization and competition of food products, strict requirements on quality assurance, reliability in food provisioning and consumer trust sustainability [5]. These are main reasons that make industries and stakeholders find ways to prevent and manage this provision issue to apply technology into agriculture foods supply chain [6].

Small and medium enterprises (SMEs) are initiated from policy by the Thai government to boost the private sector in small business of Thailand [7]. This policy caused new businesses, which included agribusiness of fresh fruits and

vegetable and resulted in having high competitive environment afterward in the business sector. The consequences made business owners to seek out for tools to help their businesses to be able to compete with their competitors in the market. RFID technology is one popular tool and innovative that they adopted, especially in the large industry sector. However, RFID technology is not still popular used and adopted amongst many small and medium enterprises. But also, technology are widely recognized as being critical factors in the supply chain because of the contribution they can make to improve the performance of both the individual organization and of the supply chain as a whole [8].

Therefore, this paper focuses on factors that affect on RFID technology adoption in logistics management to improved business performance and business competency for Thai SMEs agribusiness of fresh fruits and vegetable.

Figure 1.1 Conceptual framework
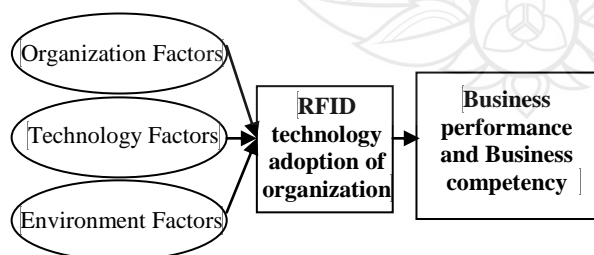
Figure 1.1 demonstrates the conceptual frameworks used in this study, which were organization, technology, and environment factors. This study aims to understand factors that affect to RFID technology adoption for Thai SMEs agribusiness of fresh fruits and vegetables, which are developed in their business to improved business performance.

Literature Review

Supply chain management

Supply chain is the movement of materials as they flow from their source to the end customer [9]. When different actor are linked from "farm to customer" such supply chain may include growers, picker, packer, processes, storage and transportation facilitators, exporters, importers, distributors, wholesalers and retailers [10].

Figure 2.1 Fresh produce supply chain
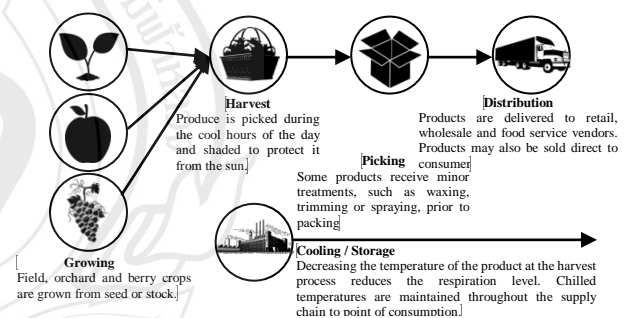
Source: Food supply chain management [11]

Figure 2.1 shows supply chain for fresh products, which includes fruits and vegetables and both are perishable product [11]. The shelf life of product depends on the supply chain's ability and efficiency to transport fresh goods to consumers, after the harvest process.

Timmermans explains that in the fresh fruits and vegetables supply chain in

Thailand, Thai consumers spend an increase proportion of consumption of fresh fruits and vegetables [12]. The observation and literature revealed that most products were sold in traditional markets and supermarkets. Therefore, supply chain of fresh fruits and vegetables in Thailand is of vital important need to be developed to serve the customer demand, which was regularly increase in consumption.

RFID technology

RFID technology was firstly used around World War 2 it was used to identify friendly aircraft [4]. In recent years, RFID technology was implemented in many supply chains and across industries to improve of their efficiency supply chains. RFID technology is a type of automatic identification technology and RFID technology is one of the ten largest supporting systems in the 21th century [13]. RFID technology offered the opportunity to allow all supply chain members to identify, track, trace and manage each product as well as to provide information in real time [14]. Food producers, manufacturers, distribution, transportation, retailers and regulatory agencies were ready to use RFID technology with the objective of increasing food product visibility and quality within supply chain [6].

The RFID technology was used in many industry sectors and business group implementations [15]. This was to improve accuracy of data and speed of data collection along their supply chains. The accuracy of data was to reduce human error in their task activities as well as to better track expiration dates of foods and theft prevention in premises. The speed of data was related to less handling required, easy to inventory count and multi object scanning. These were resulted in supply chain efficiency [16]. The business that utilize RFID technology benefit to improvement in productivity, reduction cycle time, reduce work and control of assets and thus increase in revenues.

Logistics activities

Logistics activities are parts of supply chain processes, which include storage of goods and services, and related information from point of origin to the point of consumption in order to meet customer demand. Logistics activities include internal and external activities that support connect activities within an organization to downward customers to run smoothly [17].

Jeter explains logistics activities are key activities required to facilitate the flow of a product from point of origin to point of consumption, which these activities, considered part of the overall logistics process, which are customer service, demand forecast and planning, inventory

management, logistics communication, material handling, order processing, packaging, parts and services support, and traffic and transportation [18]. Christopher identified logistics activities into 12 activities, which are customer services, demand forecast, inventory management, material handling, packaging, warehousing and store, traffic and transportation, parts and services support, reverse logistics, procurement, location selection, and order processing [19]. Therefore, this research adopted these theoretical logistics activities, which used to understand the logistics activities that were adopted the RFID technology in Thai SMEs agribusiness of fresh fruits and vegetables.

Organizational, technological, and environmental framework (OTE framework)

Tornatzky and Fleischer developed a framework that explored organizational, technological, and environmental factors in a specific context that referred to OTE framework [20]. These factors are used as the scope and framework for this study, which identified the contexts that influence the process by which the organization adopts and implements technological innovation, organizational context, technological context, and environmental context.

Organizational context was defined in terms of several descriptive measures such as business size, organization structure,

organization management styles, and the quality of human resource. Technological context described both the internal and external technologies relevant to the organization, which includes existing technologies within the organization such as efficiency, information quality, and compatibility. Environmental context was explained in the arena in which an organization conducts its business such as competitors, customers' requirement, access to resources supplied by others, and support from organization.

Although specific factors identified within the three contexts may vary across different studies, the organization, technology, and environment framework has a solid theoretical basis, consistent empirical support, and promise of applying to other IS innovation domains [21]. Therefore, this research adopted this theoretical framework and extended it to the RFID technology adoption, which used to understand factors that affect to RFID technology adoption in logistics management to improved business performance in Thai SMEs agribusiness of fresh fruits and vegetables.

Research Methods

A mixed research method is applied to this study. Both qualitative and quantitative data were collected by using both in-depth interview and questionnaire to answer questions of this study.

Qualitative data was used to understand why local organizations adopt RFID technology for the logistics activities in their agribusiness of fresh fruits and vegetable industry. Quantitative data was used to analyze and confirm those factors that affect to RFID technology adoption in logistics adoption for Thai SMEs agribusiness of fresh fruits and vegetable.

Population and sample

Population of this paper comprised Thai SMEs agribusiness of fresh fruits and vegetables in the northern part of Thailand.

Samples in this research were 30 business owners from Thai SMEs agribusiness of fresh fruits and vegetables in the northern part of Thailand, which includes Chianf Rai, Chiang Mai, Phrae, Mae Hong Son, Phayao, and Lmpang [22].

Research Tools

A set of semi-structured question is used in the interview and questionnaire to gain more data of RFID technology adoption and include factors that affect to RFID technology adoption in logistics management to improved business performance for Thai SMEs agribusiness of fresh fruits and vegetables.

A questionnaire survey was developed by using the conceptual framework to understand the RFID adoption for the Thai SMEs agribusiness

of fresh fruits and vegetables and the factors that affect to RFID technology adoption in logistics management in Thai SMEs agribusiness of fresh fruits and vegetables. Organization factors, technology factors, and environment factors used to describe factors that affect to agribusiness to decision to adopt RFID technology in their business to improved business performance and business competency.

Data analysis

Data derived in data collection process were interpreted in both qualitative and quantitative approaches and they were analyzed information in an academic report format.

Qualitative data were analyzed to gain a general understanding of findings by using thematic coding and narrative method was used to explain what happened consequently. Themes included type of business, business size, major product of their business, logistics activities that was adopted RFID technology, reasons that they adopted RFID technology.

Quantitative data were used to identify factors that affect to RFID technology adoption. The study used the Statistical Package for the Social Science (SPSS) program to analyzed quantitative data. Firstly paired samples t-test was used to test questions in each major factor to

identify strong questions that affect to other relevant major factors and affect to RFID technology adoption. Secondly, binary logistic analysis was used to identify factors that affect to RFID technology adoption. The identified factors include organizational, technological, and environmental factors. They had significant numbers and correlation numbers to answer questions of study.

Results and Discussion

There were 30 businesses respondents from Thai SMEs agribusiness of fresh fruits and vegetables in the northern part of Thailand, which were 60% from retailer-wholesalers, 6.67% from dealer, 26.67% from import-export companies, 3.33% from modern trade, and other 3.33%, were from agriculturist group in Samoeng, Chiang Mai province.

Amongst respondents business, 40% were from fresh fruit businesses, 33.33% were from fresh vegetable businesses, and 26.67% are from both fresh fruit and vegetable businesses, which constitute 63.33% small businesses, 13.33% medium businesses, and 13.33% of large businesses, according to the office of small and medium enterprises promotion to classified the business size [22].**Figure 4.1: Number of business has adopt RFID**
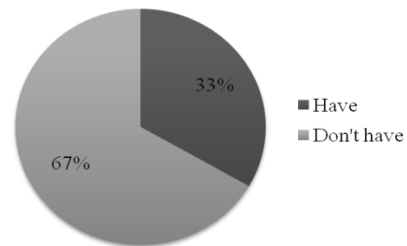

Figure 4.1 demonstrates the number of businesses that adopted RFID technology into their businesses. There was 33% of respondents adopted RFID technology whilst others 67% have not yet decided to adopt RFID technology into their business operations.
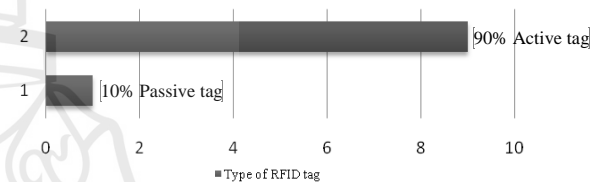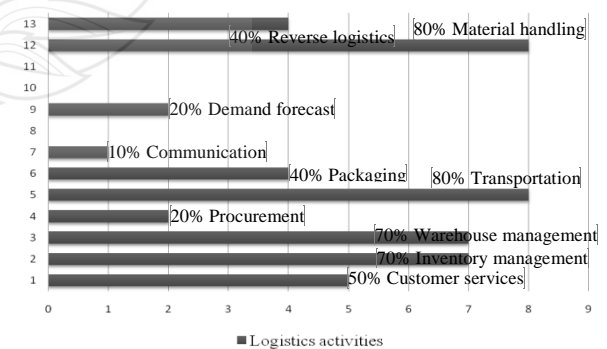
Figure 4.2: Types of RFID tag

Figure 4.2 demonstrates the type of RFID tag that was adopted in Thai SMEs agribusiness of fresh fruits and vegetables most are active tag, which was accounted for 90% of respondent's business. Others 10% were considered as passive tag.

Figure 4.3: Logistics activities adopted RFID

The logistics activities found that adopted and used RFID technology were as follows: 80% used in material handling;

80% in transportation; 70% used in warehouse management and inventory management ; 50% used in customer services; 40% used in packaging and reverse logistics; 20% used in procurement and demand forecast; and other 10% used communication process respectively.

Figure 4.4: Reason that adopt RFID technology
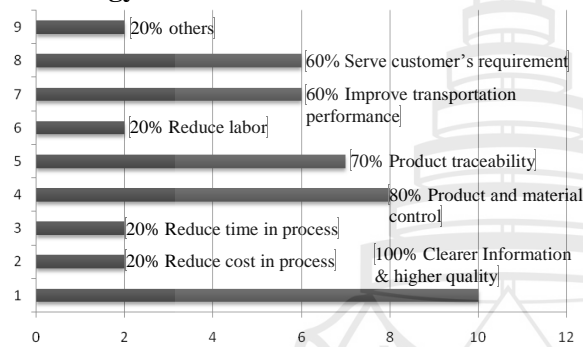
There were many reasons that agribusiness of fresh fruits and vegetables businesses adopt the RFID technology. Firstly, it was because the RFID technology provided a clearer information and higher quality. Secondly, it was found that 80% the RFID technology facilitate the product and material handling process. Thirdly, it was found that 70% product traceability. Fourthly, it was found that 60% improve transportation performance. Fifthly, it was found that 60% served customer's requirement. Sixthly, it was found that 20% reduced cost and time in process. Lastly, it was found 20% referred as they were from others reason.

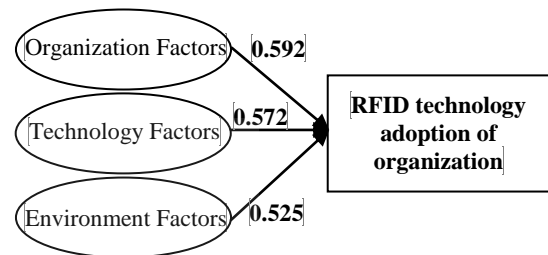**Figure 4.5: RFID technology adoption**

Figure 4.5 was referred to the OTE framework, which includes organization, technology, and environment factors. This theoretical framework used to understand factors that affect to RFID technology adoption in logistics management to an improved business performance and business competency for Thai SMEs in agribusiness of fresh fruits and vegetables. The findings of this study revealed, firstly organizational factor was at 0.592 correlations and has 0.001 significantly the strongest relationships with RFID technology adoption of organization resulted that it was 0.563 from organization readiness to adopt RFID technology, 0.555 from the availability of capital investment, and 0.542 from the availability labor and staff. Secondly, the technological factor was correlated at 0.572 and was significantly at 0.001 with RFID technology adoption of organization, which resulted 0.534 from RFID technology efficiency worth the capital invested, 0.511 from RFID technology relate with improved logistics

performance, and 0.479 from compatibility of RFID technology with organization and product. Lastly the environment factor was correlated at 0.525, and was significant at 0.003 with RFID technology adoption of organization, which resulted that 0.514 was from customers and competitors in the market, 0.503 was from organization support, and 0.477 was from customers, requirement to know the product information.

Therefore, organization factor was the strongest relationship factors that affect to RFID technology adoption in logistics management to an improved business performance and competency in Thai SMEs in agribusiness of fresh fruits and vegetables. The OTE framework provided data that was not only organization factors, but also included technology and environment factors that affected to RFID technology adoption to an improved business performance and competency in Thai SMEs agribusiness of fresh fruits and vegetables.

Conclusions

This study has showed the most vital important reason that business adopted RFID technology into their businesses was because they were aware of the importance of technology. The other reason was because the agribusiness of fresh fruits and vegetables businesses adopted the RFID technology wanted to

improve their business performance and business competency and its business process efficiency. The OTE framework was used to understand and identify significant factors that affect to adopt the RFID technology. The findings of this study revealed that not only organization factors were major factors for its adoption, but the adoption also includes technological and environmental factors.

Therefore, Thai SMEs in agribusiness of fresh fruits and vegetables and who are interested RFID technology should realize that, positive attitude towards technology should be developed amongst employees and staff members within the organization to promote their understanding and the benefit of the implementation of technology within an organization. The organization should prepare their people to be ready for the new change and ensure that the readiness, for new technology is available, capital investment is ready to take place and the level of labor and staff readiness for technological improvement has to be viable. These are factors that affect on RFID technology in logistics management to an improve business performance and business competency for Thai SMEs in agribusiness of fresh fruits and vegetables.

References

[1] Alexandratos, N. and J. Bruinsma, *World agriculture towards 2030/2050: the 2012 revision*. 2012, ESA Working paper.

[2] Simmons, J. *Food economics and consumer choice*. in *Proceedings Four-State Dairy Nutrition & Management Conference. Dubuque, Iowa*. 2010.

[3] Schmidhuber, J., *World Agriculture: Towards 2015/2030*. Rome: Food and Agriculture Organization, 2010.

[4] Finkenzeller, K., *RFID handbook: fundamentals and applications in contactless smart cards, radio frequency identification and near-field communication*. 2010: Wiley.

[5] Schiefer, G., *New technologies and their impact on the agri-food sector: an economists view*. Computers and Electronics in Agriculture, 2004. **43**(2): p. 163-172.

[6] Bourlakis, M., I.P. Vlachos, and V. Zeimpekis, *Intelligent agrifood chains and networks*. 2011: Wiley Online Library.

[7] Mingmalairaks, P., *Innovation Adoption in Thai SMEs*. 2011, RMIT University.

[8] Jin, B., *Performance implications of information technology implementation in an apparel supply chain*. Supply Chain Management: An International Journal, 2006. **11**(4): p. 309-316.

[9] Douligeris, C. and N. Tilipakis, *A knowledge management paradigm in the supply chain*. EuroMed Journal of Business, 2006. **1**(1): p. 66-83.

[10] Van Roekel, J., S. Willems, and D.M. Boselie, *Agri-Supply Chain Management to Stimulate Cross-Border Trade in Developing Countries and Emerging Economies*. 2002: World bank.

[11] Pullman, M. and Z. Wu, *Food supply chain management: Economic, social and environmental perspectives*. 2012: Routledge.

[12] Timmermans, A., *Agri-supply chain management*. 2006.

[13] Bourlakis, M.A. and P.W.H. Weightman, *Food supply chain management*. 2004: Wiley Online Library.

[14] Bourlakis, M., I. Vlachos, and V. Zeimpekis, *Retail technologies in the agrifood chain*. Intelligent Agrifood Chains and Networks, 2011: p. 27.

[15] Tzeng, S.-F., W.-H. Chen, and F.-Y. Pai, *Evaluating the business value of RFID: evidence from five case studies*. International Journal of Production Economics, 2008. **112**(2): p. 601-613.

[16] Simchi-Levi, D., E. Simchi-Levi, and P. Kaminsky, *Designing and managing the supply chain: Concepts, strategies, and cases*. 1999: McGraw-Hill Companies.

[17]Stock, J.R. and D.M. Lambert, *Strategic logistics management.* 2001.

[18]Jeter, *Key Logistics Activities.* 2013(Logistics in the Economiy and organization).

[19]Christopher, M., *Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Service Financial Times: Pitman Publishing. London, 1998 ISBN 0 273 63049 0 (hardback) 294+ 1× pp.* 1999.

[20]Tornatzky, L.G., M. Fleischer, and A.K. Chakrabarti, *The processes of technological innovation.* Vol. 273. 1990: Lexington Books Lexington, MA.

[21]Zhu, K., K.L. Kraemer, and S. Xu, *A cross-country study of electronic business adoption using the technology-organization-environment framework.* 2002.

[22]OSMEP, *ASEAN to bring information technology to support the management of industrial SMEs in the South.* 2013(ASEAN to bring information technology to support the management of industrial SMEs in the South).
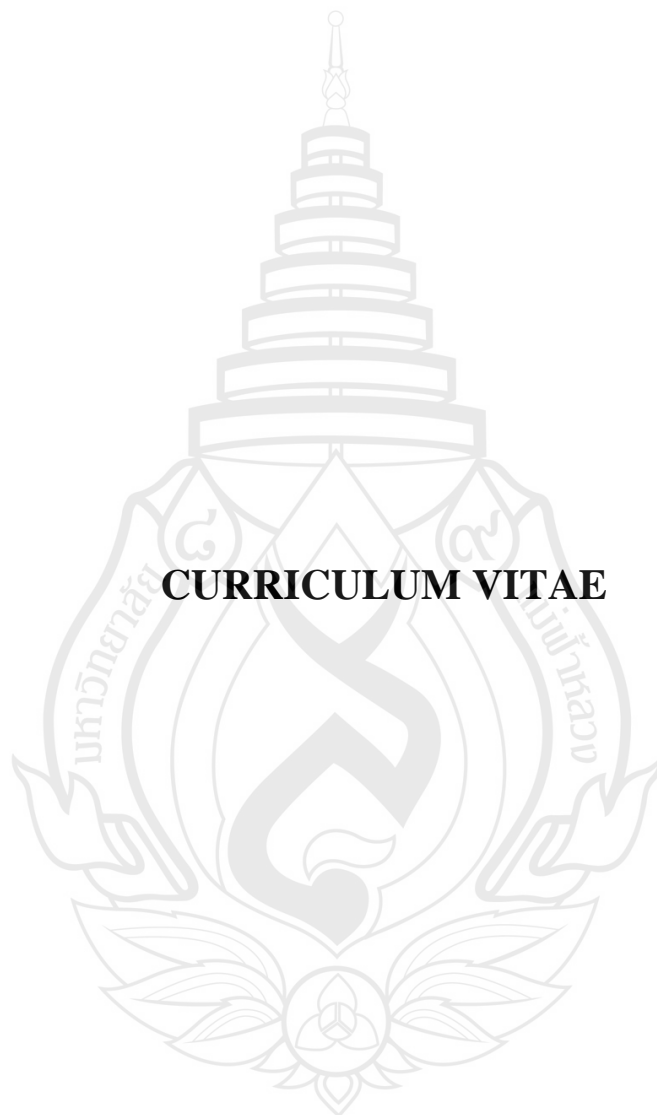
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