RADIO FREQUENCY IDENTIFICATION (RFID) AND ITS IMPACTS ON LOGISTICS ACTIVITIES

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Degree Thesis
International Busniess
2017

DEGREE THESIS	
Arcada	
DegreeProgramme:	International Business
Identificationnumber:	6249
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Title:	Radio frequency identification (RFID) and its impacts on logistics activities
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Commissioned by:	

Abstract:
The competitive business environment nowadays creates a great pressure on companies. Especially in logistics operations, it requires them to adopt technology in order to innovate the process and create better logistics integration systems. Thus, the solution is to implement radio frequency identification (RFID) technology. The purpose of this thesis is to understand the current use of RFID technology, its major benefits and concerns when it comes to RFID implementation and examine the possible improvement for these concerns. In order to understand an overview of RFID technology and its integration in logistics system, RFID technology introduction, the benefits of the technology in logistics activities and its concern are presented in the theoretical framework. The author reached the aim of the thesis using qualitative and quantitative methods, both survey questionnaire and interview were conducted. The survey questionnaire was sent to the top 100 third-party logistics providers in 2017, such as C.H.Robinson, CEVA Logistics, Coyote Logistics, DHL Supply Chain, FedEx Supply Chain, Kuehne + Nagel, Schneider, UPS, etc. The list of the top 100 companies was conducted by Inbound Logistics 2017. The interview was conducted with Sami Isomäki, who is a Technology Manager of RFIDLab Finland ry. The results of this study help to find out the major issues that hesitate logistics companies from widely implementing RFID technology and examine the possible solutions for these issues. The current use of RFID technology is recognized as stable and positive. In logistics, RFID technology is mainly used to support the inventory management. All the logistics providers strongly agreed that the increase in information visibility and real-time data, better tracking and inventory control are the major benefits. The most significant concerns of RFID implementation are cost of implementation, global standard issues and data management issues. There are possible solutions for these concerns, however it is not easy to achieve. RFID technology is believed to be strongly developed in the future and the future relation between RFID technology and barcode will be equally used in logistics chain for a long time.

Keywords:	RFID, Logistics, Logistics activities.
Numberof pages:	
Language:	English
Date ofacceptance:	

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List of Abbreviations

3PL	Third-party logistics
EIS	Enterprise Information System
EPC	Electronic product code
ERP	Enterprise Resources Planning
HF	High Frequency
LF	Low frequency
RFID	Radio frequency identification
UHF	Ultra high frequency

1. Introduction

1.1. Background

Technology is known as a critical tool in developing effective, efficient and competitive operation. Information technology allows accessing in information processing in real time (Rajaraman 2013) and automation technology is able to enhance speed and accuracy (Mehta et al. 2014). The development of new technologies creates great opportunities and advantages in different functional areas of business, including logistics and logistics activities. In logistics, Radio Frequency Identification (RFID) technology is implemented as automatic identification technology, which helps to track inventory more efficiently and to provide visibility of all assets in real time (Sweeney II 2010). Due to the non-contact reading, no human intervention and real-time information visibility features of RFID, the technology plays an important role in various logistics activities, and accurately increases the speed of identification, material, and information flow. As the result, the performance and competitiveness of operations potentially enhance by RFID technology.

Even though RFID technology was developed in the 1940s and it has a great impact on logistics and logistics activities in tracking and access applications, the use of the technology is limited due to certain issues (Thornton et al. 2006). These concerns are the barriers that not only lead organizations to hesitate in implementing RFID technology but also impact on the technology's growth. According to Lee (2008 p.51-53), the barriers in RFID technology include high implementation cost (infrastructure and storage facilities), low return on investment (ROI), lack of global standards and regulations, technical issue, political issue and consumer privacy violation issue.

The purpose of this study is to understand the impacts of RFID on different activities in logistics, determine logistics organizations' motivations and barriers in RFID implementation, and from the collected barriers of RFID, examine the solutions in order to optimize RFID uses in logistics systems. The study is carried out by collecting data from the survey questionnaires and the interview with the third-party logistics (3PL) companies in order to understand their motivation in RFID implementation and identify their most significant concern about the technology. After identifying companies' most concerns based on the survey response scale, the solutions for these

barriers are investigated by the interview with RFID vendor who develops the technology. The methodology of this thesis is explained more clearly in chapter 2.

1.2. Research Aim

The aim of this thesis is to understand the current benefits of RFID technology in logistics activities, the barriers in RFID implementation based on companies' perspective, and to find the solution for the most significant concern among RFID issues. All the information and data collected from RFID vendor developing the technology and companies having experience in RFID implementation will be analyzed in order to give an insight into the present status, issues and solutions of the technology.

1.3. Research Questions

RFID technology carries a great advantage in data gathering and real-time visibility of these data as well as some certain limitations, which lead to huge impacts on logistics and logistics activities (Jones & Chung 2007). In order to reach the aim of this thesis, the following research questions will be answered:

How is RFID technology currently used in logistics activities?

What are the motivations and the most significant concerns in RFID implementation?

How can logistics companies and RFID vendors find out the solution to overcome the barriers of RFID technology?

1.4. Demarcation

This research focuses on analyzing the current situation of RFID technology in logistics activities, understanding the motivation of companies who implement RFID technology, and finding out the most significant concern related to RFID issues and the solutions for these barriers.

The limitation of the research is that it only examines RFID technology in logistics activities of the top 100 third-party logistics (3PL) providers in 2017, which is published in the July 2017

issue (Inbound Logistics 2017). That being said, data collected from the survey and interview falls among this top 100 3PL providers, and RFID technology in other businesses, which do not belong to logistics activities will not be considered.

1.5. Structure of study

The research is primarily divided into two main parts, the first part introduces the theoretical framework drawn from secondary sources and the second part which acquires from empirical research containing the result of survey and interviews.

The first part of this research begins with an introductory chapter providing an overview of the topic, the aim and purpose of this study, and its limitation. This is followed by the research method including the techniques and methods adopted in order to obtain primary data and secondary data. The third chapter gives an introduction of RFID technology, its history, general components of a basic RFID system. The fourth and fifth chapters provide the advantages of RFID applications in logistics activities and the certain RFID issues and challenges.

In the second part of this research, answers from survey questionnaires and interviews in chapter six are explained and presented in details. These data are then analyzed and discussed in chapter seven before the conclusions are drawn.

1.6. Literature review

The literature from the field of logistics system, activities in logistics and the basic literature of RFID technology provide resources to answer the above research questions.

According to Raj et al. (2009), logistics activities can benefit from the use of information technology. These technological advances allows the reduction of distribution cost in various logistics activities such as order processing, warehousing, shipping, delivery and payment.

Luo (2012) shows that the emerging of technology in logistics can enhance the efficiency of operation in optimizing the time and space in logistics activities. With the advanced technologies such as information technology, automatic technology, logistics operations are not only able to create their own competitiveness but also the advantages in various logistics activities.

Lai & Cheng (2016) provides the important value of logistics activities, which maintains the flexibility in processing a logistics system. These logistics are divided into primary and supporting activities. Following by the general information of RFID technology introduced by Sanghera (2011) and Roussos (2008).

After introducing the general components of a basic RFID system and determining the core activities in logistics, the great impacts of RFID technology on these core logistics activities are closely examined. White paper (2011) shows the benefits of RFID in visibility in logistics. Jones and Chung (2016) provide the advantage of inventory control such as automatic replenishment and safety stock management. Jones et al. also shows that RFID allows warehousing to be optimized in specific functions such as storage, picking and packing, shipping. The benefits of RFID in order fulfillment are given by Sabbaghi and Vaidyanathan (2008). Sweeney II (2010) shows that RFID tags allow organization to maximize efficiency in logistics process by automatically checking shipment and optimizing cross-docking.

Besides the benefits of RFID on logistics activities, certain barriers of the technology are also provided. Thornton et al. (2006), Daniel Hunt et al. (2007) and Ngai et al. (2009) concern about the threat and security issues that organizations should aware of. Other concerns include privacy issues, cost of implementation, standards issue, return on investment (ROI), data management and lack of knowledge.

2. Methodology

2.1. Research method

In the theoretical framework, the basic introduction of RFID technology, its impacts on logistics activities and concerns about the technology were based on the already academic literature available, RFID journals, online sources and research papers.

In the empirical section, a mixed method is used to achieve a deep understanding of the research problem. Mixed method is the combination of both qualitative and quantitative approaches in a single study in order to collect data, analyze data (Johnson et al. 2007).

The survey questionnaire was conducted based on the information provided in the theoretical framework. The main purpose of the survey was to identify and capture the major barriers of RFID implementation in logistics operations and to understand their motivation in deploying it, which mainly aimed to answer the above research questions.

The survey questionnaire was designed as a Likert scale, which is a "rating scale used for measuring attitudes" (Jupp 2006). As aforementioned in chapter 1, the survey questionnaires were sent to the top 100 third-party logistics (3PL) providers 2017, such as C.H.Robinson, CEVA Logistics, Coyote Logistics, DHL Supply Chain, FedEx Supply Chain, Kuehne + Nagel, Schneider, UPS via email using LimeSurvey. The list of the top 100 3PL providers 2017 was conducted by Inbound Logistics and published on July 2017 under the name "-2017- Annual third-party logistics issue" (Inbound Logistics 2017). Majority of these logistics providers have their area served globally and in the United States/ Canada/ Mexico, and their market served in manufacturing, retail, wholesale, e-business and transportation. The author reached this list on the website of Inbound logistics, the link to the full issue is presented in the references section. The list of the companies is presented in the appendix section.

3PL providers were suitable for the representative sample because 3PL companies are the providers of outsourced logistics operations and supply chain, they take care of a whole logistics system (APS fulfillment 2017).

After identifying the most significant concerns of RFID, the interview with RFIDLab Finland Ry, the institution developing RFID technology in Finland, was conducted in order to find out the possible solution for these barriers. Sami Isomäki, technology manager, on behalf of RFIDLab Finland Ry was chosen as an interviewee.

2.2. Data collection

Data used in this research based on three sources, the secondary sources, a survey, and the interviews.

The selection of the secondary sources based on several internet databases and academic literature in the library. In order to select and evaluate relevant literature, different academic literature available sources, RFID journals, online sources, research papers were also considered.

As aforementioned, data for the thesis was collected by the survey questionnaire, which contains 7 questions. The construction of the questionnaire and the concept of specific question are presented in the survey result section. A survey was conducted using online statistical survey web app - LimeSurvey. Based on the list of the top 100 third-party logistics providers 2017 provided by Inbound Logistics (2017), the author collected the general contact e-mails of each company from their official website. Some of the companies did not provide e-mails, but instructed the author to fill out the general inquiry. The author also reached out to individuals working in logistics and supply chain management or as technology manager in logistics. After collecting all needed contacts, the author started to send out the survey in January 2018. The author sent the invitation email with the link to the online survey to the collected e-mail contacts, general inquiry form from the companies' websites and specific personnel. The results from the respondents were anonymously collected through the online statistical app Limesurvey. Thus, the identity of companies who answered the survey questionnaire is unavailable. Among 100 sent out invitations, 37 companies answered the survey. The invitation letter is presented in the appendix section.

An interview with Sami Isomäki was conducted on Thursday 22nd March 2018. The interviewee gave an author permission to record a whole interview. Thus, the author was able to transcribe all important information in detail and rehear from the recorder multiple times if needed.

2.3. Data management, analysis, and interpretation

In LimeSurvey, the online survey provided the statistical feature. Thus the author used this feature to gain his visibility and overview of the collected results. The presentations and analysis of logistics operations' answers were based on this statistical feature under the column chart diagram.

The collected data from the survey was transcribed from the online statistical app LimeSurvey to Microsoft Excel spreadsheet for analysis. The answers to the 5-point Likert scale is coded as follow: 1= Strongly disagree/Not at all concerned, 2= Disagree/Slightly concerned, 3= Neutral/Somewhat concerned, 4= Agree/Moderately concerned, 5= Strongly agree/Extremely concerned. The author then used SPSS Statistics software to analyze the transcribed data from Microsoft Excel. Analysis was conducted using mean and proportion with confidence interval.

From the recorded interview, all information shared by Sami Isomäki was carefully transcribed to written text. Information provided by Sami Isomäki was analyzed together with the comparison to answers of logistics providers from the survey.

The collected data is presented in form of the diagram and written text in chapter 6. The discussion and analysis of gathered information and different discoveries from the data are presented in chapter 7.

3. RFID Technology

3.1. What is RFID?

Radio frequency identification (RFID) technology is adopted to take over other identification systems such as barcode. The basic principle of barcode is that it uses a unique number to identify the item, which is applied to various products that contain a number of items. In logistics and supply chain perspective, barcode plays an important role in helping manufacturers and retailers to control the quantity of sold products and accelerate the check out process. Unfortunately, barcode has some limitations such as the inability in identifying the specific item in that type; tracking must be done manually by scanning the barcode on every item; the only information contained in the barcode is a product type code; the information in the barcode cannot be changed or added. (Sanghera 2011 pp. 15-16)

Overall, barcode provides the identification of products. RFID is there to replace barcode with greater advantages.

RFID technology allows automatically identify tagged object in order to specify its location and read the information contained in the tag with little or no human intervention. All information collected from the tagged object will be entered wirelessly into the computing data by the radio frequency in RFID. (Roussos 2008 p. 1)

The wireless communication technology has many applications in the supply chain and in different item tracking (Daniel Hunt et al. 2007 p. 1). For example, supply chain crate and pallet tracking applications in Wal-mart; keyless entry in access control systems; automatic toll collection systems at the bridges or tunnels entrance; and animal tracking devices, etc.

3.2. History of RFID

The origin application of RFID technology had been started from the World War II. It was the system called "identify friend and foe" (IFF), which used electromagnetic transitions in order to differentiate aircraft from enemies'. (Roberti 2005)

RFID technology started to become reality in the 1960s, the first commercial was electronic article surveillance (EAS) tags. In the 1970s, the technology continued to develop with applications in animal tracking, factory automation, followed by widely industrial used in payment on toll road and bridge in the 1980s. (Landt and Catlin 2001 pp. 4-6)

The overall development of the technology is shown in "The decades of RFID" (Table 1).

Table 1. The decades of RFID (Lant & Catlin 2001 p. 7)

The Decades of RFID

Decade	Event
1940 - 1950	Radar refined and used, major World War II development effort. RFID invented in 1948.
1950 - 1960	Early explorations of RFID technology, laboratory experiments.
1960 - 1970	Development of the theory of RFID. Start of applications field trials.
1970 - 1980	Explosion of RFID development. Tests of RFID accelerate. Very early adopter implementations of RFID.
1980 - 1990	Commercial applications of RFID enter mainstream.
1990 - 2000	Emergence of standards. RFID widely deployed. RFID becomes a part of everyday life.

3.3. General components of a basic RFID system

According to Jones & Chung (2007 pp. 19-21), a basic RFID system includes following four fundamental components:

A Tag is attached to the object, which needs to be tracked on and a tag contains the unique information of this object.

A Reader generates the electromagnetic signal to process radio communication through the antennas and transfers the information from the tagged item to the outside world.

An Antenna enables the communication of a tag and a reader by transferring and receiving electromagnetic signal between them.

A Host is a computer system including middleware (a reader interface layer) and database software.

3.3.1. Tag

All RFID tag contains two fundamental parts including the tag antenna and the integrated circuit (IC, or chip) (Sweeney II 2010). The tag can only work when receiving some form of power. The power allows a tag to transfer information of a tagged object to the reader via the antenna. There are three types of tag including passive tags, active tags, and semi-passive tags.

Thornton et al. (2006 p. 15) also provides the figure shown the processes of Passive and Active Tag (Figure 1)

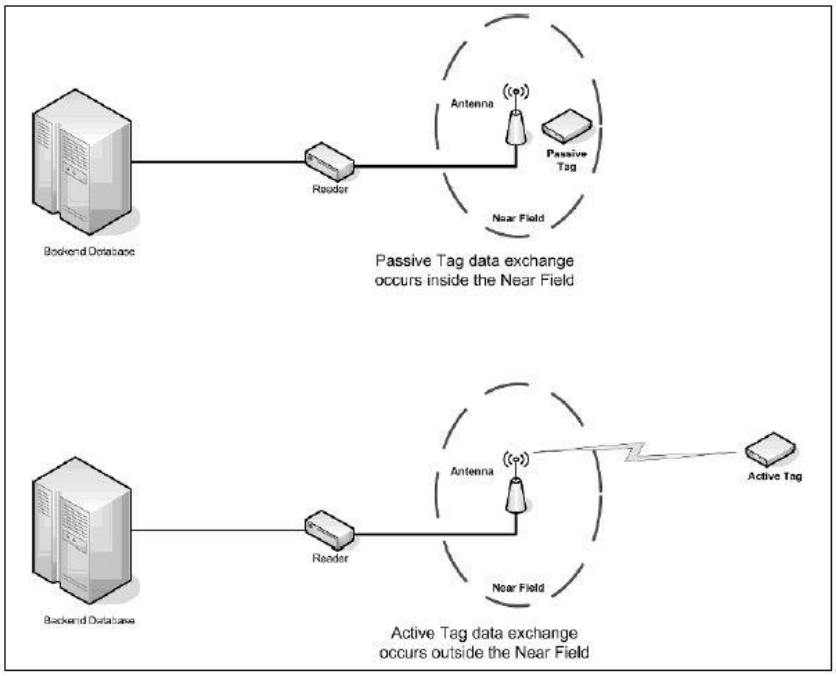

Figure 1. Passive and Active tag process (Thornton et al. 2006 p. 15)

Active tag is able to power its chip and its antenna on its own by a small battery contained in the tag. Thus, the tag can actively transmit and receive power without requiring the range of the Near Field powered from reader's antenna. The transmission ranges of active tag can go up to hundreds or even thousands of feet. (Jones & Chung 2007 p. 23-24)

Semi-passive tag is also able to power its chip by its own battery. Semi-passive tag uses its sensors for monitoring environmental conditions, detecting vibration or movement in transport and storage. However, unlike active tag, semi-passive tag does not communicate with the antenna by its internal power source but rely on the Near Field to power the chip when sending and receiving data. (Jones & Chung 2007 p. 25)

Table 2 below briefly summarizes the main differences between the three types of RFID tag. (Jones & Chung 2007 pp. 22-29)

Table 2. RFID technology comparison (Jones & Chung 2007 p. 29)

	Passive	Active	Semi-Passive
Power source	External Electromagnetic antenna field	On-board battery	On-board battery for internal circuitry External electromagnetic field for transmission
Range	Measured in feet	Up to thousands of feet	Measured in feet
Size	Smaller	Larger	Larger
Data storage	Less	More	More
Cost	Less	More	More

3.3.2. Antenna

Antenna allows a tag to receive the radio frequency signal from the reader. The antenna should be placed in appropriate position so that RFID system can operate correctly. (Johns et al. p. 32)

Both tags and readers have their own antennas (Sweeney 2010 p.79). In a tag, an antenna is attached to the chip, which helps to receive and transmit a signal. The reader antennas with a size of computer flat screen are used to receive and transmit RF signals. A reader transmits radio signals to activate a tag, reader antennas then read the information sending out by the tag and possibly write data onto a tag.

3.3.3. Reader

According to Sweeney (2010 p. 80), the antenna is connected to a reader and helps it sends out the reader's signal. As soon as the RFID tag reaches the antenna's radio field (1 inch to 100 feet or more), the tag is activated and sends out its signal to the antenna. From the antenna, the reader receives the signal, decodes it and finally sends that information to the host computer system.

3.3.4. Host

The main function of the host is to communicate with the RFID reader, which receives the input from the reader and processes the information. RFID middleware is a software placed between reader and the host in order to support the RFID system. (Jones & Chung 2007 p.33)

Sweeney (2010 p. 80) clearly describes the function of RFID middleware. The middleware or reader interface layer plays an important role in processing huge amount of information exchanged between reader, antenna and tag. Middleware then manages, filters and makes sense of the input data from the reader, and transfer it to the host system.

3.4. How RFID works? And its frequency classifications

Sanghera (2011) describes briefly a process of how RFID works and the scenario is shown in Figure 2. A tag or also called a transponder is attached to the object, it contains the unique information of the tagged object and other information such as location tracking and current situation of the object. The reader or also called interrogator is another electronic device placed in particular locations. The reader is able to read the information of the object through the tag when the tagged object passes near the reader. Then, host computer receives the information that the reader has via a wireless network. The host computers from different locations transfer the information of the tagged item to a central location. In a central location, enterprise applications integrate all the information into a database management system and ready to analyze.

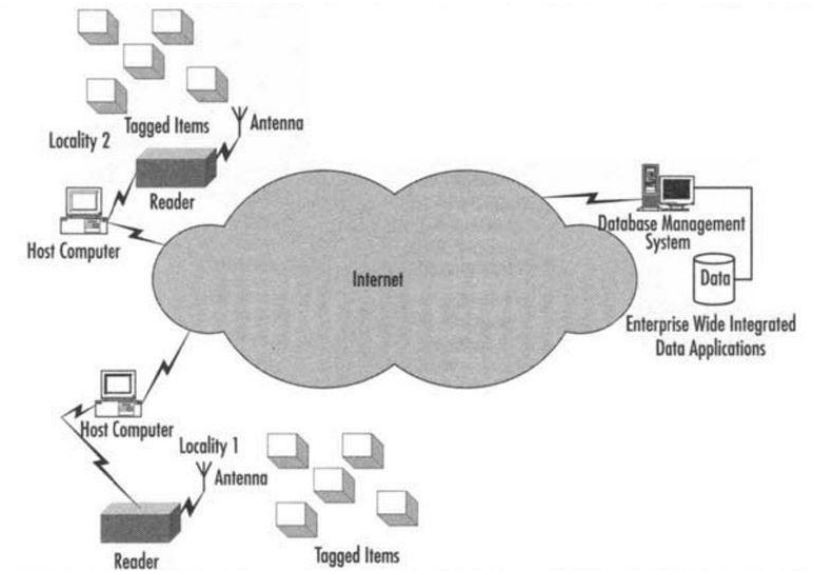

Figure 2. Readers collect information from tags at various locations and send it to a central location over the internet (Sanghera 2011 p.17)

Sanghera also shows the crucial advantages of the technology. RFID allows specific item to be identified and tracked instead of the item type only and the information that the tag contains can be adjusted or added. Moreover, RFID technology allows real-time tracking of the tagged object globally.

Sweeney (2010 p. 83) has a brief definition that helps to have a better look at how frequency works as a measurement. Frequency measures a number of movements when an electromagnetic wave jumps from one crest to another through space in a unit of time. Frequency is measured in Hertz (Hz), which is a number of this movement per second occurs in electromagnetic wave.

There are four main types radio frequency ranges: LF (low frequency), HF (high frequency), UHF (ultra-high frequency) and microwave frequencies. (Table 3)

Table 3. Radio frequency ranges in which RFID systems can operate and read distance by frequency (Sanghera 2011 p. 137)

Name	Frequency Range	Wavelength Range	ISM Frequencies	Read Range For Passive Tags
Low frequency (LF)	30 KHz–300 kHz	10 km–1 km	125–135 KHz	<50 cm
High frequency (HF)	3–30 MHz	100 m–10 m	6.78 MHz, 8.11 MHz, 13.56 MHz, 27.12 MHz	<3 m
Ultrahigh frequency (UHF)	300 MHz–3GHz	1 m–10 cm	433 MHz, 869 MHz, 915 MHz	<9 m
Microwave frequency	1–300 GHz	30 cm–1 mm	2.44 GHz, 5.80 GHz	>10 m

The table above also shows the read range in the different frequency ranges of passive tag. The active tag has the read range from 20 meters to 100 meters.

The low-frequency RFID extends the range from 30 KHz to 300 KHz. The read range in RFID systems of LF range performs shortly, only less than half a meter. Because of the low in frequency, the data transfer rate is also low, which follows with the lower reading speed. Basically, the lower the frequency of the RFID system, the higher the wavelength and vice versa. Thus, the high wavelength creates the difficulty for the LF signal to be absorbed when passing through specific atmosphere and material. LF signal is used to work around water and metal material/environment. Thanks to these characteristics, LF range is implemented in certain RFID applications, such as access control, animal and person tracking. (Sanghera p. 139)

The high-frequency RFID performs a range from 3MHz to 30 MHz. The HF has the read range of 3 meters. As abovementioned in the performance of LF range, the higher the frequency in RFID system, the lower the wavelength, thus, the signal in HF hardly generate through certain materials. The high in frequency provides a fast reading speed. HF RFID is commonly adopted in certain applications such as item-level tracking, libraries. (Sanghera p. 140)

The ultra-high frequency RFID has a range from 300 MHz to 3GHz. In UHF, the reading speed and data transfer are high. Unfortunately, because of the ultra-high frequency, the wavelength is short, UHF can be absorbed by liquids easily. The long reading distance and high reading speed are the perfect characteristics in some applications for RFID systems such as warehouse management, inventory tracking. (Sanghera p. 140-141)

The microwave extends a range from 1 GHz to 300 GHz. Microwave range performs high data transfer rate. Read distance is known as long and the same as UHF, microwave range hardly reads around water and metal. There are typical RFID applications for microwave range such as long-range access control for vehicles, automated toll payment, vehicles tracking. (Sanghera p. 141)

3.5. Standards

There are two main standardization institutions in RFID technology, one is International Standards Organization (ISO) and the other is Electronic Product Code (EPC) system. ISO is known as the international developer of standard, in Europe, different standards of RFID have been developed by the organization. The EPCglobal is a non-profit organization, it has also developed the EPC system for RFID technology standards.

EPC

The Electronic Product Code (EPC) is the unique identification number, which is assigned to object or specific entity in logistics activities. The purpose of EPC is that each item can be individually identified in the logistics system, for example, pallet, container, case, etc. (GS1 AISBL)

EPCglobal published UHF class 1 gen 2 in 2004 as the air interface protocol, which provides the requirement for communication between the reader and the tag. The UHF generation 2 becomes the global standard for UHF implementations in various sectors and it plays an important role in RFID implementations. (GS1 AISBL 2013)

ISO

The International Organization for Standardization provides the ISO/IEC 18000 standards for the air interface standards, which includes different frequency air interfaces (Table 4). Depending on the functionality of the RFID system, specific frequency air interface will be applied. (Barthel 2005 p.11)

Table 4. ISO/IEC 18000 air interface specifications (Barthel 2005 p.11)

	Frequency
ISO/IEC 18000-2	< 135 KHz
ISO/IEC 18000-3	HF 13.56 MHz
ISO/IEC 18000-4	2.45 GHz
ISO/IEC 18000-6	UHF 860-960 MHz
ISO/IEC 18000-7	433 MHz

The organization also develops ISO/IEC 15961 standard for application commanding and application responding interface, ISO/IEC 19562 standard for encoding and decoding in data protocol processing. (Barthel 2005 p.10)

Figure 3 below provides an overview of different RFID standards of the International Organization for Standardization.

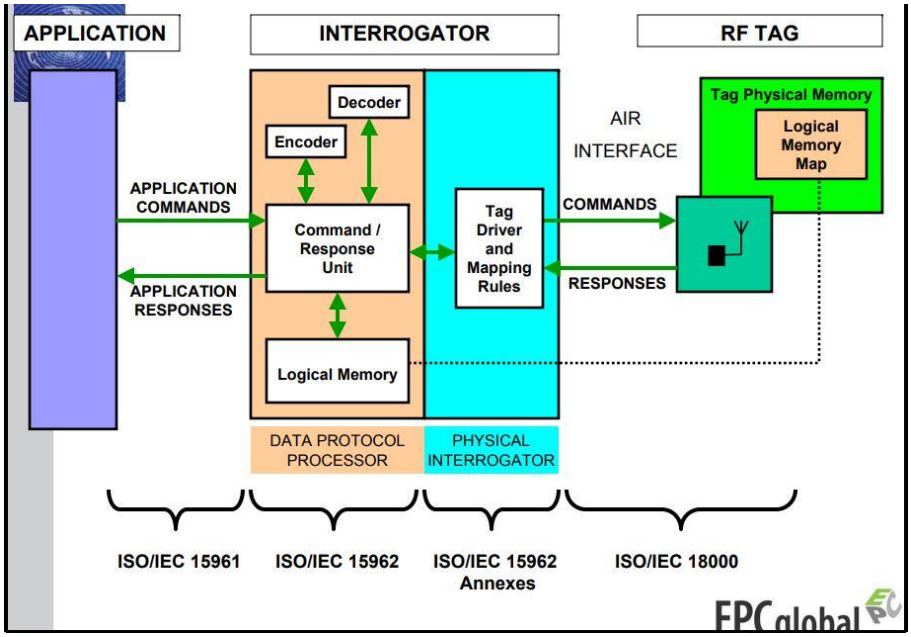

Figure 3. Different ISO/IEC standards between application interface, reader and tag (Barthel 2005 p.10)

4. The impacts of RFID on Logistics

4.1. Logistics

In the seventeenth century, the word "logistics" was first used in the French army. In the Second World War, logistics played an important role in army operation, which was meant to actively control movement of supplies, men, equipments for the war. Today, people use logistics in inventory management from suppliers to manufacturers and finished products to the end users. (Sople 2012 p. 20-21)

Based on Mangan et al. (2008 p. 9), logistics involves "getting, in the right way, the right product, in the right quantity and right quantity, in the right place at the right time, for the right customer at the right cost".

Goldsby and Martichenki (2005 p. 4) have researched that in all the definitions of logistics, inventory management is known as core factor, it applies for both goods from the form of hard goods (material, people) or soft goods (information). Logistics will be unnecessary if there is no movement of inventory.

According to Christopher (2013 p. 2), logistics is defined as " the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organization and its marketing channels in such a way that current and future profitability are maximized through the cost-effective fulfillment of orders."

4.2. RFID in logistics

According to Lai & Cheng (2016 p.36), the logistics concept is performed based on the activity flow of materials and products, from the point of supply to the point of consumption. There are different activities need to be taken into account in order to maintain the flexibility in a logistics system. Based on the importance of logistics management, these logistics activities are divided into primary and supporting activities.

Primary activities which are able to contribute to achieving logistics objective including Customer Service, Transportation, Inventory Management and Order Processing. Supporting activities which support the primary activities including Warehousing, Purchasing or Procurement, Materials Handling, Packing, Production Scheduling and Information Maintenance.

In this section, the author only discusses core activities in logistics, which play an important role in contributing the reduction of logistics costs, improvement in service and effectiveness in coordinating.

4.2.1. RFID and visibility in Logistics

RFID technology provides a huge support in logistics by enabling visibility, which means that at any time, anyone can be able to access to inventory, orders and delivery points (Jones & Chung 2016 p. 242). RFID enables efficiency in logistics by shortening or eliminating the time-wasting manual processes. It also supports labor reduction by applying automatic processes, which using always-on fixed RFID readers and on-demand handheld readers. The visibility of RFID provides real-time data, this real-time nature is considered as a benefit in giving out the latest information, so the organization can make the best decision. Better visibility supports the reduction of

operating costs, maximizes on-time deliveries and develops customer satisfaction. (White Paper 2011)

Jones & Chung (2016) have drawn a diagram, which shows the ability of RFID in providing timely information and visibility. (Figure 4)

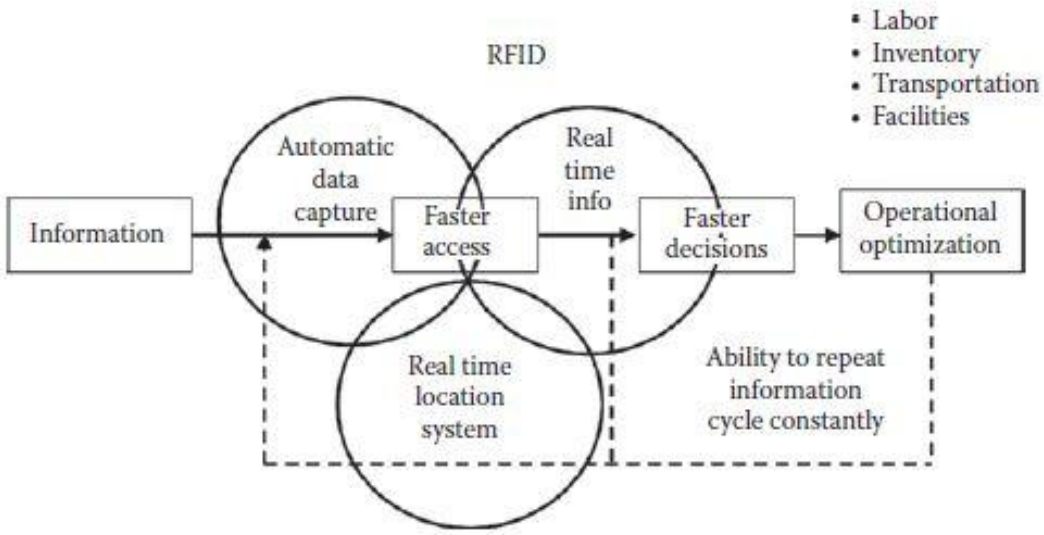

Figure 4. RFID enablings technology (Jones & Chung 2016 p. 243)

The figure shows the benefits of RFID visibility in order to support timely information in the supply chain. The whole information cycle is effectively repeated. The figure shows the promising advantage of RFID in collecting automatically real-time information, which is a crucial benefit in item tracking and inventory management. Thus, it enables the reduction of labor cost, transportation and facilities cost when moving inventory in the supply chain, which leads to the reduction in business costs.

4.2.2. RFID and Inventory control

Different advantages of RFID technology implementation in inventory control include automatic replenishment, automatic picking and stock routing and automatic order generation from current inventory. (Jones and Chung 2016 p. 256).

Thanks to RFID ability of real-time tracking, the organization is able to control the real-time information of inventory and tracks on it respective locations, inventory can be replenished

automatically when it reaches the reorder point. Different RFID applications are implemented within warehouse, retail operations and supply chain. The technology is used in warehouse to replenish picking locations, cross-docking, etc; in retail operations to replenish shelves; in the supply chain to replenish inventory in different components in its physical network. (Jones & Chung 2016 p. 257)

The real-time locator system in RFID technology enables organization to know information about employee location and inventory status. By this way, the firm can optimize the efficiency in order picking and stocking routes of employees. One of the software applications that utilizes this picking and routing benefit from RFID technology is Warehouse Management System (WMS). RFID system provides real-time employee location information as aforementioned, which creates an ease in optimizing order picking schedules, for example, the item needed to be picked is identified quickly and easily, then the system is able to assign the closest worker to handle the item. (Jones & Chung 2016 p. 257-258)

The term cross-docking is used when inventory is received at the dock and then immediately transferred to the next shipment in order to reduce a great number of labor and time for storing, replenishment, picking and packing of the product. The ability to group different orders based on the latest inventory availability by using RFID called waves automatically. The accuracy in this order batching of waves can be optimized by the real-time ability of RFID technology, which perform an accuracy of inventory and immediately identify the needed secondary location for the inventory. (Jones & Chung 2016 p. 258)

4.2.3. RFID and Warehousing

RFID technology creates an ease in product receiving process in warehousing, which allows the warehouse to automatically identify the accurate packages via the RFID tags attached to each package/item without human intervention. The firm is able to optimize an efficiency and effectiveness of warehousing process by eliminating the physical checking process. Moreover, when it comes to cross-docking (the explanation of cross-docking is mentioned in the section above), RFID immediately identifies and informs the system the position of specific packages/products need to be prepared for the next order. Then, the system automatically reads the information of RFID tags attached to packages/products needed a cross-dock movement and

assists them to the specific dock or place on the waiting vehicle. Another advantage of receiving process using RFID technology is that RFID can read accurately regardless packages/products position, while barcode can only be read when the packages are placed properly. (Jones & Chung 2016 p. 282)

In the storage zone, RFID allows different tagged products or pallets to be identified from anywhere. This ability maximizes an efficiency of storage, replenishment and picking process from various types of storage racks. The ability in automatically identified items provides productivity and accuracy in picking and packing the correct items. (Jones & Chung 2016 p. 282)

RFID technology ensures accuracy in the shipping process of different products by applying RFID readers at exists of the warehouse. After packages going through the RFID reader or portal, verification is made to ensure a correct order, accurate amount and on which outbound vehicle to be placed. (Jones & Chung 2016 p. 283)

4.2.4. RFID and Order fulfillment

As aforementioned in the "Logistics Activities" section, order processing includes collecting, checking, entering and transmitting sales-order information. The advantages of RFID technology in order fulfillment perspective are also performed in some functions of inventory control and warehouse management above. RFID eliminates the inaccuracy such as sending items to wrong destination or involving in a delay in picking/sending items. The advantage supports the great reduction in logistics and organization cost. RFID tags allow accuracy in activities involved in picking, shelving, cross-docking and this ability is able to maximize the speed of these logistics processes. (Sabbaghi & Vaidyanathan 2008 p. 78)

Other benefits of RFID technology in Logistics

4.2.5. RFID and Return management

The term "reverse logistics" means the return of used products, packaging materials, production disposal, other wastes, etc (Dyckhoff et al. 2013). Sabbaghi et al also provides another benefit of RFID technology in return management. RFID eliminates the information limitation of which

products being returned. The RFID tags attached to each item allows organization to optimize the return handling process. Based on the information contained in RFID tag on returned items, the system will automatically recalculate the current inventory and updates the latest information. (Sabbaghi et al. 2008 p. 78)

4.2.6. RFID reduces labor cost

RFID technology requires a little or without the need of having people to scan individual item with a barcode scanner. In logistics perspective, RFID tags allow the organization to maximize efficiency in logistics processes by automatically checking shipment, optimize cross-docking, identify hundreds of items at the same time and immediately update the inventory system. Less human intervention leads to reduction in damages, decrease in labor cost and operation cost will also be reduced. (Sweeney II 2010 p. 13)

4.2.7. RFID reduces Shrinkage

Lewis (2004) has shown that shrinkage occurs when orders are misplaced, robbery caused by employees, poor performance on inventory management, etc. The automatically identify ability on individual products enables RFID to immediately identify whenever shrinkage occurs. Lewis also states that problems from shrinkage take up to 5 percents of stock. Therefore preventing such losses is essential in logistics cost improvement. Sweeney II also provides an example of how RFID technology avoids shrinkage, the technology optimizes assets tracking by automatically sounding an alarm when tagged assets go through a gate.

5. Companies' concerns in RFID implementation

RFID technology has many advantages for the logistics and logistics activities, however, there are also issues and challenges, which creates reluctance in adopting the technology. The problems that organizations are facing include the security of RFID systems, privacy issues, high cost in RFID deployment, lack of global standards and regulations, environmental factors, lack of knowledge and experience, and data management.

5.1. Privacy issues

One of the most controversial issues of implementing RFID systems is the personal privacy protections of customers. By being able to record personal information of consumers, RFID technology has involved in personal privacy issues. The technology allows systems to develop consumers' personal details by recording their transactions when consumers make a purchase. RFID technology is able to record consumers' name, address, product purchased and other personal information. Based on the invisible reading of RFID tags ability, consumers can be "scanned" without their knowledge. Thus, by misusing the technology, the attacker is able to easily track on consumers with RFID tagged item after purchasing in order to obtain information such as their location or movement. (Daniel Hunt et al. 2007 pp. 98-104)

These abilities of RFID technology aforementioned have led the technology to many concerns involved in consumer informational privacy issue, consumer's physical privacy and consumer's civil liberty. Thus, organizations, which implement RFID technology, should educate customers and consumers the limitation of the technology and ensure them that RFID tags are applied on item-level only. (Ngai et al. 2009)

According to Thornton et al. (2006 p 41), there are two examples of failure in marketplace related to privacy advocates of RFID technology. The two companies are clothing manufacturer Benetton and German retailer Metro Group. In 2003, Benetton implemented RFID tags in its clothing products. Unfortunately, the privacy advocates created a website to boycott Benetton products, which then led Benetton to remove RFID tags out of all its clothing products. Another failure example is the Future Store established by Metro Group. In 2004, Future Store attached RFID tags in its customers' loyalty cards without customers' knowledge. The privacy advocates forced the store to replace all the cards with RFID tags attached on with the normal cards. Nowadays, Metro Group uses its own RFID tags to optimize supply chain process and distribution by implementing the technology on cases and pallets.

5.2. Cost of implementing RFID technology

Cost is one of the major challenges of implementing RFID technology. Since the technology requires high-cost implementation, organization must carefully concern about its need of

adopting RFID technology. The success of RFID technology implementation is measured by its cost-benefit analysis. (Ngai et al. 2009)

The cost of RFID tags ranges between $0.3 and $0.6. The cost varies depending on different types of products, for example, RFID tags cost higher on luxury products than normal products. Thus, RFID tags' price is known as major influence on the adoption of the technology. However, not only RFID tags cost organization a great amount of investment, RFID system's hardware and software application are also expensive. Another cost needed to take into concern is employee training on new RFID technology. RFID technology is still seen as a developing technology, some organizations concerned about the high risk of fully investing in the technology. (Daniel Hunt et al. 2007 pp. 104-105)

Overall, implementing RFID technology requires a great investment. These major costs fall into tags, hardware and software application, consultancy fees and employee training. (Ngai et al. 2009)

5.3. Global standards and regulations

Global standards allow barcode to be read by all retailers, unlike RFID, manufactures and retailers produce/use different types of tags that have various methods of communication. Different countries have different regulations applied to RFID frequencies and RFID power level, which leads to the impossibility of systems could be used among different countries. For example, there is no global agreement on frequency used on RFID systems, different UHF bands are applied on different countries of the world. Thus, the lack of standards and uniform regulations of RFID technology leads to the low performance of interoperability between applications and devices around the world and RFID technology adoption. (Daniel Hunt et al. 2007 pp. 105-106)

As aforementioned in chapter 4, there are two main standardization institutions in RFID. However, there is no agreement between ISO and EPCglobal of which standard should be used. ISO's and EPCglobal's standards should be uniform in order to create an interoperability of RFID systems. (Ngai et al. 2009)

5.4. Environment issues

In RFID frequencies, high frequency (HF) and ultra high frequency (UHF) are known as the common use for RFID technology implementation. Unfortunately, these two frequencies are greatly impacted by specific type of environmental factors, which are water and liquids. Liquids are able to reduce the read range or prevent the communication between tags and readers by absorbing the RFID signals. Another environmental factor should be taken into account is metal. Metal is able to deflect the radio waves of RFID, however, this problem can be solved by creating a path so that radio waves can pass through the material. The other problem is that, if some applications used in logistics process generate almost the same frequency as RFID applications, it creates bad performance of RFID technology. Fortunately, shielding RFID reader is able to prevent different frequencies from interfering with RFID signals. (Ngai et al. 2009)

5.5. Lack of knowledge and experience

RFID technology is still known as a complex technology, which requires essential knowledge and experience in implementation. Since the lack of expertise in the field, many small organizations have involved in difficulties in their initial project of piloting the technology. From customer perspective, the lack of knowledge about RFID technology might cause customer's disappointment in the cost of RFID. While bar code technology cost less than RFID technology, customer might become reluctant to use RFID technology. (Daniel Hunt et al. 2007 pp. 108)

Ngai et al. (2009) has shown that 80 percent of companies implemented RFID technology involve in the problem of lacking skills, and employee training is also a huge challenge. The experts in the field, who have RFID deployment experience, are hard to find. Thus, education of skills and knowledge related to RFID technology is critical in long run of RFID development. (Ngai et al. 2009)

5.6. Data management

Data management is a key issue of RFID technology implementation. Due to the high volume data from tagging individual product, strong data management is able to ensure this massive amount of data produced by RFID systems can be well-processed. Organizations are facing

challenges in managing RFID data such as large quantities of data, data integration across multiple facilities. As aforementioned, RFID systems can create large volume of data due to various tagged items, which leads to information overload. The technology requires the robust IT systems to handle this problem. Organizations that have multiple facilities located in different places and these facilities connect to one IT center, also involve in the same problem of information overload. The IT infrastructures not only manage the raw RFID data from these facilities but transfer these massive data to an IT center. (Daniel Hunt et al. 2007 pp. 109-110)

6. Empirical work: results and analysis

The following section introduces the results after conducting the survey questionnaires of the top 100 third-party logistics (3PL) providers in 2017 and the interview with RFIDLab Finland. All the presentation and analysis of the responses to the survey and the answers to the interview are introduced in this section.

6.1. Survey

In this section, the responses from the top 100 third-party logistics (3PL) providers in 2017 are analyzed and presented. The survey questionnaires were created and collected using the online statistical survey web app called Limesurvey.

The survey includes one validation question (Question 1: "Has your company ever used RFID technology?"). Any companies that chose the answer as "No" were excluded from the analysis.

Two question (Question 2: "In your opinion, RFID technology improves the following logistics activities?" and Question 3: "In your company, RFID technology offers the following benefits?") measure the companies' perspective on the general and specific benefits of RFID technology in logistics. Each question contains a number of sub-questions using Likert scale. The answers are coded as follow: 1= Strongly disagree/Not at all concerned, 2= Disagree/Slightly concerned, 3= Neutral/Somewhat concerned, 4= Agree/Moderately concerned, 5= Strongly agree/Extremely concerned.

Question 4: "How concerned is your company about the following barriers of RFID technology?" and Question 7: "Please, feel free to add any concerns about RFID technology that

significantly impact your business or any additional comment?" address companies' concerns in using RFID tech such as implementation cost, data management, global standard, security threat, privacy issue. Question 4 also contains number of sub-questions and their answers are also coded using 5-point Likert scale.

Question 5: "What do you think about the relation RFID technology and barcode in the next 5 years?" and Question 6: "How does your company want RFID to develop in the future?" measure the prediction and expectation of RFID technology future development.

In order to have a better understanding of the results, answers of the survey are presented under three sections. They are general information of RFID technology in logistics activities, benefits of RFID technology implementation in the company, concerns of RFID technology implementation in the company. The results are introduced under the column chart. The author presents only the chart of those questions that have outstanding answers, the rest of the charts are analyzed in the discussion section and presented in the appendices section.

6.1.1. General information of RFID technology in logistics activities

In this section, number of logistics providers using RFID technology, relation between RFID technology and barcode system in the future and the improvement of different logistics activities under RFID technology implementation are presented.

The usage of RFID technology

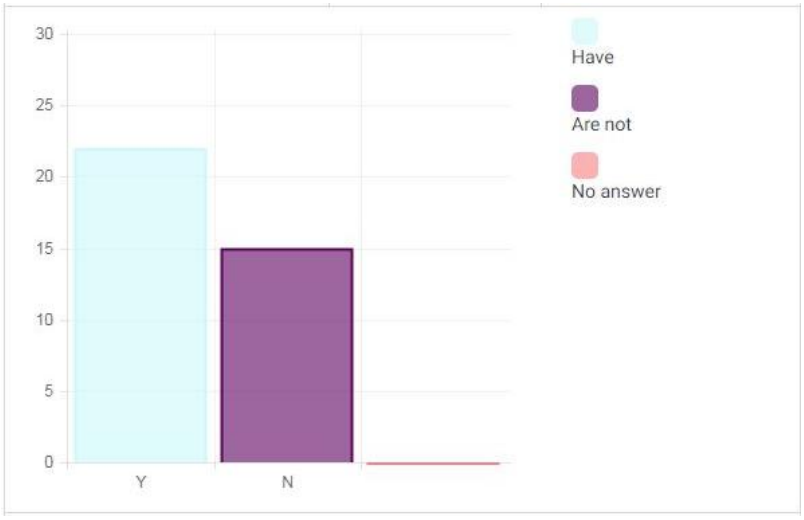

Figure 5. The usage of RFID technology

The column chart above shows the number of companies which have or do not have experience in using RFID technology. More companies implement RFID technology in their logistics systems than those who do not have any experience with RFID technology, p = 0.595 and p = 0.405, 95% CIs [0.422, 0.748] and [0.252, 0.578], respectively.

Relation between RFID technology and barcode system

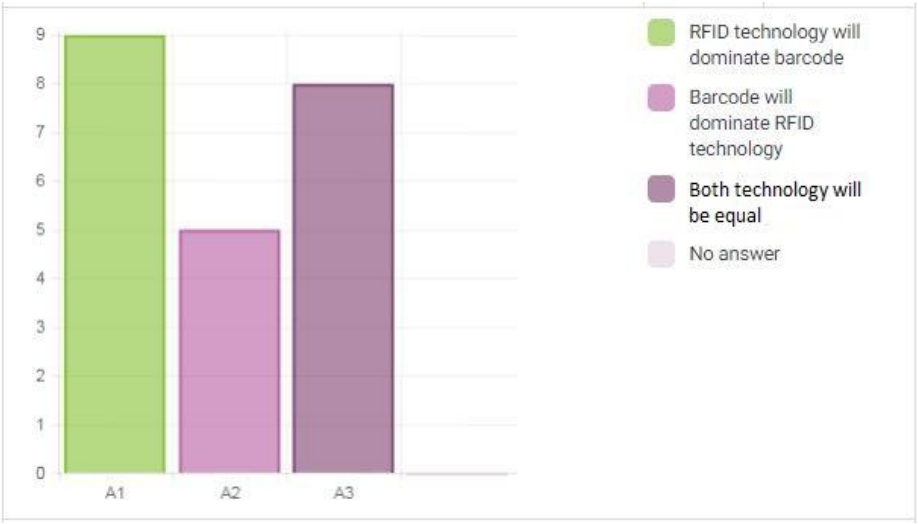

Figure 6. Relation between RFID technology and barcode system

The diagram above presents the relation of RFID technology and barcode systems in the next 5 years. The majority of logistics providers agreed that either RFID technology will dominate barcode or both technologies will be equal. The number of companies believed that RFID technology and barcode system will be equally developed almost as much as companies who gave more hope for RFID technology, p = 0.363 and p = 0.409, 95% CIs [0.180, 0.591] and [0.214, 0.633], respectively. Whereas only 5 out of 22 companies believed that barcode will dominate RFID technology in the next 5 years, p = 0.227, 95% CI [0.086, 0.458].

RFID technology improves Inventory Management

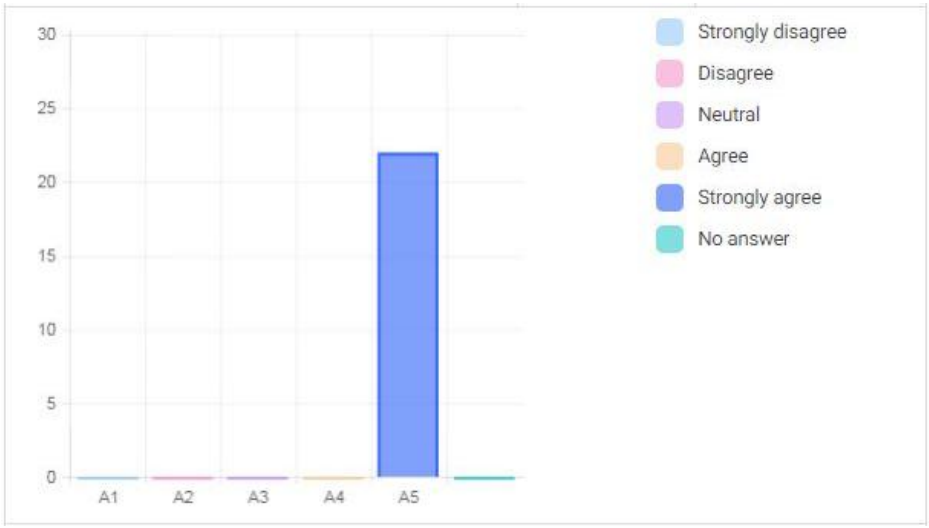

Figure 7. RFID technology improves Inventory Management

This diagram represents the attitudes of third-party logistics companies on the improvement of inventory management, after implementing RFID technology. All of the 22 companies strongly agreed that the implementation of RFID technology improved inventory management, p = 1, 95% CI [0.815, 1]. The mean of this question about the improvement of inventory management is: m = 5

RFID technology improves Order Processing

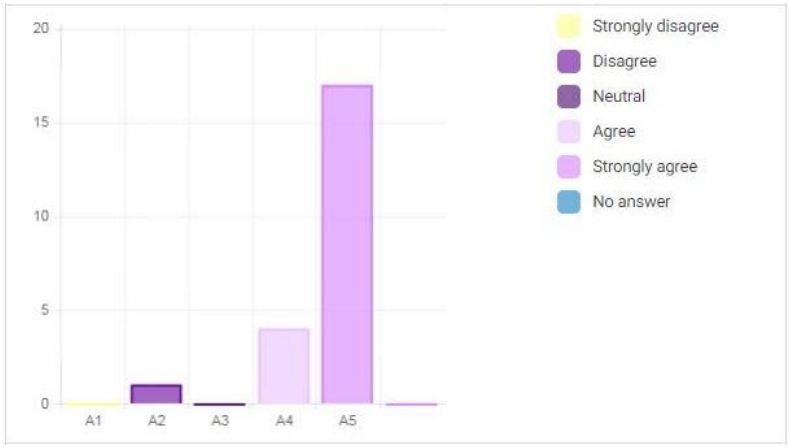

Figure 8. RFID technology improves order processing

The bar chart represents that majority of logistics providers strongly agreed and agreed that order processing was improved thanks to RFID implementation, p = 0.772 and p = 0.181, 95% CIs [0.541, 0.913] and [0.059, 0.410], respectively. Only one logistics provider did not agree with the improvement of this logistics activity, p = 0.045, 95% CI [0.002, 0.248]. Based on this question about the improvement that RFID technology has on order processing, the mean of this question is m = 4.68, 95% CI [4.36, 5.00].

RFID technology improves Warehousing

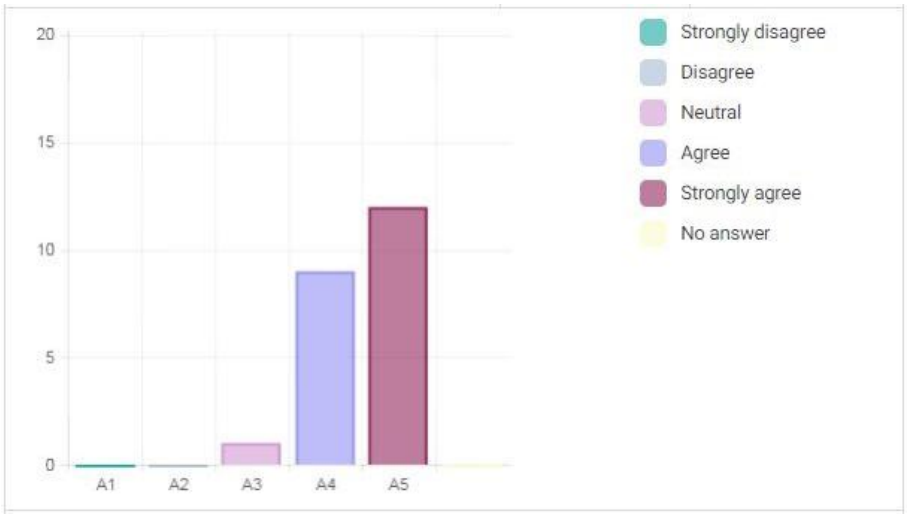

Figure 9. RFID technology improves warehousing

Based on the above diagram, nearly all the logistics providers strongly agreed and agreed that warehousing is one of the logistics activities was greatly improved by RFID technology, p = 0.545 and p = 0.409, 95% CIs [0.326, 0.749] and [0.214, 0.633], respectively. Only one company stated their opinion as neutral, p = 0.045, 95% CI [0.002, 0.248]. The mean of this question about logistics providers' opinions on RFID technology improves warehousing is: m = 4.50, 95% CI [4.24, 4.76].

RFID technology improves Transportation

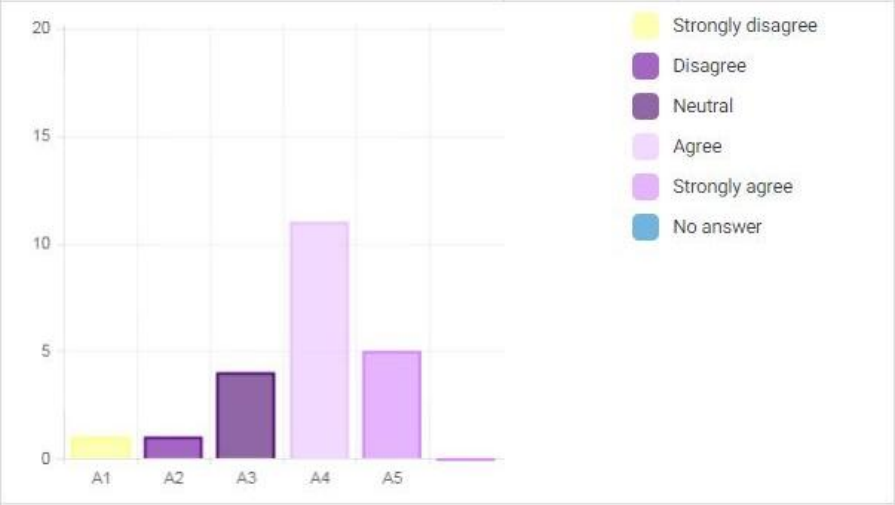

Figure 10. RFID technology improves transportation

The opinions about the improvement that RFID technology brings to transportation were different between logistics providers. The diagram shows that majority of companies agreed that RFID technology improves this logistics activity and 5 out of 22 companies strongly agreed with this, p = 0.5 and p = 0.227, 95% CIs [0.288, 0.712] and [0.086, 0.458], respectively. While 4 logistics providers gave their opinion as neutral, one company disagreed and one company strongly disagreed, p = 0.181 and p = 0.045 and p = 0.045, 95% CIs [0.059, 0.410] and [0.002, 0.248] and [0.002, 0.248] respectively. This question about the improvement of transportation has the mean: m = 3.82, 95% CI [3.37, 4.26].

RFID technology improves Customer Service

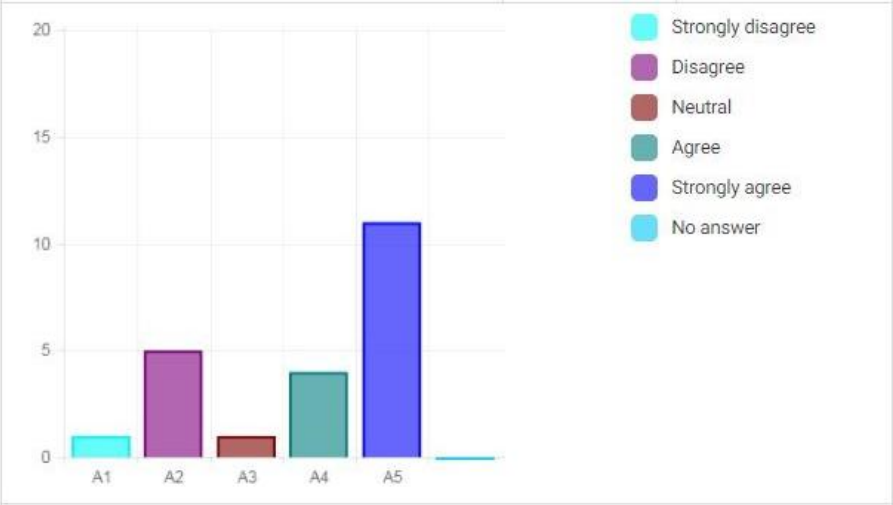

Figure 11. RFID technology improves customer service

The diagram shows that majority of logistics providers believed that customer service was improved with RFID technology deployment. 15 out of 22 companies agreed and strongly agreed that they experienced an improvement in this logistics activity, p = 0.5 and p = 0.181, 95% CIs [0.288, 0.712] and [0.059, 0.410], respectively. On the other hand, 5 companies disagreed with an experience in better customer service, one company strongly disagreed with the improvement and another one company gave their answer as neutral, p = 0.227 and p = 0.045 and p = 0.045, 95% CIs [0.086, 0.458] and [0.002, 0.248] and [0.002, 0.248] respectively. The mean of this question about RFID improves customer service is: m = 3.86, 95% CI [3.25, 4.48].

6.1.2. Benefits of RFID technology implementation in the company

Attitudes of logistics providers on different benefits brought by implementing RFID technology in their companies are introduced in this section.

RFID technology offers Real-time data and increases Information visibility in the company

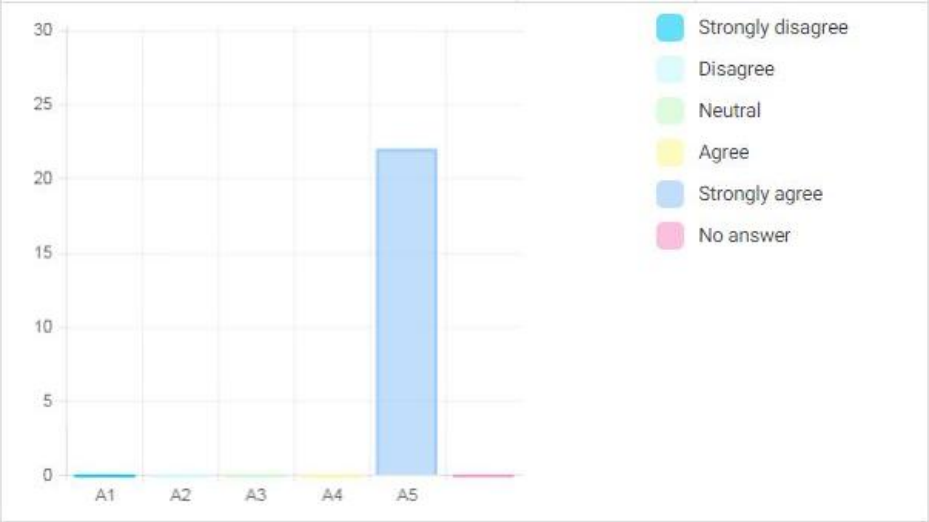

Figure 12. RFID technology offers Real-time data and increases Information visibility

The chart above shows the attitudes of logistics providers about real-time data and information visibility brought by RFID technology. All of 22 companies strongly agreed that RFID technology utilized the visibility of data and provided real-time information ability, p = 1, 95% CI [0.815, 1]. The mean of this question about a better information visibility and real-time data is m = 5.

RFID technology offers better tracking and inventory control in the company

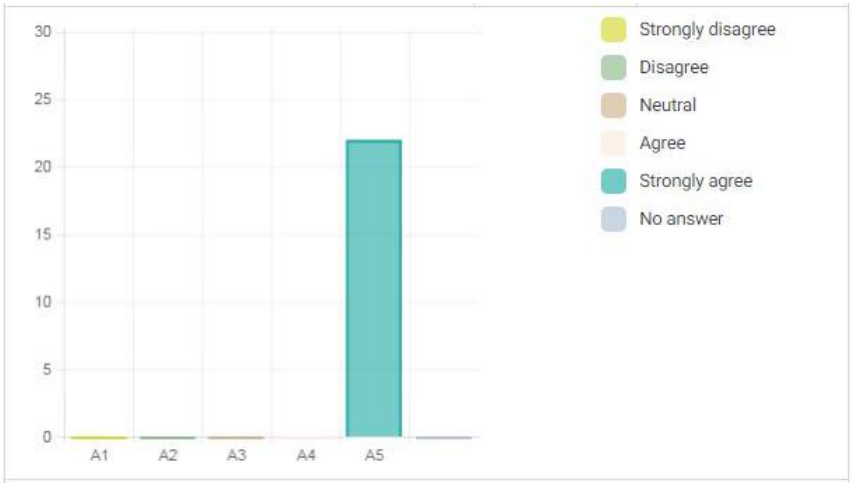

Figure 13. RFID technology offers better tracking and inventory control

This column chart represents companies' opinion on better tracking and inventory control when using RFID technology. Inventory control was strongly agreed by all 22 logistics providers as an advantage of RFID technology, p = 1, 95% CI [0.815, 1]. The mean of this question about a better tracking and inventory control is m = 5.

RFID technology offers less out of stock and increases sale in the company

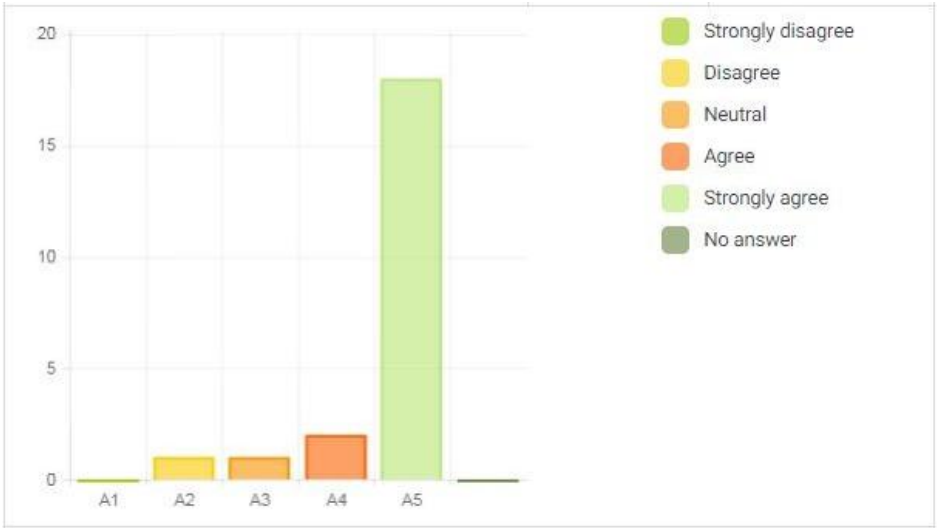

Figure 14. RFID technology offers less out of stock and increases sale

The diagram represents the attitudes of companies on the increase of sale and decrease out of stock due to RFID implementation. The majority of logistics providers strongly agreed the offered benefit, p = 0.818, 95% CI [0.589, 0.94]. While only one company did not experience their increase in sale or better stock control, p = 0.045, 95% CI [0.002, 0.248]. The mean of this question about RFID technology's offer in decreasing out of stock and increasing sales is: m = 4.68, 95% CI [4.34, 5.03].

RFID technology offers better warehouse performance in the company

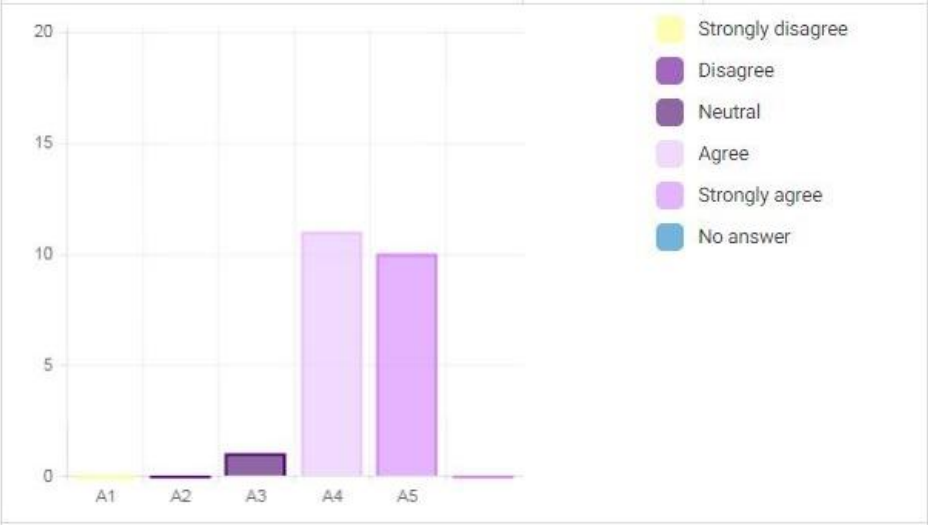

Figure 15. RFID technology offers better warehouse performance

The diagram shows companies' attitudes toward warehouse performance after using RFID technology. The majority of companies agreed and strongly agreed that warehouse performed better with RFID implementation, p = 0.5 and p = 0.454, 95% CIs [0.288, 0.712] and [0.25, 0.673], respectively . None of the companies disagreed or strongly disagreed, while only 1 one logistics providers gave the opinion as neutral, p = 0.045, 95% CI [0.002, 0.248]. The mean of this question about RFID technology's offer in a better warehouse performance is: m = 4.41, 95% CI [4.15, 4.67].

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RFID technology offers better identification process in the company

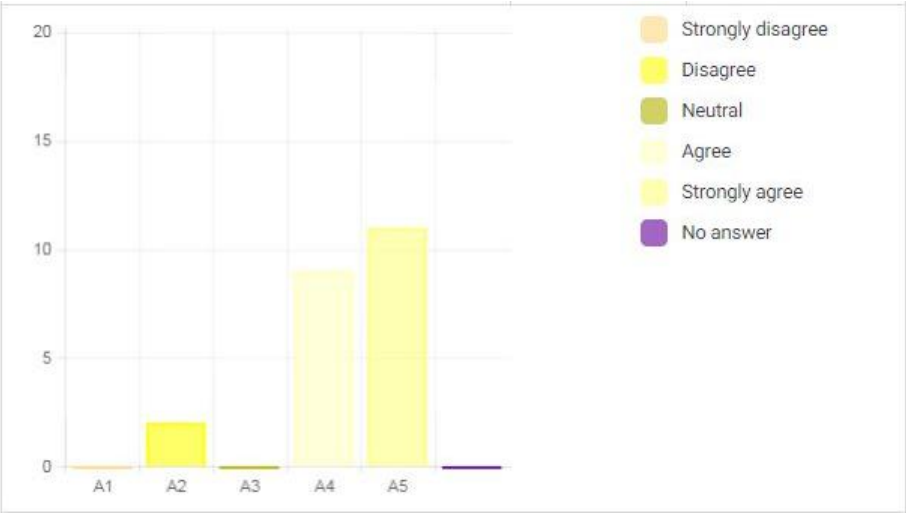

Figure 16. RFID technology offers better identification process

The diagram above shows that nearly all logistics providers strongly agreed and agreed that they experienced the faster and cheaper identification process in their company, p = 0.5 and p = 0.409, 95% CIs [0.288, 0.712] and [0.214, 0.633], respectively. Only 2 out of 22 companies did not experience the improvement in their identification process, p = 0.091, 95% CI [0.016, 0.306]. The mean of this question about the offer of RFID technology for a better identification process is: m = 4.32, 95% CI [3.92, 4.71].

RFID technology offers better customer service due to higher delivery reliability

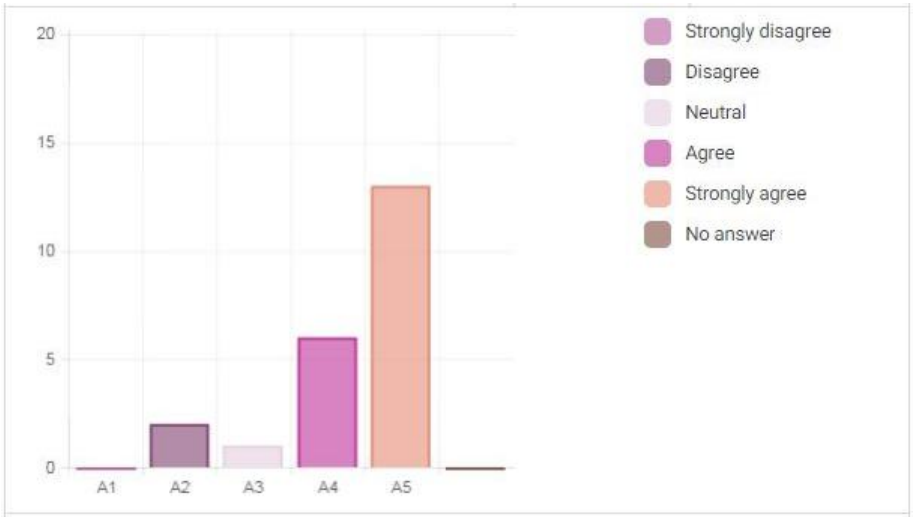

Figure 17. RFID technology offers better customer service due to delivery reliability

Logistics providers' opinions were different when it comes to customer service. The diagram shows that majority of companies strongly agreed that they experienced better customer service due to delivery reliability and 6 out of 22 companies agreed with this, $p = 0.591$ and $p = 0.273$, 95% CIs [0.367, 0.785] and [0.116, 0.504], respectively. While only one logistics provider stated its answer as neutral 2 companies gave their opinion as disagree, $p = 0.045$ and $p = 0.091$, 95% CIs [0.002, 0.248] and [0.016, 0.306], respectively. The mean of this question about a better customer service due to delivery reliability due to RFID implementation is: $m = 4.36$, 95% CI [3.94, 4.79].

RFID technology offers labor cost reduction in the company

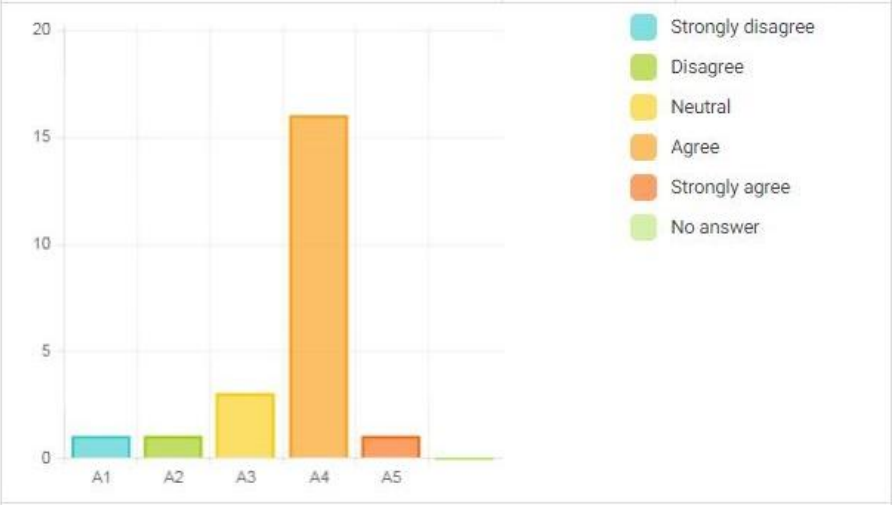

Figure 18. RFID technology offers labor cost reduction

The diagram above represents logistics providers' opinions about the reduction in labor cost thanks to RFID technology. 16 out of 22 companies agreed that they were able to reduce the cost of labor, p = 0.727, 95% CI [0.496, 0.884]. Even though majority of companies agreed with this offer, 3 out of 22 logistics providers gave their opinion as neutral, one company disagreed and another one strongly disagreed, p = 0.136 and p = 0.045 and p = 0.045, 95% CIs [0.036, 0.36] and [0.002, 0.248] and [0.002, 0.248], respectively. The mean of this question about RFID technology's offer in labor cost reduction is: m = 3.68, 95% CI [3.31, 4.05].

6.1.3. Concerns of RFID technology implementation in the company

This section presents logistics providers' attitudes toward different barriers that companies are facing when using the technology.

Companies' concern about cost of implementing RFID technology

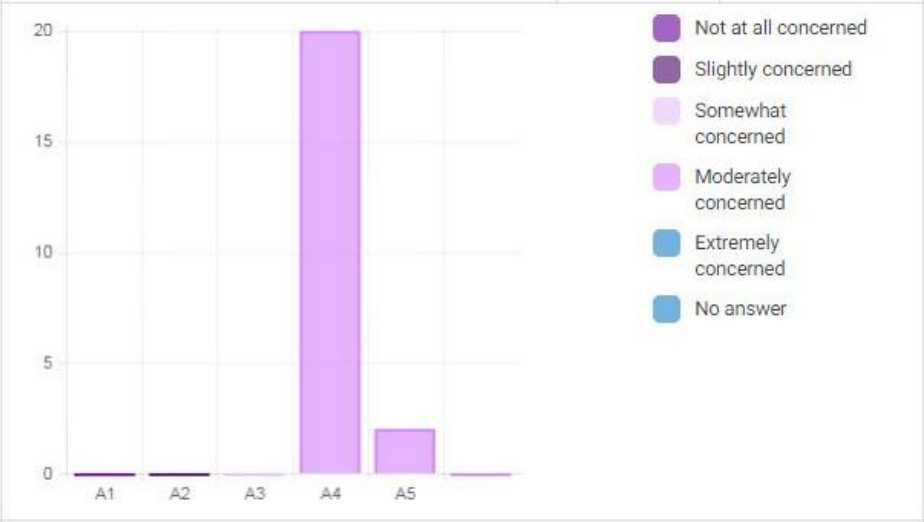

Figure 19. Companies' concern about cost of implementing RFID technology

The column chart above presents companies' concerns about RFID implementation cost. The diagram shows that cost of implementing RFID is a barrier when 20 out of 22 logistics providers moderately concerned about it, p = 0.909, 95% CI [0.694, 0.984]. While the other two companies extremely concerned about this issue, p = 0.091, 95% CI [0.016, 0.306]. The mean of this question about the concern of the implementation cost is: m = 4.09, 95% CI [3.96, 4.22].

Companies' concern about global standards and regulations of RFID technology

Figure 20. Companies' concern about global standards and regulations of RFID technology

The figure above presents logistics providers' concerns about the standards and regulations of RFID technology. All of companies moderately concerned and strongly concerned about this issue, p = 0.864 and p = 0.136, 95% CIs [0.64, 0.964] and [0.035, 0.359], respectively. The mean of this question about the concern of global standard is: m = 4.14, 95% CI [3.98, 4.29].

Companies' concern about data management

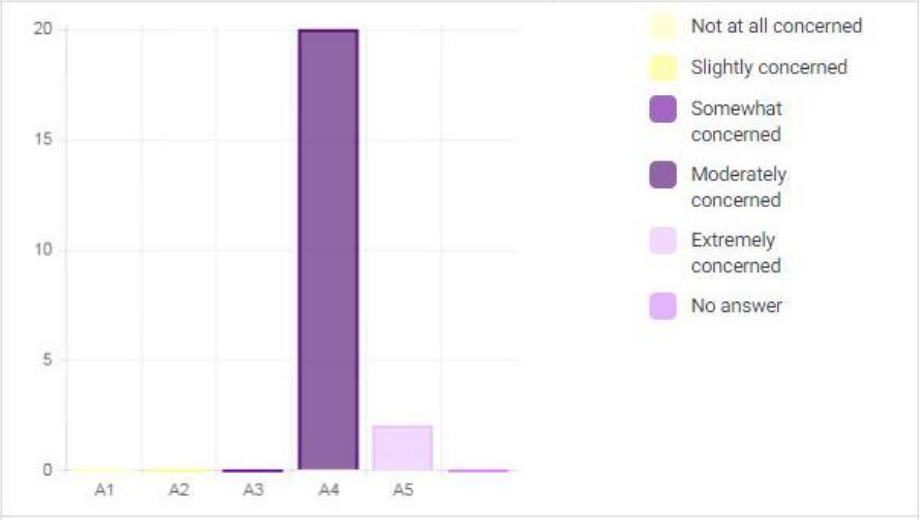

Figure 21. Companies' concern about data management

The diagram above presents companies' concerns about managing all the data collected by RFID technology. 20 out of 22 logistics providers moderately concerned about it, p = 0.909, 95% CI [0.694, 0.984]. While the other two companies extremely concerned about this issue, p = 0.091, 95% CI [0.016, 0.306]. The mean of this question about the concern of data management is: m = 4.09, 95% CI [3.96, 4.22].

Companies' concern about security threat

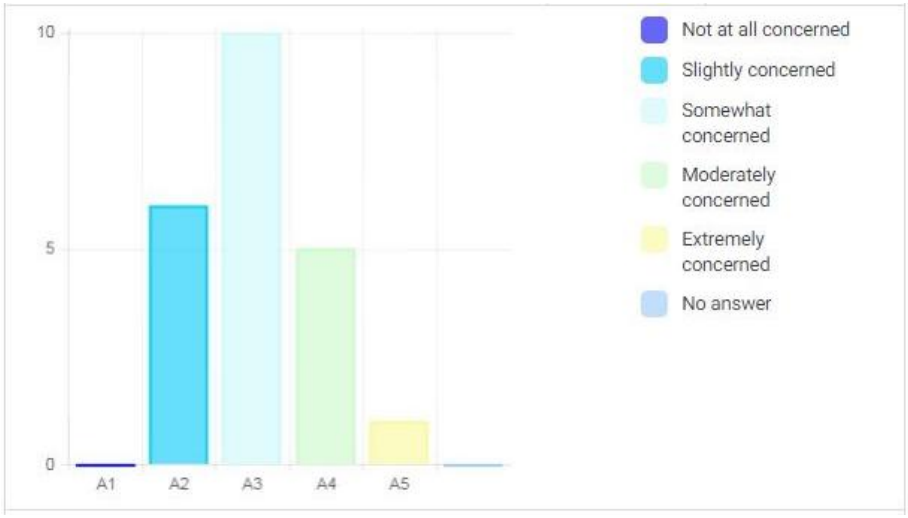

Figure 22. Companies' concern about security threat

The diagram represents logistics providers' opinion on their concern about security threat in using RFID technology. Nearly half of the logistics providers stated their answer as "somewhat concern" while 6 out of 22 companies only concerned slightly about this issue, p = 0.455 and p = 0.273, 95% CIs [0.251, 0.673] and [0.116, 0.504], respectively. The mean for this question about the concern of security threat is: m = 3.05, 95% CI [2.67, 3.42].

Companies' concern about lack of knowledge and experience

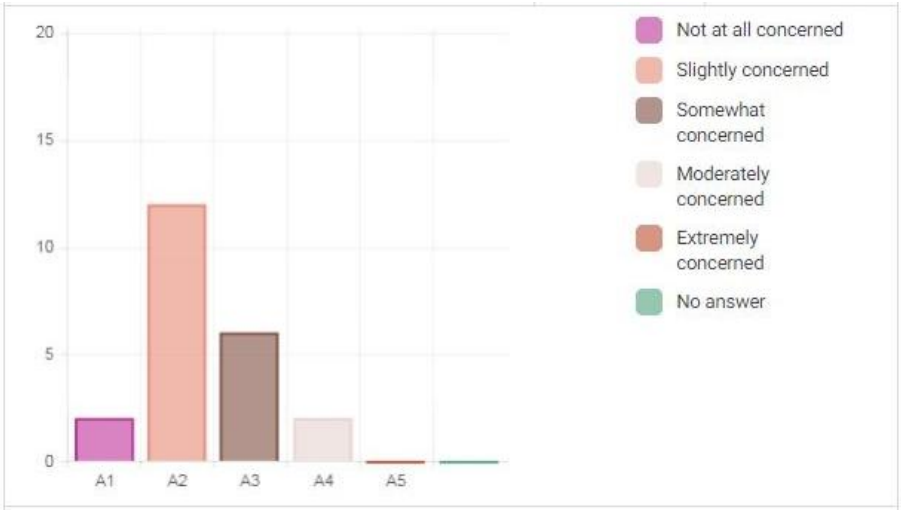

Figure 23. Companies' concern about lack of knowledge and experience

The above diagram shows that majority of companies did not see lack of knowledge and experience about RFID technology as an issue. 12 companies slightly concerned about this issue, 6 companies gave their answer as "somewhat concerned", while 2 companies did not concern at all, p = 0.546 and p = 0.273 and p = 0.091, 95% CIs [0.326, 0.749] and [0.116, 0.504] and [0.016, 0.306], respectively. The mean of this question about RFID technology's offer in labor cost reduction is: m = 2.36, 95% CI [2.01, 2.71].

At the end of the survey, there is an open question about companies' expectations on the future development of RFID technology in order to utilize benefits of the technology in logistics systems. They expected that RFID becomes standard in Supply Chain, and all the players (manufacturer, supplier, logistics, retailer, etc) can share the information and benefits on the same platform, by which new value-added service is created. They also believed that RFID still needs some technology breakthrough (e.g. hard to get 100% response when RFID is attached on metal or liquid), and cost reduction (personally feel $0.01/pc is mandatory in order to be widely used).

6.2. Interview

The main purpose of the interview was to find out the possible solutions for the significant concerns measured in the survey using 5-point Likert scale. The structure of the interview guide is divided into three parts. They include the general information of RFID technology in logistics (Question 1 and 2), specific benefits of RFID in logistics activities (Question 3 and 4), and the possible solutions for the significant challenges in RFID implementation addressed in the survey (Question 5-9).

Question 1 and 2 answer the development of RFID technology in the last 5 years and its current use in the logistics industry. Question 3 and 4 measure the major benefits of RFID technology in logistics activities and company's expectations of the technology in the logistics system. Question 5 to 9 help to understand the interviewee's thoughts on the significant concerns from the survey and to find out the possible solutions.

The answers from the interview are analyzed and presented in this section. The brief summary of RFIDLab Finland ry and interviewee information is also introduced.

6.2.1. RFIDLab Finland ry

Sami Isomäki, Technology Manager, on behalf of RFIDLab Finland ry was chosen to be an interviewee. The interview was held on March 22nd, 2018 at the showroom in Vantaa. RFIDLab Finland is a neutral non-profit association. It helps companies with potential business in identification technology, RFID and NFC, to have an efficient initiative and to create network. RFIDLab Finland also provides its RFID or NFC solution for companies representing logistics service providers, manufacturers, wholesalers and retailers. Every year, RFIDLab Finland offers RFID seminars, training and consulting for operations using identification technology in their business. (RFIDLab 2016)

6.2.2. Results

Current situation of RFID technology in the logistics industry

According to Sami Isomäki, the current implementation of RFID technology is known as stable. In logistics industry, the technology is widely implemented in manufacturing, warehousing, transportation, and order processing activities. Sami Isomäki also mentioned that base on the ability of automatically identifying and reading RFID tag, RFID technology is mainly used to create an efficiency in inventory management activity. Thus, the business using RFID technology the most is clothing and apparel business, where tagged products can be tracked through the logistics chain, from the manufacturing to the store, and from the store to the point of sales.

Development and improvement of RFID technology in the last 5 years?

The technology manager shared that in the last 5 years, RFID technology has been quite steady. Although RFID tag has been developed year by year, nothing has been grown dramatically. In logistics, most of the cases are based on UHF Gen 2 standard, which is a standard for RFID reader and RFID tag operation. Nowadays, many tag and reader manufacturers have widely created their product based on this Gen 2 standard, which makes RFID technology more efficiently due to the high competition.

Major benefits of RFID technology in logistics

Sami Isomäki shared that based on the companies using RFID technology, the most advantages that logistics and supply chain are able to benefit from are better visibility in inventory management, faster operation in warehousing and order processing, ability to work in challenging environment.

With RFID technology, information and status of an individual item can be collected automatically with a RFID reader. By this way, the company is able to check which items are available at the store. Thanks to its better visibility benefit, RFID technology optimizes inventory management. Usually, inventory accuracy is about 70%, with RFID it could be 90-95% correct.

Many manual tasks such as receiving goods and pallets can take a lot of time by using barcode. This time-consuming problem can be solved with RFID technology. A RFID reader is able to identify and collect all the information of tagged products effortlessly, therefore order processing is accelerated and warehouse management is optimized.

He also shared that there is a challenge for barcode when it comes to certain environment. RFID tagged product can be read by simply waving a reader. Unlike RFID technology, barcode cannot be read if the tag is unclear or the sight of light is far away from the barcode.

Companies' expectations of RFID technology

Sami Isomäki stated that beside the major benefits that he answered in the previous question, companies' expectations for RFID technology have come to certain points. He focused on two main points, which are the cost of tag and technology development. Companies believe that in order to get RFID technology to be widely used, the cost of the tag should get cheaper. Moreover, many companies have the same trouble when RFID tag is known as unreadable when it comes to particular environments such as metal and liquid. Thus, they expect the technology breakthrough.

Major challenges of RFID technology in logistics

According to Sami Isomäki, there are three major challenges of RFID implementation. They are slow adoption, the reading issue in challenging environment, the cost of tag on certain products.

He stated that RFID technology has its slow development. In huge retail stores, they have thousands of vendors and manufacturers who come from different locations. Thus, in order to create logistics chain with RFID technology, it takes a lot of time for these vendors and manufacturers to use RFID tag to mark their products. Sami Isomäki shared that barcode was in the same situation when the technology was at it beginning 30 years ago.

Some kind of products is known as challenging products when it comes to RFID implementation, such as metal products or products contain liquid. RFID tag cannot be read when the pallet is full of metal products, because the metal will block the signal from penetrating through the whole pallet. Fortunately, Sami Isomäki believed that RFID tag is developed to have technology breakthrough, it is becoming more sensitive and getting better year by year.

The technology manager also listed tag price as a major challenge, when a normal passive RFID tag costs 10 cents per piece. Thus, there is a huge effect when using these tags on low-value products such as milk, the price of products themselves will be dramatically affected.

Sami Isomäki's thoughts about the significant concerns of the top 100 3PL providers in 2017

After conducting a survey of the top 100 3PL providers 2017, the most significant concerns about RFID implementation were global standards, data management and implementation cost.

Sami Isomäki shared that the standard of RFID technology is quite good. Companies that stated global standards as their concern may be because they require a different kind of data to store in the tag, which requires being standardized differently. He also said that GS1 is a global organization, it actually standardizes how RFID reader and tag operation. All the products with barcode technology are also based on GS1 standard, it standardizes how barcode looks like and the type of data input in the barcode.

He agreed that data management is one of the significant concerns while using RFID technology with many reading points, it creates a huge amount of data. Thus, company needs a strong system that can support and process all received data. These systems such as warehouse management or Enterprise Resources Planning system (ERP) can be unable to process this huge amount of data because they systems are quite old and they are made for using with barcode. Sami Isomäki also shared that in the logistics chain, data management is known as a problem because different participants are unable to share the data. For example, a lot of companies use only point to point connection, the information can only be shared between the two companies, this creates difficulty when there are more than 2 participants in the logistics chain. With RFID, it is more beneficial to use a cloud-based system that all the data is updated to the cloud and all the companies in the chain are able to connect to the cloud to get all the information.

Sami Isomäki also agreed with the high implementation cost of as one of the significant concerns. As he answered the previous question, the cost of RFID tag itself is able to affect the price of the product. Moreover, the high cost of implementation is the main reason creates hesitation in using the technology.

Sami Isomäki's thoughts about improvement for the most significant concerns from the survey

For the global standard issue, Sami Isomäki shared that the basic consumer products already have standard available as aforementioned. However, he also said that in particular industry like the oil industry, it has to create its own standard to support its specific type of product. Moreover, Sami Isomäki believed that global standard is an issue when it comes to the case of huge retail stores. These stores provide thousands of products from different locations, therefore it takes a lot of time to mandate all vendors and manufacturers to tag their products with the same RFID standard. He also shared that although EPCGlobal is global standard, there is a problem with frequency bands known as IMS bands (Industrial Scientific and Medical Bands) in different countries.

The technology manager suggested that in order to process a huge amount of data collected from many RFID reading points, logistics companies should implement stronger system rather than

warehouse management system and ERP system, for example the Enterprise Information System (EIS). Furthermore, Sami Isomäki also shared that cloud-based system is able to improve data management efficiently, where all participants in the logistics chain are able to access the same data effortlessly and conveniently.

Sami Isomäki shared that RFID technology is developing to become better and cheaper. However, he provided that it would be costly for the actual integration of the reading system to some background system due to its complicated process. Moreover, it also costs a huge amount of investment if company decides to acquire customized programs. He said that implementation cost is a problem because companies claim that they will implement RFID technology in mass numbers when the price falls, while RFID technology producers said that the price will fall if there are mass RFID implementation. He also shared that the cost is only known as high for those who are the pioneers in using RFID technology because they have to examine the possible benefits for many years. Thus, Sami Isomäki suggested the solution for this problem is that it requires all participants in logistics chain to implement RFID economically.

Future relation of RFID technology and barcode system

Sami Isomäki believed that nowadays, RFID tag and barcode are used at the same time on the same item. Barcode is printed on top of the RFID tag and both of them share the same information. By this way, in the logistics chain, different parties can be able to use different technologies to read the same item. He confidently said that RFID technology and barcode will be used equally for a long time.

7. Discussion

The interview with RFIDLab Finland Ry about RFID implementation in logistics operations show that the current situation of the technology is known as stable and positive. In logistics industry, RFID technology is widely deployed in order processing, manufacturing and warehousing. According to the survey, among five logistics activities, all logistics providers strongly agreed that inventory management was improved as the result of RFID technology implementation. Other major improvements were order processing, warehousing and transportation. 21 logistics providers agreed and strongly agreed with the better performance in order processing and warehousing, while 16 companies agreed and strongly agreed that they experienced the improvement in transportation, $p = 0.954$ and $p = 0.727$, 95% CIs [0.751, 0.997] and [0.495, 0.883], respectively. Despite the better performance of the four logistics activities, customer service was not improved as much as others with RFID technology. 15 logistics providers experienced the improvement of customer service, while 6 companies strongly disagreed and disagreed, $p = 0.681$ and $p = 0.272$, 95% CIs [0.451, 0.852] and [0.116, 0.504], respectively. As the result, the implementation of RFID technology performed the positive result in logistics activities, especially in inventory management, order processing, warehousing and transportation, while customer service was not improved as much as others. However, it seems that a current problem is to convince all logistics and supply chain members towards integration with RFID technology. It is a slow process to mandate all vendors and manufacturers to mark all products with RFID tag and to use the same RFID standard.

Based on the conducted survey, all logistics providers strongly experienced that RFID technology increased information visibility and real-time data, and brought better tracking and inventory control to their company. Other major benefits were better warehouse performance, faster and cheaper identification process, less out of stock, better customer service due to higher delivery reliability and labor cost reduction. 21 logistics providers agreed and strongly agreed with better warehouse performance as a benefit of RFID technology, $p = 0.954$, 95% CI [0.751, 0.997]. 20 companies experienced their benefits as faster and cheaper identification process and less out of stock, $p = 0.909$, 95% CI [0.694, 0.984]. While 19 out of 22 companies experienced better customer service and 17 out of 22 companies were able to reduce their labor cost, $p = 0.863$ and $p = 0.773$, 95% CIs [0.64, 0.964] and [0.542, 0.913], respectively. Beside these major

benefits, 10 out of 22 logistics providers disagreed and strongly disagreed that their company experienced reduce shrinkage, p = 0.455, 95% CI [0.251, 0.673]. As the result, the significant benefits from RFID technology that logistics providers experienced in their company were the increase in information visibility and real-time data, better tracking and inventory control, followed by better warehouse performance, better identification process, less out of stock and labor cost reduction. Even though the theoretical section about the benefits of RFID technology on logistics provides that reduction in theft and shrinkage is one the advantages offered by RFID, the majority of companies refused these benefits.

In logistics operations, besides the benefits offered by RFID technology, there is still hesitation in implementation of the technology. The logistics providers stated that their top three significant concerns are the cost of implementation, global standards and data management.

Costs are known as a major concern that hesitates RFID implementation. By using RFID technology on basic consumer goods as item level, the price of low-value products is affected dramatically when individually identified. Moreover, due to the complicated process, RFID implementation is known as costly for the actual integration of the reading system to some background system, and it costs even more with customized programs. Sami Isomäki from RFIDLab Finland ry suggested that the cost can be shared base on benefits when all participants in logistics chain implement RFID technology. However, it is not easy to make it happens, because of the complexity in logistics chain operations, and cost and financial benefits of RFID implementation are different among participants.

The survey on logistics providers and the interview with RFIDLab Finland ry showed standardization as an issue. As aforementioned in the theoretical section, although EPCGlobal is developed as a global standard, which is nearly able to work together with ISO standard, Sami Isomäki stated that there is a problem with frequency bands applied for different countries. Moreover, it takes a lot of time to mandate all vendors and manufacturers to tag their products with the same RFID standard. Thus, another problem is that when there are many RFID vendors involved with different standards, higher cost is required for devices to support these different standards.

Data management is also a crucial concern that hesitates logistics operations in RFID implementation. A huge amount of data is created when it comes to reading RFID tag in bulk or many reading points, this is where errors are addressed. Thus, logistics operations should implement a stronger system which is able to support and process huge received data. Moreover, Sami Isomäki believed that integration of data management in logistics operations and data exchange between logistics chain can be improved using cloud-based systems. By this way, all members in logistics chain are able to effortlessly gain access to the same information, therefore better logistics system integration is created.

Besides the top three significant concerns based on logistics providers, security threat, lack of knowledge and experience were slightly concerned or stated as somewhat concerned. Majority of companies gave their answer as somewhat concerned when it came to the concern about security threat and only 6 out of 22 companies slightly concerned about it, $p = 0.455$ and $p = 0.272$, 95% CIs [0.251, 0.673] and [0.116, 0.504], respectively. 12 logistics providers did not concerned about the lack of knowledge and experience of RFID technology and only 6 companies slightly concerned about this issue, $p = 0.545$ and $p = 0.272$, 95% CIs [0.326, 0.749] and [0.116, 0.504], respectively. Most of companies did not concern at all about privacy issues and environmental issues. 15 companies did not see privacy issues as a barrier and 16 companies did not have any problems when it comes to reading with products containing metal and liquid, $p = 0.682$ and $p = 0.727$, 95% CIs [0.451, 0.852] and [0.495, 0.883], respectively. As the result, the significant concerns of RFID technology implementation base on 22 logistics providers were cost of implementation, global standards and data management. They also gave slightly concern about security threat, lack of knowledge and technology maturity, while privacy issues and environmental issues were not known as barriers to them.

Even though the survey shows that the majority of logistics providers believed that RFID technology will dominate barcode, RFID vendor, RFIDLab Finland ry, believed that barcode and RFID technology will be equally developed for a long time in the future. The combination of RFID and barcode is used to share the same information on the same product. This creates an advantage for logistics chain members since they are able to use different technologies to identify the product.

8. Conclusion

From the survey questionnaires and the conducted interview, this thesis aimed to understand the current situation of RFID technology in logistics; the motivations and concerns of RFID implementation; and the possible solution for these concerns. In the last 5 years, the development of RFID technology has risen positively, the technology has reduced its technical problems. They include error reading with products contain liquid and metal, reading issue when it comes to simultaneously read in bulk the whole pallet with tagged products. Currently, the situation of RFID technology is known as stable and more RFID projects are carried out. However, in logistics chain, the technology is known as slow development because it seems to be a current problem to mandate all vendors and manufacturers to mark their products with RFID tag and to use the same RFID standard system.

In logistics activities, the main reason that companies implemented RFID technology was to optimize inventory management in their logistics system. Furthermore, logistics operations strongly agreed that increases in information visibility and real-time data, as well as better tracking, were the major benefits brought by RFID technology.

Beside these major benefits, there is still hesitation in RFID deployment due to some significant concerns. These include cost of implementation, data management and global standard. One way to improve the high implementation cost is to share between the supply chain members. However, due to the difference in cost and financial benefit between participants, it is hard to make it happened. Data management is another major concern when it comes to processing a huge amount of data. In order to improve this issue, instead of using systems such as ERPs or warehouse management system, which are designed for barcode, logistics operations need a stronger system to support the huge amount of received RFID data. Furthermore, cloud-based system is a great solution for better logistics system integration, where data exchange between logistics chain can be improved. Even though EPCglobal and ISO are two main standardization institutions, different standard requirement for different countries is a major barrier for RFID applications. RFID vendor, RFIDLab Finland ry, shared that they developed devices which could be able to operate with different standard requirements. However, the cost to implement this technology is known as high, and it greatly affects the price of low value items, for example, milk.

The results of the questionnaire and the interview go along with the research in the literature review. As discussed in the theoretical part about the logistics activities and benefits of RFID technology in logistics, better inventory control, better warehouse management and faster order fulfillment are the advantages offered by RFID. The answers from logistics providers and RFID vendor, RFIDLab Finland ry, showed that when it comes to RFID implementation, inventory management is one of the logistics activities which is improved the most. The major advantages that logistics and supply chain operation are able to benefit from RFID technology are better visibility in inventory control, which increases inventory accuracy from 70% to 90%-95%, faster and better process in warehousing and order fulfillment. However, technology manager, Sami Isomäki, mentioned a benefit of RFID, which is not indicated in the theoretical section is the ability to work in challenging environment. It means unlike RFID technology, barcode system cannot be read if the sight of light from a reader is over specific distance or the tag is unclear.

The challenges of RFID deployment also fall into the theoretical section. As discussed in the companies' concerns in RFID implementation section, these issues include cost of implementation, global standard, data management, environmental issue. Based on the survey questionnaire, some of the logistics providers stated that they concern about environmental issue when it is hard to get 100% response if RFID tag is attached to metal or liquid product; they believe cost of tag should be reduced in order to be widely used; they believe RFID should become standard in logistics and supply chain, and all supply chain members are able to share the same information and benefit from the same platform. Sami Isomäki from RFIDLab Finland ry mentioned a major challenge, which is not discussed in the above theoretical section is the slow adoption of the technology. It takes a lot of time for all logistics and supply chain members to use the same RFID standard to attach RFID tag on their products.

The relation between RFID technology and barcode for a next 5 years is known as equally develop, where barcode is printed over the RFID tag. By this way, logistics chain members without RFID implementation are still able to use another technology to read the product.

This study was conducted to understand the insight of the current use of RFID technology in logistics, the benefits and major concerns of RFID in logistics operations and the possible improvements of these significant concerns. The results of this study provide the current problems of RFID technology, these are the major barriers that hinder the success of the

technology. Furthermore, after identifying these significant problems, RFID vendor, who develops RFID technology, not only searches for the possible improvements and solutions for them, but prevents future issues. In logistics operations, the findings of this study provides the ability to create better logistics chain integration together with RFID technology.

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Appendices

Appendix 1. The rest of the diagrams

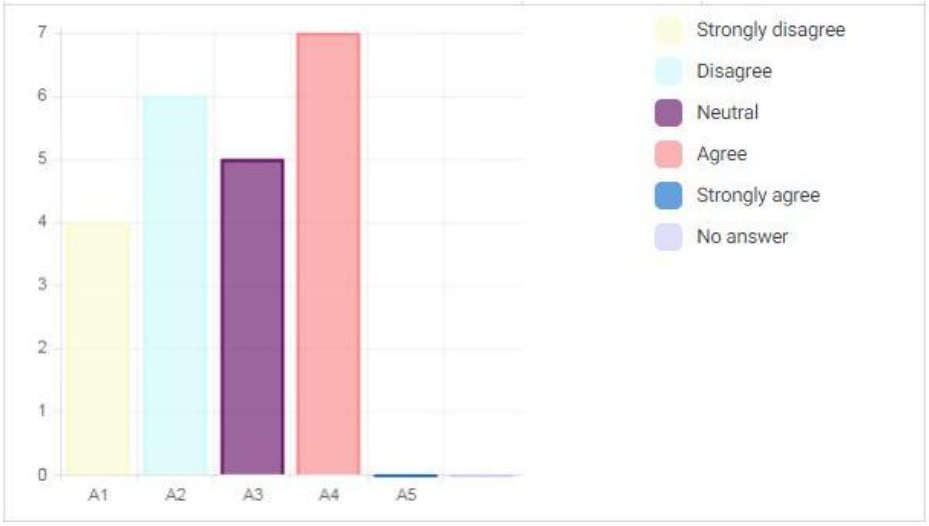


Figure 24. RFID technology offers reduce shrinkage

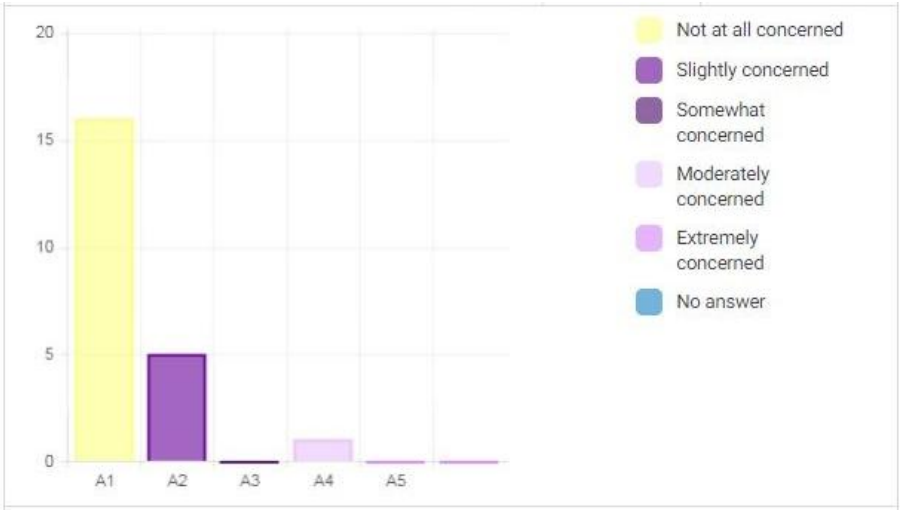


Figure 25. Companies' concern about environmental issues

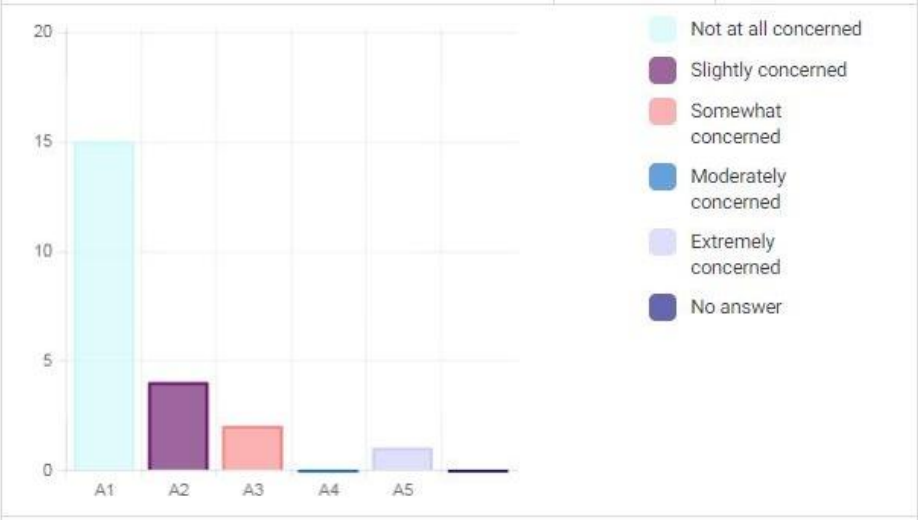


Figure 26. Companies' concern about privacy issue

Appendix 2. Survey questionnaire

Has your company ever used RFID technology?

Yes | No | No answer

In your opinion, RFID tech improves the following logistic activities:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No answer
Customer Service	○	○	○	○	○	●
Inventory Management	○	○	○	○	○	●
Order processing	○	○	○	○	○	●
Warehousing	○	○	○	○	○	●
Transportation	○	○	○	○	○	●

In your company, RFID tech offers the following benefits:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	No answer
Real time data, increase information visibility	○	○	○	○	○	●
Better tracking and inventory control	○	○	○	○	○	●
Improve stacked lead-time	○	○	○	○	○	●
Less out of stock, increase sale	○	○	○	○	○	●
Theft reduction	○	○	○	○	○	●
Faster and cheaper identification process	○	○	○	○	○	●
Labor cost reduction	○	○	○	○	○	●
Reduce shrinkage	○	○	○	○	○	●
Better customer service due to higher delivery reliability	○	○	○	○	○	●
Better warehouse performance	○	○	○	○	○	●

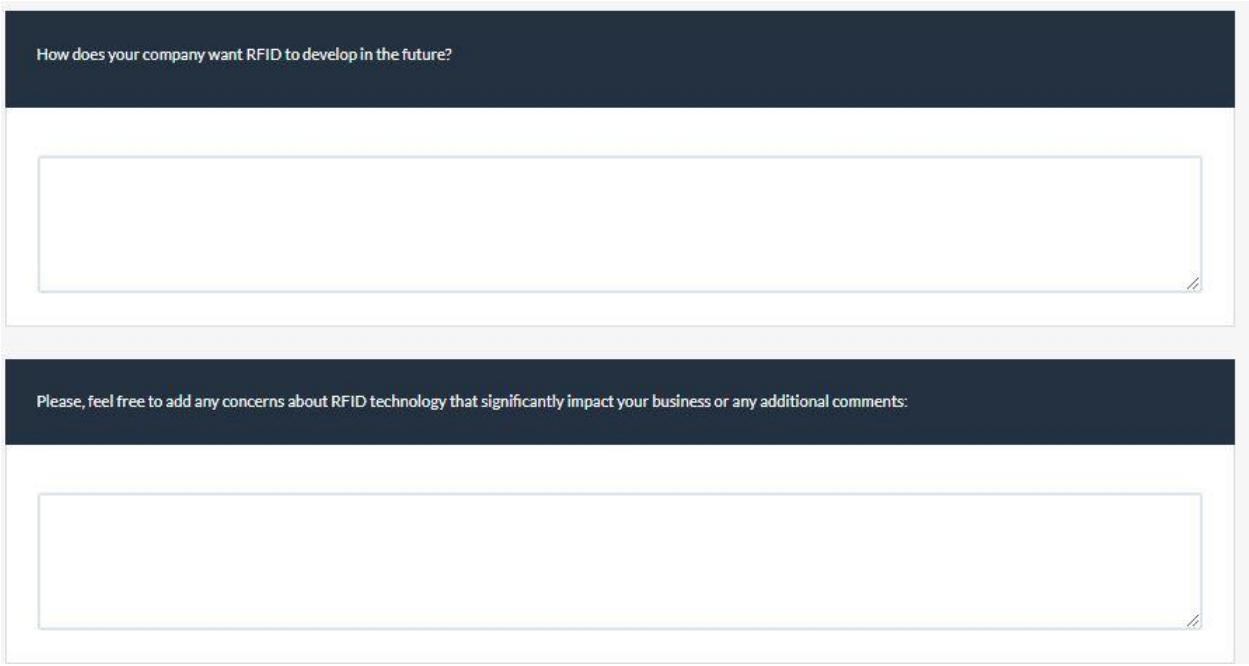
How concerned is your company about the following barriers of RFID tech?

	Not at all concerned	Slightly concerned	Somewhat concerned	Moderately concerned	Extremely concerned	No answer
Security thread (attack on RFID systems)	○	○	○	○	○	●
Privacy issues	○	○	○	○	○	●
Improve stacked lead-time	○	○	○	○	○	●
Cost of implementation	○	○	○	○	○	●
Global standards and regulations	○	○	○	○	○	●
Environmental issues	○	○	○	○	○	●
Lack of knowledge and experience	○	○	○	○	○	●
Technology maturity	○	○	○	○	○	●
Data management	○	○	○	○	○	●
No issues	○	○	○	○	○	●

What do you think about the relation between RFID technology and barcode in the next 5 years?

ⓘ Choose one of the following answers

- ○ RFID technology will dominate barcode
- ○ Barcode will dominate RFID technology
- ○ Both technology will be equal
- ● No answer



Appendix 3. Interview

Interviewee: Sami Isomäki

Company: RFIDLab Finland ry, Vantaa, Finland

Title: Technology manager

Date and Time: Thursday 22nd March 2018 9:00-9:55

Questions:

About RFID

1/ How RFID is currently used in logistics industry?

2/ What do you think about the development and improvement of RFID technology in the last 5 years?

About RFID in logistics activities

3/ Based on the companies using RFID technology for their logistics system, what are the major benefits of the technology?

4/ What are company expectations of RFID technology for their logistics system?

RFID barriers

5/ Where do you see the (major) barriers of RFID technology in logistics?

After conducting a survey questionnaire on the top 100 3PL providers 2017, besides the benefits of RFID on logistics activities, the most significant concerns about RFID implementation are Cost of implementation, global standards and data management.

6/ According to the survey result, what impacts do you think these concerns have on RFID technology?

7/ How do you see the possible solutions for these concerns so that companies are able to overcome this barrier and optimize their logistics system?

8/ What is the future relation of RFID technology and barcode system in the next 5 years?

9/ Do you have any open view or anything else to add?

Appendix 4. List of the top 100 third-party logistics providers (Inbound Logistics 2017)

A.N. Deringer	Mallory Alexander International Logistics
Agility	Matson Logistics
Alliance Shippers	MD Logistics
Americold	MIQ Logistics
APL Logistics	
Approved Freight Forwarders	
Armada	
Atlanta Bonded Warehouse	National Retail Systems (NRS)
Averitt Express	NFI

Bender Group
BLG Logistics
BlueGrace Logistics
BNSF Logistics
Burris Logistics

C.H. Robinson
Cardinal Health Integrated Logistics
CaseStack
Celadon Logistics
CEVA Logistics
Comprehensive Logistics
Corporate Traffic Logistics
Coyote Logistics
Crane Worldwide Logistics
Crowley Logistics
CT Logistics

DHL Supply Chain
Distribution Technology
DSC Logistics
Dupre' Logistics

Echo Global Logistics
Estes Forwarding Worldwide
Evans Distribution Systems
Expeditors International

FedEx Supply Chain
Fidelitone
FLS Transportation Services

General Dynamics Information Technology
GEODIS
GlobalTranz Enterprises

ODW Logistics
Odyssey Logistics & Technology

Penske Logistics
Performance Team
Pilot Freight Services
Port Jersey Logistics
Port Logistics Group
ProTrans
Purolator International

R2 Logistics
Redwood Logistics
Regal Logistics
Rinchem Company
RR Donnelley/DLS Worldwide
Ruan
Ryder

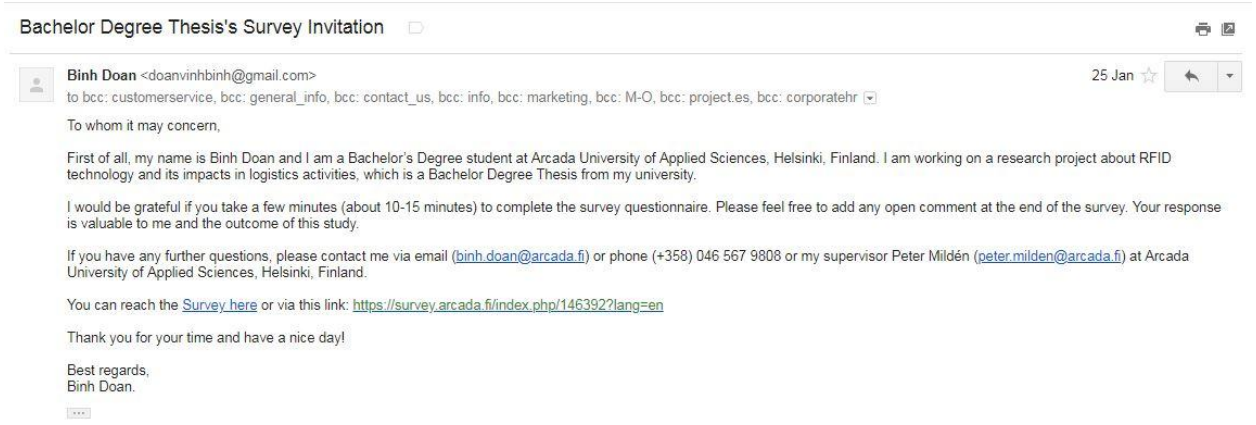
Saddle Creek Logistics Services
Schenker
Schneider
SEKO Logistics
Sunset Transportation
Swift Logistics
Syfan Logistics
syncreon

Taylored Services
TransGroup Global Logistics
Transplace
Transportation Insight
Tucker Company Worldwide

Union Pacific Distribution Services
Universal Logistics Holdings
Unyson

Holman Distribution	UPS UTXL
J.B. Hunt Transport Johanson Transportation Service	Vantix Logistics Veritiv VersaCold Logistics Services Verst Group Logistics
KAG Logistics Kane Is Able Kenco KINEXO Kuehne + Nagel	Wagner Logistics Werner Logistics WSI (Warehouse Specialists, LLC)
Landstar System LEGACY Supply Chain Services LeSaint Logistics Lynden	XPO Logistics Yusen Logistics (Americas)

Appendix 5. Invitation e-mail for the Survey Questionnaire



Bachelor Degree Thesis's Survey Invitation

Binh Doan <doanvinhbinh@gmail.com> 25 Jan

to bcc: customerservice, bcc: general_info, bcc: contact_us, bcc: info, bcc: marketing, bcc: M-O, bcc: project.es, bcc: corporatehr

To whom it may concern,

First of all, my name is Binh Doan and I am a Bachelor's Degree student at Arcada University of Applied Sciences, Helsinki, Finland. I am working on a research project about RFID technology and its impacts in logistics activities, which is a Bachelor Degree Thesis from my university.

I would be grateful if you take a few minutes (about 10-15 minutes) to complete the survey questionnaire. Please feel free to add any open comment at the end of the survey. Your response is valuable to me and the outcome of this study.

If you have any further questions, please contact me via email (binh.doan@arcada.fi) or phone (+358) 046 567 9808 or my supervisor Peter Mildén (peter.milden@arcada.fi) at Arcada University of Applied Sciences, Helsinki, Finland.

You can reach the Survey here or via this link: https://survey.arcada.fi/index.php/146392?lang=en

Thank you for your time and have a nice day!

Best regards,
Binh Doan.