



RFID Technology in Logistical Activities

Suvash Rijal

FOREWORD

This bachelor thesis is the concluding part of our degree at Arcada University of Applied Sciences. The idea of writing my bachelor thesis on ‘RFID Technology in Logistical Activities’ started to grow in 2015 when I was doing a course in Logistical Module at Arcada UAS. During the course, Warehousing and Optimization, we were lectured in accordance with two sections; Inventory Control and Computer Course. As a part of computer course, we were provided with an opportunity to make an educational excursion to RFID Lab Finland Ry located in Technopolis Building in Vantaa, Finland. Technical Manager, Sami Isomäki from RFID Lab Finland Ry provided general information on RFID technology, its applications in different business sectors, demos in inventory control and RFID-tag printing. This technology triggered curiosity in me and I started gathering information on it. Findings on RFID Technology and its application on logistics were very interesting. It was the point when I decided to write my degree thesis on the application RFID technology in various logistical activities.

This thesis is an outcome of fruitful collaboration of every individual who has positively contributed with enormous commitment, motivation, and enthusiasm in this research. I express my special gratitude towards Lecturers from Arcada University of Applied Sciences who conducted pre-thesis courses and contributed with all support and information. My supervisor, Ann-Christine Sved assisted me throughout the work and always taken the time to discuss different matters and provided with important input and guidance. Interviewee Sami Isomäki from RFID Lab Finland, Heikki Lahtinen from Limowa Oy and Respondents to survey from different companies are also among special characters who deserve special thanks for their support. Without your effort, this bachelor thesis would not have been what it is today.

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Supervisor (Arcada):	Ann-Christine Sved
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<p>Abstract: Digitization and adoption of technology into business operations is higher in Finland. In the field of logistics and supply chain, this journey was already started during the 90s with the implementation of RFID Technology in logistical activities. Since then, there has been ups and downs situation with this technology. This thesis focuses on understanding the present situation of RFID Technology, experiences and expectations of user companies and non-user companies and future growth of RFID Technology in Finland. For the better understanding of the topic, an overview of RFID technology, different cases and various RFID implementations in Finland is discussed in theoretical section. To achieve thesis aim, a survey and interviews were conducted. Survey were answered by companies in Finland like Kone, Havi Logistics, Kovanen Logistics, Zara and Kaukokiito. Interviews were taken with Sami Isomäki, Technology Manager; RFID Lab Finland Ry and Heikki Lathinen, Project Manager; LIMOWA RY. The results obtained in the empirical section of this thesis are to some extent expected and flow along the theoretical section of this thesis. The present position of RFID Technology in Finnish Market is steady and positive. Companies using RFID Technology are satisfied and would like to recommend this technology to other similar companies who can possibly implement this technology in their operations. Also, user companies have experienced several advantages with RFID implementation. Whereas there is a huge gap in understanding this technology by users and non-user companies of RFID. The cost of implementation and other technical and business issues are recognized as major challenges for its implementation. Regarding the future growth, RFID technology is believed to grow in Finnish Market. Barcode and RFID are only two existing technologies in the market that can assist logistical operation. Majority user companies believe that in RFID will replace Barcode in the sector of logistics.</p> <p>User-experience is positive and concerned authorities are working together to resolve issues with this technology. Therefore, RFID will sooner or later make its outbreak in Finnish Market.</p>	
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1 INTRODUCTION

This section contains the background of this research, research aim, research question, focus and limitation of research and abbreviations used in this entire degree thesis.

1.1 Background

With the rapid development of technologies in last few decades, like other business operations, logistical activities as well realized a drastic change in the way they perform previously. Manual inventory management techniques were replaced by barcodes in early 70s. Ever since barcode technology is developed, modified and equipped with more advanced technologies for the efficient and systematic function (Barcode History, 2012). Even though barcode technologies are modified and developed, there are certain limitations of barcode technologies. Demand for faster and more accurate operation is getting higher. Therefore, advanced technology like RFID is considered as a better replacement to the barcode. RFID has the potentiality to overcome the limitations of barcodes as well accelerate faster, convenient and accurate operation. (NordicId, 2011)

Finland, as a country representing first world country, has set the benchmark in adopting information technology and digitalization in business operations. Like others field, Finnish Logistics and Supply Chain seem positive towards newer concepts like Logistics 4.0 to develop digitalized solution for their operations (Festo Finland,2017). RFID technology could be one of the technology to back up these kinds of newer concepts. RFID Technology carries huge possibilities to contribute Finnish companies in adding competitiveness in their supply chain. Application of RFID Technology into logistical operations could be an option to optimize logistics and supply chain activities performed in Finland. RFID technology was first introduced to the world in the late 50s primarily focused in logistical activities. Rather its commercialization made successful outbreaks in sectors like security, livestock rearing and others. (Nfcnearfiledcommunication.Org, 2016).

1.2 Research Aim

Technologically RFID is way better than existing technologies adopted in logistics and supply chain activities. Although this technology has been around us from a long time and has updated timely to adopt itself in this field, it is often described as mixed feelings of enthusiasm and doubts. The main aim of this research is to understand the present situation of RFID application in logistical activities, experiences, and expectations of companies and possibilities of future growth in the Finnish market. Information on users' experiences, expectations of possible users and thoughts of different organizations working in similar fields are the base for this research. Understanding, analyzing this information and determining present and future position of RFID technology in logistical activities will be focused.

1.3 Research Question

Although RFID technology is ahead of existing technologies used in the logistics sector, wider application of this technology into logistical activities has not yet made noticeable outbreak in Finland. Therefore, this research will answer the following questions:

What is the present situation of RFID Technology Implementation in Finland?

What are Finnish Companies' experiences and expectations with this technology?

What are the possibilities of future growth in Finnish Market?

1.4 Focus and limitations

This research is primarily focused on understanding the use of RFID Technology in various logistical operations in Finland, experiences and expectations and possibilities of growth of RFID Technology implementation in Logistical Activities in Finland. Overview of RFID technology and case studies included in the theoretical section is totally based on RFID Technology and its application. The empirical section is drawn based on survey and interviews. Questionnaires for the empirical section is answered by the responsible personnel of the companies that has already adopted this technology and those

planning to adopt this technology in near future into their logistical operation. Interviews are taken from the authorized personnel from organizations working in the similar field.

This research is limited only in RFID implementation in Logistical Activities in Finland. Therefore, this research has no relation to RFID use in other business operations other than logistical activities.

1.5 Structure of the study

This research altogether contains five different sections: Introduction, Theoretical Framework, Method, Empirical Section and Discussion. Introduction section explains motives, methods, research design and its limitation. Theoretical parts include an overview of RFID technology, advantages of the application of RFID in Logistical Activities and concerns regarding RFID technology. Different cases on the successful implementation of RFID technology into logistical activities in Finland are discussed in this section. The method section includes procedures applied to obtain empirical section, implementation of the survey, research approach and data collection. The empirical section includes the result of survey and interviews. Answered survey questionnaires are presented thoroughly, analyzed and explained in this section. Also, interviews are transcribed in empirical section of this thesis. Lastly, results are discussed and the conclusion is drawn in the discussion section.

1.6 Abbreviations

Abbreviation form of different technical words is used repeatedly in this thesis. The full forms are as follow:

RFID : Radio Frequency Identification

Tech: Technology

LF: Low Frequency

HF: High Frequency

UHF: Ultra High Frequency

SCM: Supply Chain Management

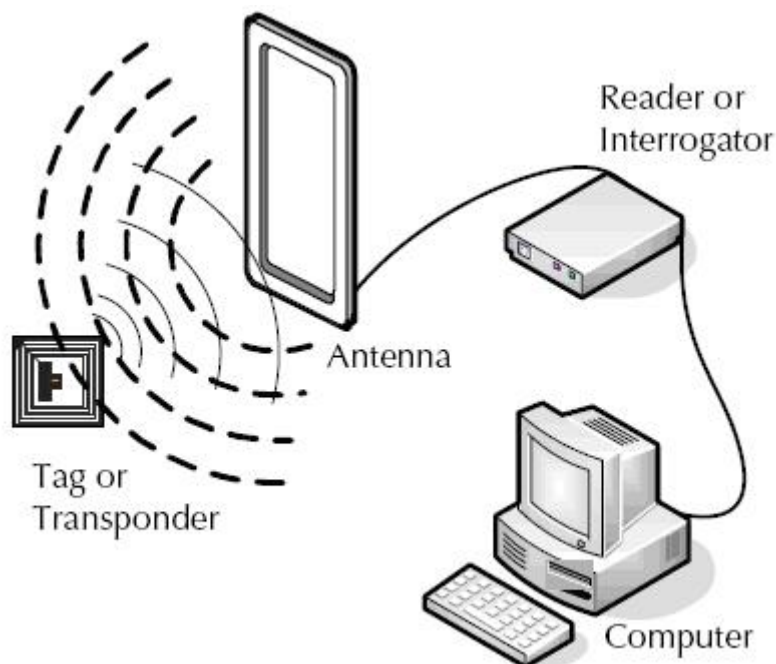
2 RFID TECHNOLOGY: OVERVIEW AND APPLICATION

Radio Frequency Identification (RFID) is an automated identification technology that uses tags to transmit data upon RFID reader queries. In another word, RFID is the wireless non-contact use of radio-frequency electromagnetic fields to transfer data for the purposes of automatically identifying and tracking tags attached to assets (Jin Li, Cheng Tao, 2006). There exist RFID technologies of different categories based on their capacity. Even if they are different in system or categories, they all are based on same fundamental principle where the attribution of unique physical goods can be easily transposed to the computer system (Fabian Ropraz, 2008).

This section includes general concept of the technology, components of RFID Technology, and frequencies of RFID and History on development of RFID Technology

2.1 Components of RFID Technology

As RFID technology is a system, it comprises of different components. The basic components of RFID systems are RFID tags, antenna, reader or interrogator and the host computer with application software.



2.1.1 Tags

Tags are tiny microchips with memory and an antenna coil in it. These tags are programmed with information that uniquely identifies itself. When RFID tags receive a query or a request, it respond by transmitting its unique identification codes and other data back to the interrogator. RFID tags are of two kinds: Active RFID Tags and Passive RFID Tags. (FireflyRFID, 2016)

Active RFID tags have an internal power source usually battery to transmit signal to the reader. Active RFID tags are bit expensive than passive RFID tags as they have greater communication distance and comparatively higher memory capacity. These tags operate in Ultra High Frequency (UHF) and it has read range of 30 to 100 + meters. Active RFID tags are commonly used for assets tracking, rail cars and industrial manufacturing, mining and construction. (Impinj, 2016)

Passive RFID tags have no internal power supply therefore these tags are powered by incoming radio frequencies that are received through tag's internal antenna. These tags are read relatively from short distance. They operate in Low frequency (LF), high frequency (HF) and Ultra High Frequency (UHF). It has read range of near contact to 25+ meters. Tags are comparatively cheaper than Active RFID tags as well there are wide range of tag sizes and types. These tags are commonly used in Supply Chain, High Volume manufacturing, pharmaceuticals, item tracking and electronic tools. (Impinj 2016)

2.1.2 RFID Antenna

RFID antenna is made up of coil with one or more windings and a matching network. RFID antenna uses power from the reader to generate a field allowing the reader to transmit and receive signals from the RFID tags. RFID antenna radiate the electromagnetic waves produced by the reader and in the same way, receives radio frequency signals from the transponder. (Jemuel, 2014)

2.1.3 Reader

RFID reader is the main component of RFID system and is termed as brain of the RFID system. Readers, also called transceiver or interrogator, are devices that transmit and receive radio waves to communicate with RFID tags. The radio frequency energy from the reader antenna is collected by the RFID tag antenna and used to power up the microchip. (FireflyRFID, 2016)

2.1.4 Host Computer

Host computer are equipped with application software to operate RFID system. The main function of host computer is to leverage the data generated by an RFID system and host reader driver components. Complete control over RFID system is made through host computer.

2.1.5 Additional Accessories

Based on requirements, there are few other additional accessories in RFID system like **RFID printer, Hand-held readers and computers, and Software.**

If the company intends to print their own RFID tags, it is possible with the use of RFID printers. These RFID printers can encode tags as well. Printing own RFID Tags/labels give user an opportunity to produce a required number of tags and can resize, change and edit tags themselves in no time. (Swedberg,2013)

Hand-held readers and computers perform same task as RFID reader and computer but are portable. It provides simplicity and more advance functionality of RFID system in company. These readers and computers are more effective to find and locate items in larger areas and it is more effective to understand inventories in faster and efficient manner. (Pugh,2015)

Addition of accessories to the RFID system might require additional Software to operate effectively. Beside that changing features and operation of RFID would require specific RFID software. Better software acts as competitive advantages to the system and effectiveness in operation. (Suzanne,2014)

2.2 Frequencies of RFID

Based on the capacity of tags, RFID technology operates in different frequencies. Frequency refers to the size of radio waves used to communicate between components of RFID system. Different types of frequencies are Low Frequency (LF), high frequency (HF), Ultra-High Frequency (UHF) and Microwave. System with lower frequency has shorter reading range and slower of data transmission. But this system with lower frequency has increased capabilities of reading near or on metal or liquid surfaces. Whereas system with higher frequency has longer reading range and faster data transmission but are more sensitive to radio wave interference caused by liquids and metals in the environment. (Impinj, 2016)

Frequency Range	LF	HF	UHF	Microwave
	125-134.2 KHz	1MHz-400 MHz	860 MHz -960 MHz	1 -5.8 GHz
Data Speed	Slower ←————→ Faster			
Ability to read near metal	Better ←————→ Worst			
Antenna Coil	Longer ←————→ Shorter			

Fig 2: Types of frequencies of RFID tags (source: Alexan Tech. Inc. 2009)

Low Frequency RFID operates in frequency range between 30 KHz to 300 KHz. Most common LF RFID in operation is 125 KHz and few in 134 KHz. Although LF RFID is not much sensitive to radio wave interference, it has very short reading range i.e. 10 cm and has slower transmission rate. (Alexan Tech Inc., 2009)

High Frequency RFID operates in frequency range between 3 to 30 MHz. Most common HF RFID in operation is 13.56 MHz Read Range for HF RFID is in between 10 cm and 1 meter. This RFID tags as well have shorter read range but has faster transmission rate

as compared to LF RFID. They are commonly used for ticketing, payment and data transfer application. (Alexan Tech Inc., 2009)

Ultra-High Frequency RFID operates in frequency range between 300 MHz to 3 GHz. UHF Gen2 RFID system that operates between 900 and 915 MHz is among the most commonly used UHF RFID. Passive UHF system has read range up to 12 meters whereas active UHF system has read range up to 100+ meters. UHF RFID has very long read range and faster data transmission rate. But the radio waves from UHF RFID cannot pass through metallic and liquid items. These UHF RFID are widely used in retail inventory management, pharmaceutical and wireless device. Due its advantageous capacity, UHF is the fastest growing segment of RFID market. (Impinj, 2016)

Microwave frequency RFID operates at range between 1 to 5.8 GHz. Read ranges of this RFID is very long compared to others. The most common use of this RFID tag is made for electronic toll collection. (Alexan Tech Inc., 2009)

2.3 History

Concept of RFID was traced back to Second World War technology. Countries like German, Japan, America and Britain were all using radar which had been discovered by Sir Robert Alexander Watson Watt. Radar at those days was used to warn about the approaching planes while they were still miles away. But the then technology was unable to identify the planes belonged to enemy and even pilots and officers returning from a mission. Watson-Watt with British in a secret project developed first active identify friend of foe (IFF) system. A transmitter was installed on each British plane that received signals from radar stations and it began broadcasting a signal back that identified aircraft as friendly. RFID works on same concept and it worked as a base of development of RFID Technology. (Roberti, 2005)

Commercialization of RFID started in 1960s when Sensomatic and Checkpoint worked in collaboration with companies like Knogo that developed electronic article surveillance

equipment to counter the theft of merchandise. In the 1970s, RFID technology took a right track of growth as developers, inventors, companies, academic institution and government laboratories were actively working on RFID. On January 23 1973, Mario W. Cardullo received the first U.S. patent for an active RFID tag with rewriteable memory. That same year, Charles Walton from California received patent for passive transponder used to unlock a door without a key. Later Walton licensed technology to a lock maker company called Schlage. Los Alamos National Laboratory during 1970s played a vital role in the development of RFID Technology. The U.S. Government, Energy Department asked Los Alamos National Laboratory to develop a system for tracking nuclear materials. For this project, Los Alamos came up with idea to install a transponder in a truck and readers at gates of secure facilities. The transponder worked when gate antenna responded with ID and other potential data like driver's ID. These systems developed under Los Alamos was widely used on roads, bridges and tunnels around the world. In the 1980s, The U.S. Government, Agriculture Department asked Los Alamos to develop passive RFID Tags to track cows. This was the era when RFID Technology enter mainstream. During this project, Los Alamos came up with passive RFID system that used Ultra High Frequency (UHF) radio waves that helped identifying cows and ensure that each cow got the right dosage of hormones and medicines wasn't given twice accidentally. (Landt, 2005)

In the early 1990s, IBM developed an UHF RFID system which offered longer range and faster data transfer. It was IBM who did early pilot project with Wal-Mart but due to financial to financial problem, they did not commercialize their patented UHF RFID but sold its patents to a barcode system provider called Intermec. Intermec in the mid-1990s applied this technology into warehouse tracking to farming. Between 1999 and 2003, two professors, David Brock and Sanjay Sharma, from Massachusetts Institute of Technology turned RFID into a networking technology by linking objects to Internet through the tag. This change in RFID technology helped this technology to get easily adopted by business firms as manufacturer could automatically inform respective business partner know when a shipment was leaving the dock at a manufacturing warehouse, and retailer could automatically let the manufacture know when the goods arrived. A company, Auto-Id Center, formed under these two professors worked in RFID implementation in more than 100 large end-user companies and renowned institutions like the U.S. Department Defense.

Also, the company established their research labs in Australia, UK, Switzerland, Japan and China. They developed two air interface protocols namely Electronic Product Code (EPC) and a network architecture for looking up data associated on an RFID tag on the Internet. Later in 2003, this company passed all its research responsibilities on to Auto-ID Labs. (Roberti, 2005)

These days RFID technologies are well adopted in different operations of aerospace, apparel, energy, defense, health care, logistics, manufacturing and retails. The most known and successful implementation was experienced by Walmart, Billabong, Zara and the US defense force. Development and modification of this technology is continuing.

2.4 RFID Technology in Logistical activities

Physical movement of goods from the point of production to the final consumption is possible with the proper application of different logistical activities. These activities are interdependent to each other for successful logistic process. Definition of logistics, brief description on logistics activities and advantages of implementing RFID Technology in logistics activities are discussed in this section.

2.4.1 Logistics and Logistical Activities

Definition of logistics and the way it is performed has been changing with the change in technologies that has been backing up different logistical operation and activities in different businesses. However, the evergreen definition of logistics is process of getting the right things, at right place, at the right time. NATO defines logistics as the science of planning and carrying out the movement and maintenance of forces (NATO,2012). Logistics is a business planning framework for the management of material, service, information and capital flows that includes increasingly complex information, communication and control systems required in business environment. Basic function and objective of logistics includes procurement, maintenance, distribution, and replacement of personnel

and material (Logistics World,2016).Widely recognized professional association of supply chain management professionals, The Council of Supply Chain Management Professionals (CSCMP), defines logistics as “A major part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers’ requirements.”

As logistics is a process, it comprises of different activities. Logistical activities facilitate the flow of product from production point to the final consumption. These logistics activities are recognized as Customer Response, Inventory Management, Supply Handling, Warehousing and Transportation.

Customer response has direct relation with customers where different activities are performed that is concerned with optimization of customer service (CS). Activities includes preparation and implementation of CS policy, evaluating customer satisfaction, receiving and processing orders and invoicing and collections. These activities are believed to ensure the right product to the right customer at the right place and the right time, at the lowest cost possible. (Logistics Blog,2010)

Inventory management is one of the most challenging activity of logistics. **Inventory management** should keep their primary concerns on achieving higher customer levels with the lowest possible holding cost. The best practice to overcome these challenges is to maintain lowest possible inventories with intention to fulfill customer service policy requirement. Inventories are treated as capital in business. Therefore, understocking and overstocking are to be avoided in logistical operations. Inventory management employs tools like inventory control to ensure all the stocks are systematically issued, accounted and stored in the best interest of an entity in handling its inventory. Inventory control focuses to employ technology and system in order to maximize a company’s use of inventory. (Arkrani,2012)

Supply handling is always backed up by inventory planning and management. Companies perform this supply handling activity building inventories either through manufacturing or procurement process to meet requirements established in inventory planning and man-

agement. It includes activities like preparation of supplier service policy, sourcing, purchase order processing and payments. **Supply handling** is employed to minimize the total acquisition cost (TAC) and at the same time, it should meet availability, response time, quality of inventory. (Logistics Blog,2010)

Physical movement of goods via right means of **transportation** not only establish connection between different points from production to final consumption and vice versa, but also establish direct relation with customer service and cost of good. Transportation cost are often the largest single cost among logistical activities. Therefore, they are managed with preparation of proper network design, shipment management, fleet and container management, carrier management, freight management and terminal management. (Inman,2016)

Warehouse in another key logistics activity in any firm dealing with physical goods. Warehouses play role of planned space for storage of goods maintaining quality and quantity of goods and materials and make them available for shipping in right time. Also, warehouse helps to reduce labor cost, space management and time cycle management. It is very important for firm to locate their warehouse centrally to achieve service and economic benefits (Jackie Lorey). Recent days, it is very common to outsource this activity to third party logistics, also known as 3PL.

2.4.2 Advantages of implementing RFID Technology in logistical activities

Huge numbers of **inventory monitoring and visibility** of assets with application of RFID technology can benefit Fast Moving Consumer Good (FMCG) industries. Especially in FMCG industries, replenishment-based system is a common practice in inventory control. There is always of upstream and downstream flow of goods. Companies therefore should be aware of out-of-stock situation. RFID Technology will automatically prevent out-of-stock situation by placing an automatic order whenever the total inventory at a warehouse or distribution-center drops below a certain level. This is possible because RFID-tagged products will allow stores to track the location and count of inventories in real time. Also,

it eases the process of monitoring demand for certain products and place orders in advance. (Decision-craft, 2016)

In retailing and apparel businesses, it is very essential to understand the **demand trend at point of sale**. Understanding demand trends are directly related to the success of business, customer satisfaction and sales. With the implementation of RFID technology, business can understand demand trends and lead the business based on it. Misplacement and theft of goods are among the major problem in all kind of retail, distribution and manufacturing industries. Companies with the application of RFID technology has remarkably avoided **shrinkage** via continuous monitoring and tracking of items. (Decision-craft, 2016)

``The bullwhip effect is a distribution channel phenomenon in which forecasts yield supply chain inefficiencies. It refers to increasing swings in inventory in response to shifts in customer demand as you move further up the supply chain`` - (Wikipedia, 2016)

Technical limitation in conventional system may avoid firms for obtaining information on actual sales data and bear chance of amplifying the magnitude of bullwhip effect. RFID is equipped with technologies that can provide accurate and real time information on product sales. This **reduces bullwhip effect** and at the same time high cost of supply-demand imbalances that occurs from bullwhip effect. Also, barcode technology and conventional systems perform tracking function but are limited. RFID systems consists of technology that provides complete visibility of product movement in the supply chain. Supplier and receiver can read the possible delivery dates and on any interruption in supply, companies can make decision on inventory control in advance resulting in increased total useful shelf life of items. It is not required to load and unload items in every check-point as RFID technology can automatically read them from distance. It saves time and effort as well as result in **reduction in total lead-time**. (Decision-craft, 2016)

There is chance of occurring of human and technical error occurs while performing activities like sorting and pick-up from warehouses and stores. It is stressful task to confirm availability, location and information of goods. In manual handling and even using tech-

nologies like barcodes, issuing items requires searching of items and even physical movements of goods. It consumes labor force and time for positioning correctly in pallets for scanning and billing. RFID system can eradicate these errors and stresses. RFID technology can trace locations, gives information about the product and check availability of goods in respective warehouses and stores. Also, reading the items in any position and billings can be done automatically without the involvement of labor force **improves sort/pick rate** in inventory control. (Decision-craft, 2016)

Due to limitation in usage-time for perishable goods, company should be careful in handling these goods. Due to lack of sufficient time for timely inventory checking, lack of information update and misreading the information, an expired item may get delivered to a customer. Spoilage of goods during placement and taking inventory record is another problem occurring during inventory control. These mistakes not only cost for the replacement but they can destroy company's goodwill. Finding spoiled and expired goods in time could lessen the financial burden in some cases as some distributor or producer agree to replace or pay money back on these conditions. With RFID system, it is very easy to take timely inventory record as well it can automatically give an information about the expiry dates about the goods. Location can easily be traced and user can ensure the right product in right place. As record keeping can be made without movement, scanning and human involvement, there is less chance of spoiling goods. Another interesting fact about RFID system is possibility of **updating information on tags** dynamically. (Decision-craft, 2016)

RFID technology provides firm with **more business opportunities**. Especially it can enhance and consolidate customer services. RFID technology works as base for self-checkout in retail stores and other services like automatic shelves. Self-checkout in stores help customer from skipping long lines in counter whereas automatic shelves provides product description to customer digitally (Chris Brown,2011).

Use of RFID technology reduce different cost appeared in logistical operation. One of the major cost reduced with the use of RFID technology is **Labor cost**. First and foremost, advantage of applying RFID eliminates manual scanning of cases and pallets in every

point from manufacturing to final sales (Chris Brown,2011). Taking records of inventories are simpler and automatic as well as can be performed in desired time. These can reduce huge amount of labor force and cost entitled for labor. Automatic shelves and self-checkout service would replace customer service points and counters with cashiers. Also, RFID technology help reduce security related cost with reduction in theft of goods. Beside direct labor cost, RFID helps to reduce numerous indirect costs concerned with human resource management for e.g. insurance, training, security and others.

Several advantages mentioned above automatically add **competitive advantages** into business operation and quality performances. The dictionary meaning of competitive advantage is a condition or circumstance that puts a company in a favorable or superior business position. Use of RFID technology can reduce cost and time in overall logistical operation. Firm can use these advantages in adding additional services or reducing cost on products. Therefore, RFID can offer both competitive advantages based on cost and differentiation (QuickMBA,2016).

2.4.3 Case: Zara Clothing

In 2014, Intidex S.A., parent company of Zara-chain decided to build its inventory system on RFID technology. Spanish Apparel Powerhouse, Zara studied RFID technology for long time and finally decided to adopt it into their inventory system by the year 2014. During initial phase, more than 1000 stores from 22 countries implemented RFID technology. Zara stores in Finland were among them. All the Zara stores in Finland were deployed with RFID System (RFID24-7.com. 2014). In Zara Stores in Finland, RFID tags were used as labels in expensive goods like wallets, belts and shoes. Garments costing 25 euros or more were labeled with RFID Tags.

Zara bought 500 million RFID chips ahead of the rollout. Engineers and logistics experts from Zara worked on major concerns of RFID implementation. First and foremost, project was to figure out how to reuse the chips that can minimize cost concern. Another project was to ensure that customers are not followed by tracking device out of the door to fix

privacy concern. Zara put RFID tags inside the larger security tags Zara attaches to each item that protects the chip, allowing for reuse and were removable at checkout. With the application of RFID technology, Inventories are performed once every six weeks and they got more accurate pictures of sales, fashion trends and styles in comparison to previous routine of performing inventories once every six months. On every sales of a garment, data from its chip creates an instant order to the stockroom to send an identical item. In case a customer can't find an item, sales person can search availability of goods in their stores or nearer Zara stores just by pointing hand held device's camera at barcode of similar items. (Christopher Bjork, 2014)

Intidex CEO Pablo Isla in his letter on Annual Report 2014 mentioned that implementation of RFID Technology to their stores and logistical centers as expansion and modernization of the management, designs and logistical operational centers. With this move to newer technology, they experienced more efficient inventory and stock taking as well made them faster by 80%. Also, the company was successful to reduce the labor force in their outlets after the application of RFID technology. These success stories added more enthusiasm among Zara team members. Therefore, they aimed to rollout RFID Technology in all their 2000 stores worldwide by the year 2016. (Intidex S.A. 2015, Pg. 107-109)

2.4.4 RFID Technology implementation in Finland

In the present context, there are various national and international companies operating as RFID System supplier, developer and integrator in the Finnish Market. Similarly, numerous large and medium scale companies operating in Finland has implemented this technology. Non-profit organization like RFID Lab Finland Ry is working as umbrella organization for networking between suppliers and users, developing initiatives and provides services like consultation, trainings and seminars. Participation of educational institutions and research centers in Finland are taking positive roles for the better application of this system in Finland (RFIDLab 2017). This represent that RFID is penetrating Finnish market in an organized manner.

Application of RFID Technology has been made in wide range of business operations. The most popular applications were made in asset tracking, manufacturing process and

packaging, transportation and supply chain. Companies operating in Finland like Lassila & Tikanoja, Honkajoki, Martela, paperinkeräys Group, Sixt, Valmet Paper has been using RFID Technology in asset management (Vilant RFID, 2017). Valio and Lindström Group is adopting this technology for their asset management as well. Private and governmental firms like Finnish Transport Agency (Liikennevirasto), Helsinki Metro, Stora Enso and VR Transport has implemented RFID Technology in Transportation segment. Logistics and Supply Chain activities in companies like ABB, Nokia, Nokian Tyres, Plandent, Sandvik, Valmet Automotive, Valtra and Würth are assisted by RFID Technology (Vilant RFID, 2017).

Lassila and Tikanoja, a service company in recycling and waste management, applied RFID Technology for tracking their receiving and sending processes of containers for waste bottles and glasses. They are gaining advantages like accurate logistics processes, efficient asset management and increased customer satisfaction. Similarly, Finnish interior design and solutions supplier, Martela applied RFID systems into their furniture products already during the production. Martela and their customers gained advantages like accurate book keeping, reduced human errors and faster inventory processes. Renowned Finnish Paper company, Valmet Paper applied RFID Technology to track their inventories of spare parts of machineries used in paper production. Valmet paper gained advantages like efficient management, undisturbed productions and improved customer service. (Vilant RFID, 2017)

Leading power electronics and automation technology company, ABB implemented RFID technology to improve outbound logistics management. With this application, ABB gained advantages like automatic stock control, minimization of loading errors and savings in floor spaces (Smartrac, 2017). Similarly, ABB inbound logistics in Helsinki production facility is assisted by RFID technology to optimize inbound material flow from more than 150 suppliers. This has resulted in faster order and replenishment processes from Kanban boxes and lower in inventory levels (Vilant, RFID). The Finnish tools and equipment supplier, Würth, has deployed RFID Technology already in the year 1995 AD, introducing themselves as one of the first Finnish company to adopt this technology. Würth overcame shortage and untimely delivery of spare parts with the implementation of RFID in Kanban Boxes (Vilant, 2017). Producer of baking, cooking and tissue paper,

Metsä Fibre, has implemented RFID Technology for better logistical operations. RFID system deployed by Metsä Fibre helped to facilitate global distribution, accurate on-time delivery, uninterrupted production, minimization of shipping errors and inventory management by customers(Confidex,2017).

2.5 RFID TECHNOLOGY: Issues and challenges

Like other IT based system, RFID technology also bear risks of attacks from hackers and cyber-attackers with criminal intentions. Also, RFID technology has been long blamed for invading privacy of people and snooping information without knowledge of people. Therefore, this technology has been facing criticisms from civil liberties groups and other legal hindrances on its application. Concerns aroused with RFID Tech. are discussed in this section:

2.5.1 Security threat to system itself:

While deploying RFID technology into system, company can choose types of tags among basic tags, tags with symmetric keys and tags with public keys. Company preferring basic tags should pay extra attention as basic tags do not use any encryption that mean it can be **counterfeited** easily. Hackers or attackers with wrong intention can re-write false information or can modify data in tag in order to gain access. Hackers can transform invalid tags into valid and vice-versa with modification of the existing data. Using this trick, one can replace product information like price of product to get an expensive item in cheaper price. Not only hackers change tag of one object with that of another but they also can create own tag using information attached to another tag. (Security-wing,2016)

Another major threat to RFID system is **sniffing** where hacker has possibility to use own reader to read tags and use them as per own preferences as most of RFID tags lacks system to recognize and differentiate real and fake RFID reader. There exists possibility of attack to database via **spoofing** attack that can create big mess in system and even denial of services. (Thingmakgic,2016)

Other risks to RFID technology are physical risks and virus attacks. One with wrong intention can remove tags from item, fully or partially damage them, use magnets and other items to disturb operation and on some cases, use radial band to destroy data. Like any other IT system, RFID is at risk of virus attack. Lack of proper system setup to avoid virus attacks can lead to serious database disruption. (Security-Wing,2016)

2.5.2 Privacy concern:

The most discussed issued about RFID Technology is privacy concern of customers or consumers. RFID tags can be tracked even after the item with RFID tags leaves supply chain or retail stores. One can track the location and movement of customer carrying the item with RFID tags based on the area covered by RFID reader's field. On certain kind of RFID tags, one with RFID tag reader can read tags embedded to the product without consumer notice. This can provide hackers with an opportunity to learn product carried by a person and can learn his personal buying behavior. This information gained in wrong manner could be misused. Possibility of using mobile robots and high-gain antenna to follow, track location and movement of costumer even from longer distance has brought more serious threat on privacy concern of the people. In case customers, themselves are aware of this privacy concern and wanted to remove RFID tags, it is not that easy to get rid of it. Often RFID tags are laminated strongly with plastic coats into product surface or hidden inside product for avoiding physical damages to RFID tags. Trying to get rid of RFID tags forcefully may result in damages to product or it's appearances. (Technovelgy,2016)

2.5.3 Environmental factors:

UHF RFID tags are proved to work well in very low temperature despite ice and frost but in case of thick ice layer over 10 millimeters, it requires more transmission power (Nummela, Ukkonen, Sydänheimo,2008). But there are still doubts on RFID performances because of certain exceptional nature of water and liquids. Liquids can absorb

radio energy/signals which have potentiality to limit range or avoid read and write operations together. On harsh environment, some adhesive and label material can absorb moisture from environment. This might separate tags from products or partially or totally damage tags (Eric WT,2007)

2.5.4 Cost:

Many renowned companies operating in logistics sector has already made profound research about RFID technology and are in ‘wait and see’ situation before application of RFID technology into their mainstream business. World’s leading Cargo Company, DHL has applied this technology into their different operations like uniform management and temperature monitoring system during transportation (DHL,2008). Among different reasons mentioned by DHL, Cost is pointed as one of the major challenge for the application of RFID Technology into mainstream business(DHL,2016). Unit cost for RFID tags are higher as well as system setup requires huge investment. Active RFID tag cost as much as 25\$ per tag and passive RFID tags costs between 7-10 cents per tags. Of course price depends on volumes but still these prices cost huge investment for any company (RFID Journal,2016). Cost of RFID enterprise system, application software, maintenance, security to system and hiring human resources for this technology is relatively higher. These fixed and variable costs elongate time-period to achieve Return on investment (RFID Journal,2016).

2.5.5 Lack of standardization:

There are numerous manufacturers and users of RFID technology in the global market. Despite this fact, there is no global standard for RFID technology. Manufacturers are producing and installing different types of RFID technologies in different ways as per the demand and need of users’ operation (Technovelgy,2016). Working on different kinds of RFID technologies is itself challenging to manufacturer and similarly it is much stressful for companies adopting RFID technologies. For e.g. a milk producer company A supplies

bottle of milks to Retailer X and Retailer Y. If Retailer X and Retailer Y are using different RFID, then it is very expensive and stressful for company A to work on two different RFID.

Two different standardizing companies, International Standard Organization (ISO) and Electronic Product Code (EPC) are working on standardization of RFID technology. There exists some disagreement between these two organization on standard of RFID they have maintained separately. This has also led dilemma in manufacturers and users for which standard to accept. (Bob Violino,2016)

3 RESEARCH METHODS

In this section, methodology, approach, and data collection method for this degree thesis is discussed.

Results for the empirical section are obtained by conducting survey and interviews. Both methods are based on qualitative approach. Qualitative research is exploratory research deployed to understand reasons, opinions, and motivations. Qualitative research method assists researcher in finding insights and developing hypotheses for potential quantitative research by uncovering trends in thoughts, opinions and deeper into the problems. (Wyse,2011)

Numerous companies performing various logistical activities in Finland are chosen for answering questionnaires for the survey. Responses were collected from companies like Kone, Havi Logistics, Kovanen Logistics, Kaukokiito. Reason why qualitative approach and these companies are chosen via survey is due to the requirement of specific answers for this thesis. We expected that answer to surveys from companies that has already implemented RFID and companies that could possibly use RFID technology can help this thesis to answer and achieve its research question and research aim respectively.

Altogether two interviews were conducted for this empirical section. Technology Manager from RFID Lab Finland Ry, Sami Isomäki and Project Manager from LIMOWA Ry, Heikki Lahtinen were interviewed. Both the interviewees represented them on behalf of their organization. The reason why these companies and representatives are chosen is due to their field of operation and nature of the organization. Both companies were non-profit

association working in the field of Logistics and Technology with wide organizational networks. Their answers and opinions were very relevant to sketch our empirical section as well as strengthened the qualitative approach used this thesis.

3.1 Implementation of the survey

The survey was conducted on the month of April, 2017. Wide range of companies were chosen for answering the survey. A mass email was sent to various companies in Finland. However, the response rate was relatively lower than expected. Altogether 17 completed responses arrived. Out of which, 15 responses received via email sent and 2 responses were made in paper during my personal visit to companies.

This survey was created using online survey site, Zoho Survey. It was designed using special 'Logic Option' provided by survey site where companies with RFID Technology already in use and companies that can possibly use RFID in near future would answer three common questions and rest question separately. Question 1 and Question 2 were set as a common question for both kinds of firms. Answer based on question 2 would take respondents to respective questions. Respondents those who answered 'Yes' to Question 2 i.e. companies with RFID Technology already in use answered Questions 3-10. Whereas respondents who answered 'No' to Question 2 i.e. companies who can possibly use RFID Technology answered Questions 11-13. Again, question no 14 was a common question to companies from both categories. Question 14 was generated to collect the respondents' opinion on RFID Technology.

3.2 Approach

The qualitative research approach is used in this research. Empirical section of this research is based on survey questionnaires answered by representatives of companies in Finland and interviews with authorized personnel of organization working in the similar field. Questionnaires are developed on Internet Based Survey Website namely "Zoho_Survey" and made available to concerned companies via Email or personal visit.

Analysis of data was made without application of any means or tools. However, Discussion and conclusion is drawn based on the results obtained from the empirical section of this research.

3.3 Data Collection

Data for the theoretical framework is based on the secondary data. Source of these secondary data are online materials, journals, books and other research papers. The empirical section is built based on survey and interviews. Answers from the survey are collected online from respondents and interview was organized with authorized personnel of the respective organization.

4 EMPIRICAL SECTION

In this empirical section of this the thesis, results obtained by conducting surveys and interviews are mentioned. Answers to interviews and responses to surveys are presented and analyzed.

4.1 Interview:

In this section, a brief introduction to interviewees and their organization is made. Results from interviews are presented and analyzed.

4.1.1 Interview 1: Sami Isomäki, RFID Lab Finland Ry

Sami Isömaki on behalf of RFID Lab Finland Ry was interviewed on March 28, 2017. RFID Lab Finland is a neutral non-profit association operating in Finland established with a mission to improve operational efficiencies of companies with identification technology. More than 40 organizations representing RFID integrator and supplier companies and potential end users of RFID representing the manufacturer, retailers, logistics and other service providers are working in collaboration RFID Lab Finland as its members. RFID lab helps these member companies and other interested institutions in creating networks and developing initiatives. Beside these, they operate RFID show room in their

office located at Technopolis, Vantaa. Also, they organize seminars, training, consultation services and conferences on RFID Lab in targeting organizations in different locations in Finland. (RFID Lab, 2017)

4.1.2 Interview 2: Heikki Lahtinen, LIMOWA RY

Heikki Lahtinen on behalf of LIMOWA Ry was interviewed on 04 May 2017. LIMOWA Ry is non-profit association focused on creating logistics hub and to develop support center competence area. This association works closely with more than 60 member organizations in Finland for their international reach for logistics development and co-operation. Also, LIMOWA coordinates development projects, organizes public funding and promotes networking in logistics center area. Other objectives of LIMOWA includes promotion of innovative logistics center solutions and export of Finnish leading edge expertise in international logistics center projects. They assist companies in generating service products and outsourcing chains as well help in generation of tangible business advantages for companies. Also, they promote utilization of intelligent machines and smart systems into logistics. (LIMOWA,2017)

4.1.3 Results

The present situation of RFID Implementation in Finland:

RFID Lab Finland Ry:

Per Säämi Isomäki, the present situation of RFID Technology in Finland is steady. RFID has been in Finnish logistical activities since a long time and is exploring newer area of implementation in logistics and supply chain. These days, use of RFID has boomed in returnable assets like containers, trans-boxes, pallets and roll cages. Using RFID into every single product is not feasible therefore use of RFID is still not visible to the final consumer. Therefore, RFID implementation is common in manufacturing, warehouses and transportation activities. He also mentioned that RFID Lab Finland is not informed about every single implementation in Finland as companies with better competitive advantages from RFID Technology prefer to remain silent.

LIMOWA Ry:

The present position of RFID Technology is a lot more different from what Lahtinen has expected 10 years ago. Even though Finland has numerous developers and professionals of this field since long time, presence in Finnish Market is low. Companies are not able to decide on investment and division of benefits among players in supply chain. Also, there lack business collaborations for harmonization, standardization, and uniformity in RFID usage. As newer concepts like industry 4.0, Logistics 4.0 and Internet of thing (IOT) are debated in Finnish Logistics and Supply Chain, RFID Technology has slowly begun to grow. Therefore, RFID in the present situation is still a big promise in Finland.

Experiences and Expectations with RFID Technology**RFID Lab Finland Ry:**

Companies that has possibilities to adopt RFID Technology in their operations usually remain skeptical with RFID Technology. RFID Lab has been working on to train personnel from different companies, students, and other visitors. Also, they help in consultation, determining right system and finding suitable integrator for the companies. Cases and references from user companies show that they are satisfied with RFID Technology.

LIMOWA Ry:

Lahtinen stated that expectation of user companies has reached to some extent. He suggested going through case studies and references found in webpages of organization like RFID Lab Finland Ry and supplier/integrator companies like Finn-ID, Vilant, Confidex, Top-Tunniste and many others. Their experience with this technology is positive. Also, he mentioned situations from last 10 years where expectations of these users rose and then plummeted respectively. Now, end users' expectation against RFID is again growing.

Successful/Unsuccessful Implementation:**RFID Lab Finland Ry:**

There has been both successful and unsuccessful practice with RFID implementation in Finland. Companies operating in large scale like Lindström are piloting this project with the deployment of hundreds of readers at a time. Also, there has been cases where RFID implementation has failed in Trans-boxes as the tags were damaged when trans-boxes washed in high water pressure. It was to blame wrong glues used to stick RFID tags in trans-boxes. Therefore, RFID failures are more dependent to minor technical errors rather than technological errors.

Advantages of RFID Implementation

RFID Lab Finland Ry:

He focused on top three advantages of RFID implementation in logistics and supply chain. These major three advantages; Less Errors, faster operations and better visibility of supply chain would automatically create other advantages in business. Some other outcomes are less working hour per operation, mass identification, accuracy and identifying the accurate delivery time to reduce the size of warehouses.

LIMOWA Ry:

Lahtinen defined benefits of RFID into two levels; general and advanced level. General benefits for companies are faster and accurate reading of stocks through automatic identification resulting in increased productivity. Advance benefits could be obtained in form of accurate and up to date data and zero information lead-time. Most often companies do not focus themselves in obtaining advanced benefits of this technology. Many companies are the utilizing of these benefits for increasing process-quality and business enhancement.

Challenges of RFID Implementations

RFID Lab Finland Ry:

Sami Isomäki mentioned the conservative attitude of Finnish companies as the major challenge for the RFID implementation. They usually do not prefer to jump or invest to newer technology. Maybe this attitude is the outcome of distrust on newer technology or small and complicated Finnish Market. Strong Information Technology (IT) background is required for RFID Technology implementation. There is a lack of professionals with sufficient IT knowledge and even companies with strong IT setup. There exist fewer technical error with RFID tags when used in metals and liquid as well as cost factors during and after RFID installation.

LIMOWA Ry:

Lahtinen compares challenges to RFID with that of Barcode that happened nearly 30 years ago when Barcode technology make its outbreak in groceries stores. At the then time, retailers pushed manufacturer to put a barcode on their items. Manufacturers made an investment on barcode technology whereas retailers were the one to obtain more benefits from barcode technology in comparison to the manufacturer. Therefore, a division of equal benefits among players is a primary hurdle in RFID implementation. Beside that companies are not yet successful in developing a common understanding for uniformity in RFID system, tags, types of data included and ways to integrate this data into information systems.

Future Growth of RFID Technology in Finland

RFID Lab Finland Ry:

Sami Isomäki believes that outbreak of technology does happen overnight. Technological development and commercialization itself is a slow process and takes time. He compared the development of RFID Technology with that of Barcode Technology that took nearly

30 years to make its first commercial outbreak into supermarkets. He notified that outbreak has begun in Finland as the implementation of RFID has emerged it has introduced newer and better concept for operating older techniques and has created newer business opportunities. He recalled last 2-3 years where RFID implementation has emerged rapidly in assisting Kanban System and self-checking '24/7 shops'. These '24/7 Shops' are among the newest concept adopted by companies like Würth and Trailcont where customers have access to container-shop at any time all year around. All the activities for sales, inventory control and other are backed-up by RFID Technology.

Sami Isomäki predicts that the RFID Technology will have steady growth in future. RFID is part of a newer concept like Internet of Things (IOT). Therefore, RFID growth is directly proportional to the growth of IOT. RFID technology is not going to get limited only with identification of goods in future. Companies expect more functionality from RFID Technology. The addition of sensor along RFID Technology is the outcome of this expectation. For example, RFID in meat shipments identify them and at the same time provides with information on temperature and moisture.

LIMOWA Ry:

Lahtinen believes that there are lots of opportunities created by RFID in business processes and operations. It is not limited only to increasing productivity and automate manual processes but also accuracy in information and zero-information lead time. More benefits can be achieved from this technology if companies would be able to utilize this information in a more efficient way for example in production planning or inventory control or to improve customer experiences. Due to these potentialities, RFID will have noticeable growth in future.

Roles of organization in RFID promotion

RFID Lab Finland Ry: RFID Lab Finland promote RFID in all sector but logistics and supply chain is one of the big areas for RFID implementation. RFID Lab offers consultation services to companies. They test the feasibility of RFID in the respective company,

suggesting right RFID system and finding system integrators. RFID Lab Finland organizes more than 20 training, seminars, and conferences annually in different locations in Finland. Also, they help in networking with different companies in Finland.

LIMOWA Ry:

Lathinen introduced LIMOWA Association as an impartial logistical developer in Finland. LIMOWA is a neutral party for all other parties associated and does not speaking on behalf of RFID only. LIMOWA believes that RFID could be a part of logistics process enhancement and efficiency in both transportation and intra logistics (Material handling and Warehousing). Plan of LIMOWA is not to limit RFID only in physical logistics but also to utilize them along with other intangible supply chain activities like information system.

Open View

RFID Lab Finland Ry:

RFID Lab Finland often gets questioned from professional if any competitive technology to RFID has arrived in Finland. Per Sami Isomäki, there is no similar technology in present market that can possibly replace RFID in logistics and supply chain. Only existing option in this field is either Barcode or RFID. The company not preferring RFID would go for 2D Barcode, 3D Barcode or QR code. There are sufficient numbers of companies already with RFID technology, good numbers of RFID integrators, supplier and system manufacturer. Educational institutions and research association are playing responsible roles in this sector. Therefore, he is satisfied with the present position of RFID Technology in Finnish Market.

LIMOWA RY:

Lahtinen himself is from Industrial Engineering Background. He personally and in LIMOWA, they are more focused on creating business benefits through RFID rather than

its technological aspect. They accept the fact that RFID is technologically ahead and offers automatic identification and business opportunities. Now, all the concerned authority should focus on uniformity of RFID System, tags' location, and integration data into information system through business collaborations

4.2 Survey

Results of the survey are presented and analyzed in this section. Survey responses were collected from companies that have already adopted RFID and companies that can possibly adopt RFID Technology. Both companies answered few common questionnaires and rest separate questionnaires. Special 'Logic' option from Zoho-online survey site was deployed to guide respondents to respective questionnaires. For the better understanding of the readers, survey results are categorized into three sections. They are common section, user companies, and non-user companies respectively.

4.2.1 Common Section:

In this sections, results from common questionnaires to the user and non-user companies are presented and analyzed.

Logistical Activities performed in company

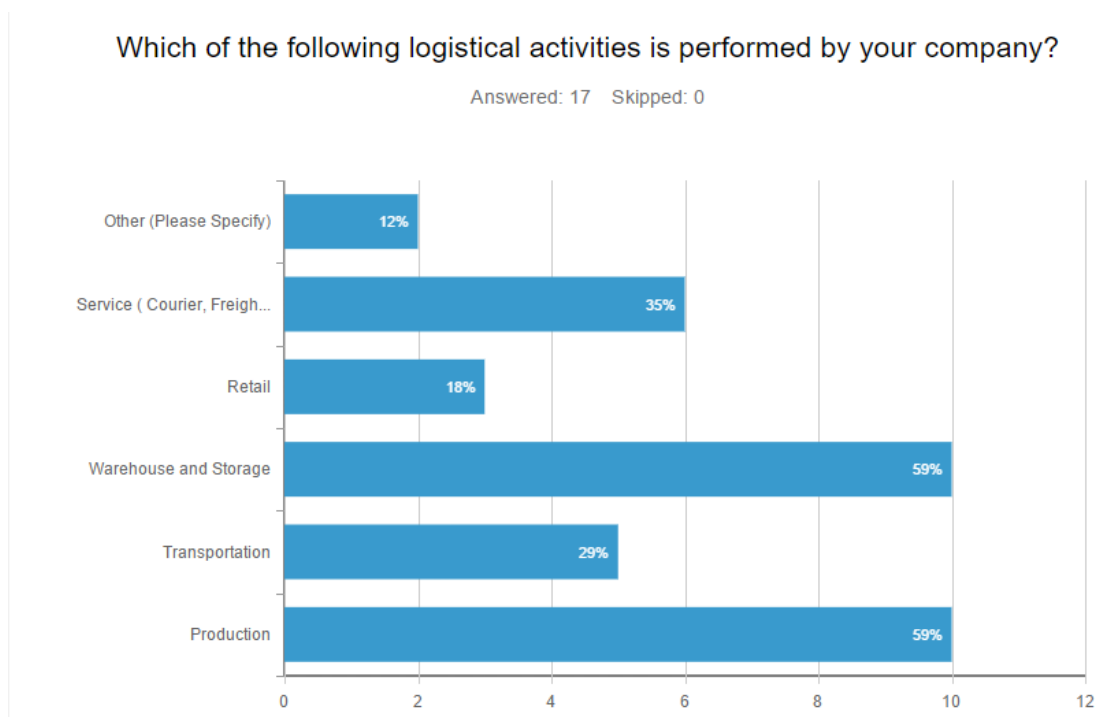


Fig 2: Logistical Activities in company

The above graphical figure represents the different logistical activities performed by the companies. The majority of the companies perform both production and warehouse and storage as their logistical activities. Second major logistical activities performed were logistical services like courier, freight and postal services. 2 out of 17 companies mentioned other logistical activities. Out of which one remain unspecified and another was specified as 'Terminals'.

Use of RFID Technology

Do your company use RFID Technology?

Answered: 17 Skipped: 0

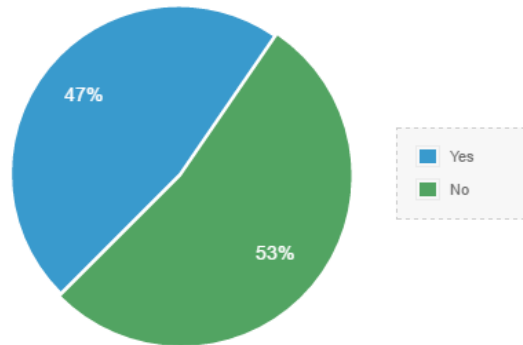


Fig 3: Use of RFID Technology

The pie-chart diagram represents the companies with or without RFID Technology in use. This was an integral part of this survey as answers to this question took respondents to respective segments of this survey. The numbers of companies having RFID Technology in use are nearly as much as companies not having RFID Technology in use. 8 out of 17 companies have RFID technology in use. Whereas 9 out of 17 companies do not have RFID technology in use.

Opinions

The last question for the survey was asked in form of open view of respondents towards RFID Technology. The purpose of this question was to collect independent opinions. 8 out of 17 respondents replied this question. All 8 responses are listed below:

1. We are more in piloting mode, only some of our factories use RFID in a limited scope.
2. RFID tags and system operation cost are costlier for our products. Let's see what happen in future.
3. It sounds interesting, but changing to a new technology is always a big step.
4. No more idea about RFID Technology.
5. Waiting for better and cheaper versions.

6. No comments.
7. Most likely we will pilot this project in our company sooner.
8. RFID technology can uplift Finnish Logistics and Supply Chain.

The above statements represent mixed opinions for RFID technology. Majority of responses were made based on cost factors. Also, they seem optimistic about the implementation and better opportunities created by RFID Technology.

4.2.2 User Companies

In this section, results from the questionnaires to RFID user companies are presented and analyzed.

Duration of use of RFID Technology

How long have your company been using RFID Technology?

Answered: 8 Skipped: 9

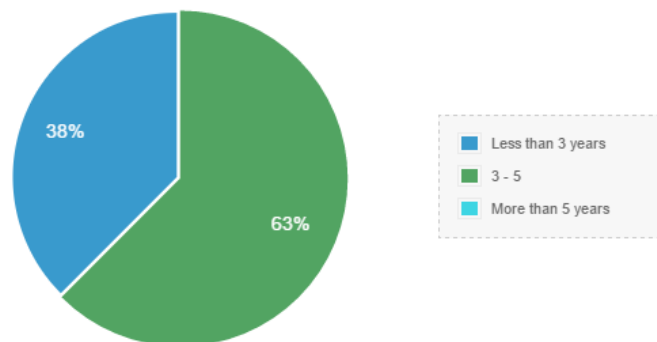


Fig 4: Duration of use of RFID Technology

The pie chart diagram above represents the duration of use of RFID Technology in their respective company. The majority, 63% of companies have been adopting this technology for 3-5 years. While 38% of the companies has been adopting this technology for less than 3 years. None of the company has adopted this technology for more than 5 years.

Assistance of business operation by RFID Technology (In %)

What percentage of your total business operation is assisted by RFID Technology?

Answered: 8 Skipped: 9

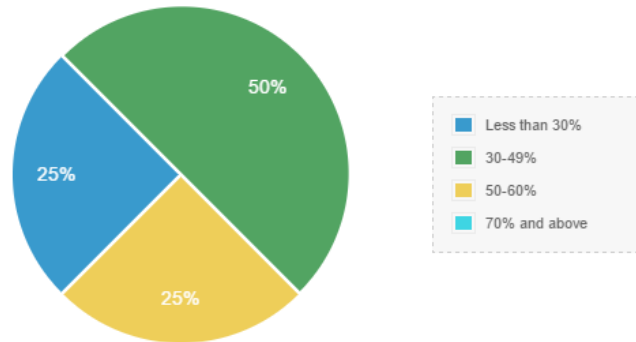


Fig 4: Percentage of RFID application in business operations

The pie-chart diagram above represents the percentage of total business operation assisted by RFID Technology. The majority of companies' 30-49% of business operations are assisted by RFID technology. Companies with business operations assisted by RFID technology between 50-60% are exactly equal to companies with business operations assisted by RFID technology below 30% i.e. both accounting to 25%. None of the company's operation is assisted by RFID Technology over 70%.

Advantages of RFID Technology

Which of the following advantage(s) do your company experience with the application of RFID Technology?

Answered: 8 Skipped: 9

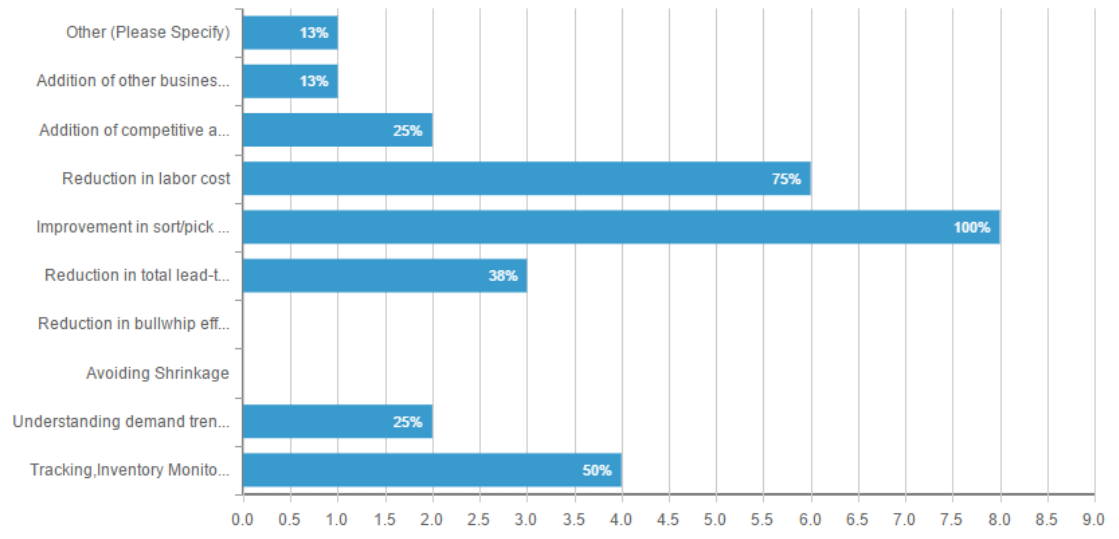


Fig 6: Advantages of RFID Technology

The graphical figure above represents different advantages experienced by RFID user companies. Majority, 100% of the companies experienced improvement in sort/pick up rate. The second majority, 75% of the companies experienced the reduction in labor cost. Other major advantages experienced by user companies are tracking, inventory monitoring, visibility, reduction in total lead-time, addition to competitive advantages in operations and sales, understanding demand trends, the addition of other business opportunities and other (unspecified) respectively. None of the user companies experienced reduction in bullwhip effect and avoiding shrinkage.

Issues with RFID Technology

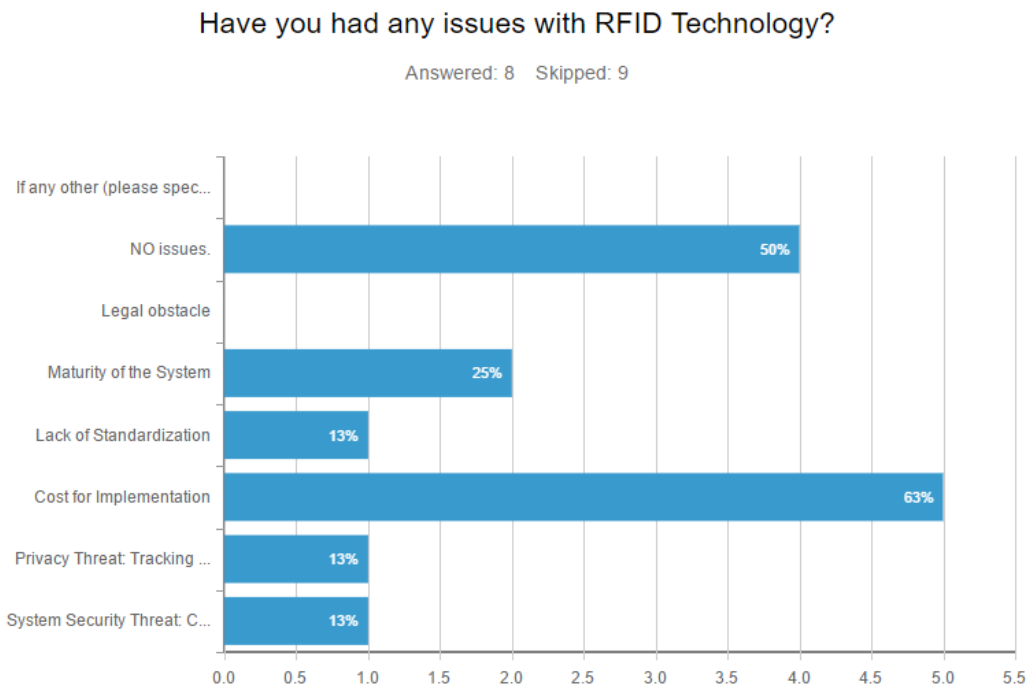


Fig 7: Issues with RFID Technology

The above graphical figure represents the issues with RFID Technology faced by user companies. The majority of companies marked cost of implementation as a greatest issue with RFID Technology. The second majority, 50% of the companies marked that they do not have any issues with RFID Technology. 2 out of 8 companies have an issue with the maturity of system.

1 out of 8 companies have issues with lack of standardization, privacy concern, and system security threat. There is no issues with legal obstacles and others.

Satisfaction with technology

Is your company satisfied with the application of RFID Technology?

Answered: 8 Skipped: 9

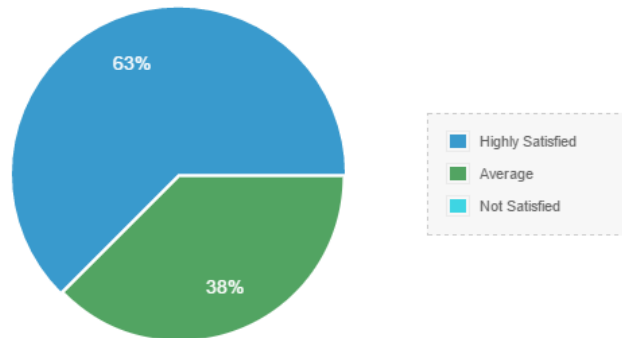


Fig 8: Satisfaction with RFID Technology

The above pie chart diagram represents the satisfaction with RFID Technology. The majority of user companies are highly satisfied with this technology. 3 out of 8 companies are averagely satisfied with this technology. There is no company with Zero Satisfaction.

Plans regarding RFID Technology

What is the future of RFID Technology in your company?

Answered: 8 Skipped: 9

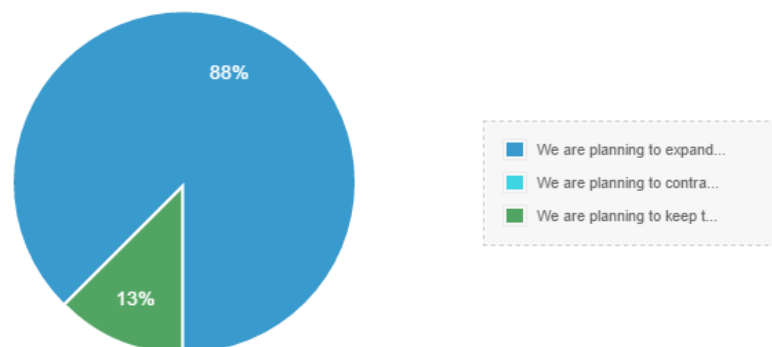


Fig 9: Plans regarding RFID Technology

The above pie chart diagram represents plans regarding RFID technology in their companies. 7 out of 8 companies are planning to expand RFID implementation into more

business operations. 1 out of 8 companies is planning to keep the use of RFID technology as the same level as now. None of them is planning to contract (reduce) RFID implementation from their business operations.

Recommendation

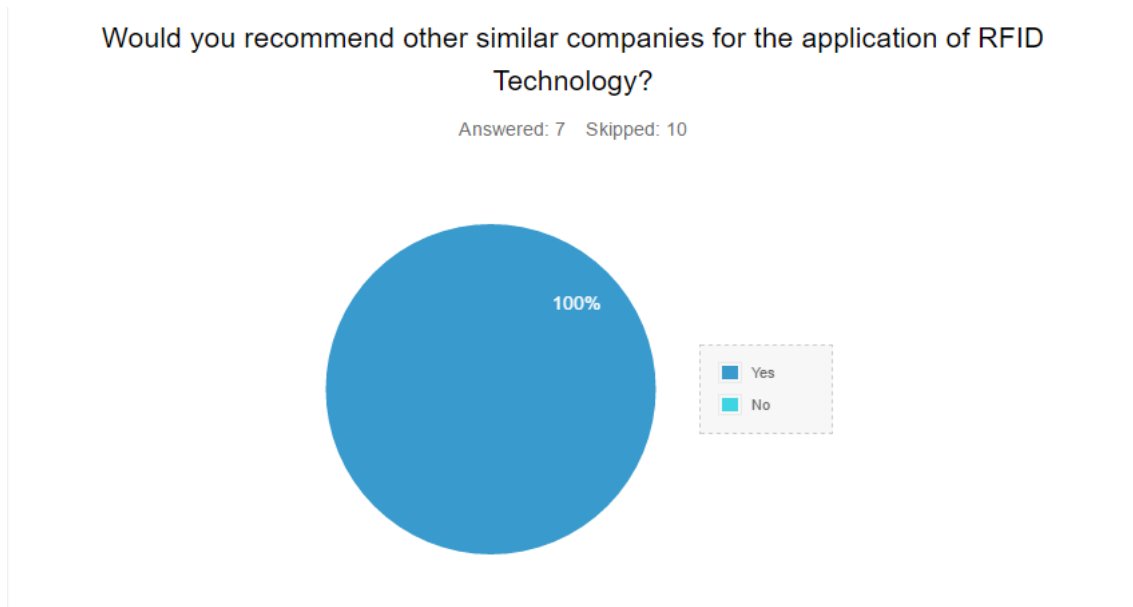


Fig 10: Recommendation

The above pie chart diagram represents the companies wish to recommend RFID Technology to companies with similar business operations. 8 out of 8 i.e. 100% of the companies would like to recommend RFID technology to other similar companies.

RFID Vs Barcode

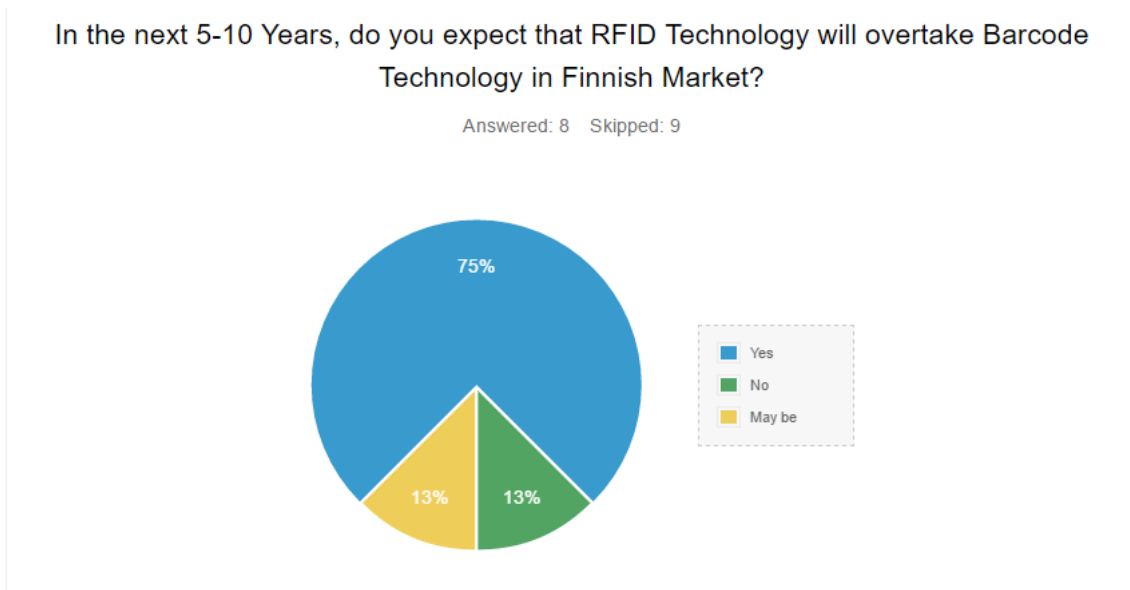


Fig 11: RFID Vs Barcode

The pie chart diagram above represents the expectation of companies regarding the replacement of barcode technology with RFID in next 5-10 years. 6 out of 8 companies think that RFID will replace barcode technology in 5-10 years in the Finnish Market. 1 out of 8 thinks that RFID cannot replace Barcode technology in respective time. 1 out of 8 seems unsure about this technological replacement.

4.2.3 Possible-user companies

In this section, responses obtained from questionnaires to non-users (can possibly use RFID in near future) companies are presented and analyzed.

Plans regarding implementation of RFID Technology

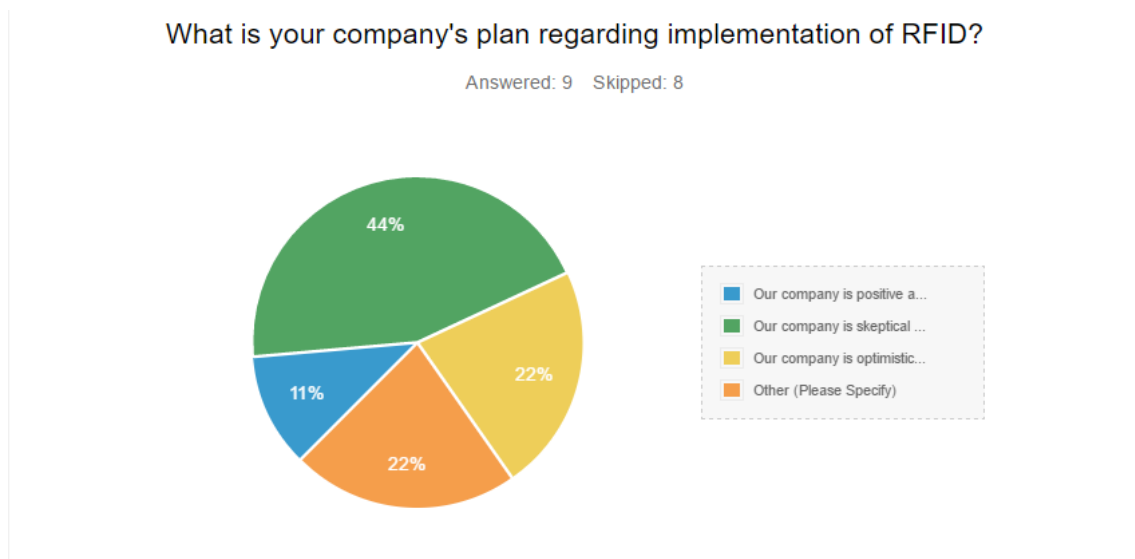


Fig 12: Plans regarding implementation of RFID Technology

The above pie chart diagram represents plans regarding the implementation of RFID technology by possible user RFID Technology. Majority of companies seem skeptical about the use of RFID technology into their operation. 2 out of 9 are optimistic about the implementation of RFID technology into their operations. Also, 2 out of 9 have specified other reasons regarding implementation of RFID technology. One company mentioned that RFID is still too expensive for food logistics and next mentioned that they are operating well with Barcode Technology. Only 1 out of 9 companies remained positive about the implementation of RFID Technology into their business operations.

Training and Seminar

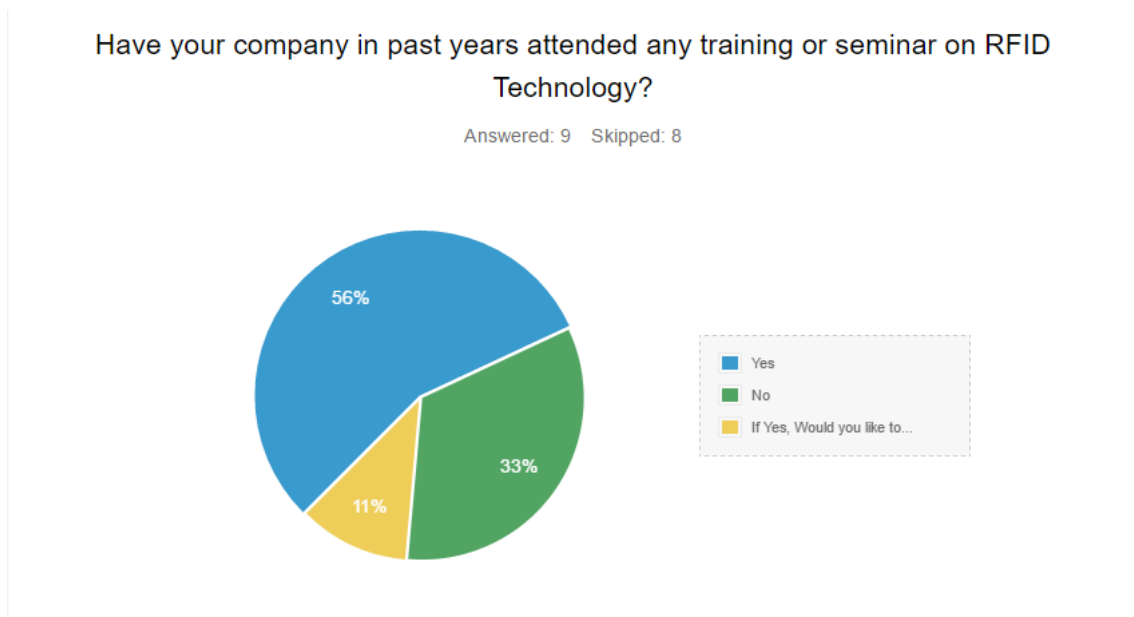


Fig 13: Trainings and Seminar

The above pie chart diagram represents participation of trainings and seminars on RFID Technology. The majority of companies have attended seminars and trainings on RFID Technology. Only 1 out of 6 companies those attended trainings and seminars on RFID Technology specified that they were offered free demos and trainings from different RFID supplier companies. 3 out of 9 non-user companies of RFID Technology had not attended any trainings and seminars.

Challenges for implementation

What challenge(s) are recognized by your company for the implementation of RFID technology in near future?

Answered: 9 Skipped: 8

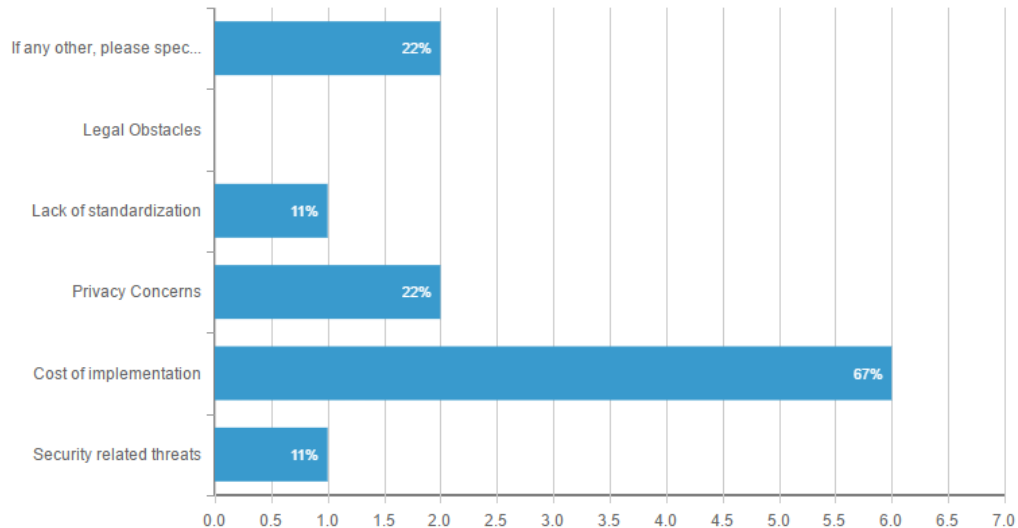


Fig 14: Challenges for implementation

The above graphical diagram represents different challenges for the implementation of RFID technology into their operations. Majority of companies recognized cost of implementation as a major challenge for the implementation of RFID Technology. 2 out of 9 recognized privacy concerns as another challenge for RFID implementation. Also, 2 out of 9 companies specified other reasons as challenges for RFID implementation. One of them mentioned running cost and next company mentioned that they do not have yet made enough research for RFID implementation. Minority of companies i.e. 1 out of 9 recognized lack of standardization and security threats as challenges for RFID implementation. None of the companies recognized legal obstacles as a challenge for RFID implementation.

5 DISCUSSION

In this last section of the thesis, findings on theoretical section and results obtained in empirical section via survey and interviews are discussed. Also, Conclusion is drawn along discussion and further research is suggested.

RFID started its commercialization in 1980 and deployment in Finland already started in the 90s. Therefore, RFID has long been in Finnish Market and possible user companies recognize this technology since long. During these time, wider application of RFID technology has been made in various logistical activities in Finland. Especially companies seem to adopt this technology more in manufacturing processes but various other operational application has been explored recently. The majority of companies that have already adopted RFID Technology were performing production and warehouse as their major logistical activities. Therefore, the results of the responses are in line with the theoretical section of this thesis. The results of survey and opinions of the interviewees represent that the present situation of RFID technology application is steady but positive. In the survey, companies that adopted this technology represents companies with various logistical activities from production to retail. Also, the numbers of companies that already adopted RFID Technology were nearly as much as the companies without RFID technology in use which was very interesting. None of the companies has been adopting this technology for more than 5 years. This represents that the RFID implementation has grown in last few years. However, companies adopting this technology for last 3-5 years is more than the companies adopting this technology less than 3 years.

From the survey, all the companies with RFID technologies experienced improvement in sort/pick up rate. Other major experiences were a reduction in labor cost, tracking, inventory monitoring and visibility, reduction in total lead-time and understanding demand trends respectively. Only 1 out of 8 companies experienced addition of other business opportunities and none of the company experienced advantages like reduction in bullwhip effect or shrinkage reduction. Both interviewees stated that companies are experiencing faster and more accurate operations with better visibility of supply chain. These benefits have bestowed companies with better productivity and competitive advantages. At this point, companies seem to enjoy only the general advantages of RFID Technology. There are numerous more business advantages to be gained with technical advancement of this

system and proper use of data and information for business enhancement. Therefore, user companies should focus on achieving advanced benefits of this technology.

In the survey, half the number of respondents from user companies have no issue with this technology. Other half faced the cost of implementation as a major challenge with RFID Technology. 25% of them pointed maturity of the system as another challenge for RFID implementation. Whereas 63% non- user companies identified the cost of implementation as major challenge with RFID technology. Also, most respondents on the open question in the survey pointed cost factor of RFID Technology. Other major challenges pointed were privacy concerns and running costs. Neither of these companies pointed legal obstacles as a challenge for RFID implementation. Interviewees believe that RFID is technologically advanced with fewer exceptions but still other challenges exist in RFID implementation. They agree with the cost of implementation and lack of uniformity in RFID system. But there are more other hurdles due to ignorance, technical misunderstanding, disinterest and lack of business collaborations between companies. Privacy concerns is a serious issue with RFID but seem to be ignored by majority of companies. The majority of them are focused in cost factor rather than uniformity of system, standardization, and others. Business collaborations to face these challenges would timely overcome these issues with RFID technology implementation.

The result of the empirical section indicates positive sign about the future growth of RFID Technology in Finnish Market. In the survey, 62% of RFID user companies are highly satisfied and the rest 38% of them are averagely satisfied. None of the user company was dissatisfied with this technology. Also, 88% of the user companies wanted to expand RFID into other business operations and the rest were planning to keep the RFID use at the same level as now. None of the company intend to contract the RFID use from business operations. All the user companies from the survey would like to recommend RFID Technology other similar companies. These represent that expectations of user companies have reached with RFID Technology. But the majority, 44% of non-user but potential companies of RFID Technology are skeptical about the use of RFID implementation in their companies. 22% each of them is either positive or optimistic about the RFID implementation whereas 11% have their own reason; not feasible with food logistics and going well with Barcode Technology. Not profit associations like RFID Lab Finland Ry and

LIMOWA Ry are positive about the growth of RFID Technology in logistical sector. When user companies are satisfied, and would recommend this technology to future possible user of RFID but the majority of these companies remained either skeptical or not applying RFID at all into their operations shows that there is a huge gap in understanding and adopting RFID Technology. This gap might be the reason of attitude of Finnish companies pointed in interviewees. If we take reference from answers to open question and challenges for RFID implementation by non-user companies, these gaps can be filled when the cost for RFID technology will lower, uniformity and standardization is set and other issues are solved.

5.1 Conclusion:

The aim of this thesis was to understand (1) the present position of RFID Implementation in logistical activities in Finland, (2) Experiences and Expectations with RFID Technology, and (3) Possibilities of future growth. The growth of RFID has faced a turbulent situation in Finland since its implementation. But the situation has changed in last 5 years as implementation has emerged. More numbers of companies are piloting them as well as the noticeable percentage of business operation is assisted by RFID Technology. The present position of RFID Technology is steady but positive. User companies are experiencing noticeable benefits from this technology. There are possibilities of gaining more advanced benefits for user companies with proper utilization of data and information. The majority of companies identified cost as major challenge for RFID implementation and usage. But there exists other technical challenges like uniformity and standardization of RFID system are a lot more challenging than cost factor. More business collaborations are suggested to overcome these technical hurdles in RFID implementation. User companies are satisfied with this technology. They are either expanding or at least using RFID in the same level as it is. They are very positive about recommending this technology to similar companies. Concerned authorities like RFID Lab Ry and LIMOWA are playing better role in promoting RFID implementations. These represent the growth of RFID technology in near future. Whereas companies with the possibility to implement RFID Technology into their operations seems skeptical with this technology. Better references from user companies and continuation of present roles and activities from an organization

like RFID Lab and LIMOWA might breakdown 'Wait and See Attitude' of Finnish companies.

Continuation of this thesis is possible as many newer areas of research in RFID is explored during this thesis work. Topics like roles of RFID in digitalization of Logistics, Roles of RFID in Logistics 4.0, Business opportunities creation via RFID, Gaining competitive advantages through RFID would be subject worth further research.

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APPENDICES

Survey Email

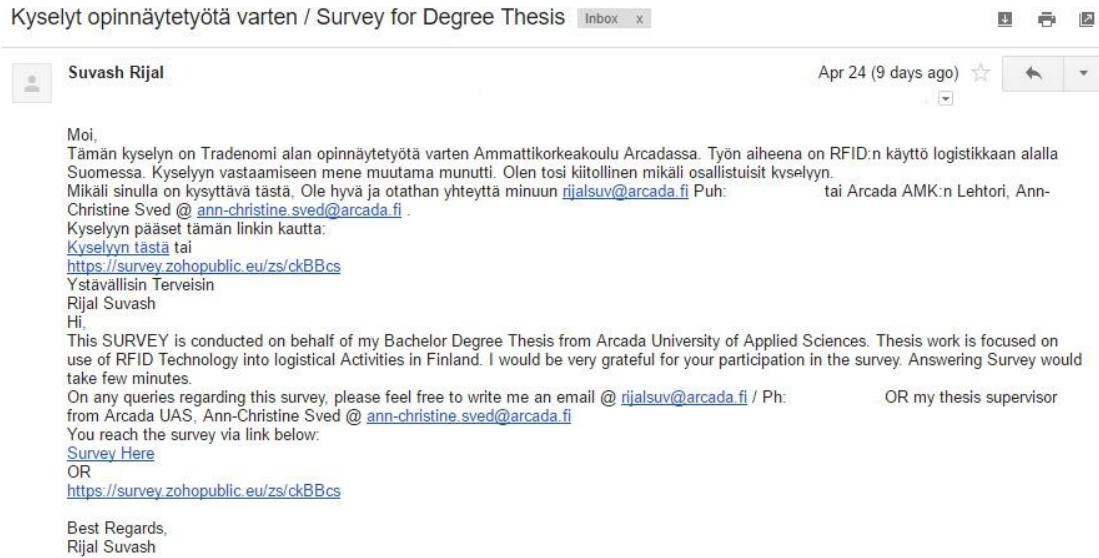


Fig 15: Attachment 1

Survey Questionnaires

1. Which of the following logistical activities is performed by your firm/organization?

- Production
- Transportation
- Warehouse and Storage
- Retail
- Service (Courier,Postal, Freight, Cargo)
- If any other (please specify)

2. Do your company uses RFID Technology?

- Yes
- No

3. How long have your company been using RFID Technology?

- Less than 3 years
- 3-5 years
- More than 5 years

4. What percentage of your total business operation is assisted by RFID Technology?

- Less than 30%
- 30-49%
- 50-69%
- 70% and above

5. Which of the following advantage(s) is your company experiencing with the application of RFID Technology?

- Tracking, Inventory Monitoring and Visibility
- Understanding demand trend
- Avoiding Shrinkage
- Reduction of total lead time
- Improvement in sort/pick rate
- Reduction in labor cost
- Addition of competitive advantages in operation and sales
- Addition of other business opportunities like self check out and automatic shelves
- Other (please specify)

6. Have you had any issues with RFID Technology?

- System Security Threat: Counterfeiting, Spoofing, Sniffing
- Privacy threat: Tracking Customer
- Cost for implementation
- Lack of standardization
- Maturity of the system
- Legal Obstacle
- No issues
- If any other (please specify)

7. Is your company satisfied with the application of RFID Technology?

- Highly Satisfied
- Average
- Not Satisfied

8. What is the future of RFID Technology in your company?

- We are planning to expand RFID implementation into more business operations.
- We are planning to contract(to reduce) RFID implementation from our business operations
- We are planning to keep the use of RFID technology at the same level as now

9. Would you recommend other similar companies for the application of RFID Technology?

- Yes
- No

10. In next 5-10 years, do you expect that RFID Technology will overtake Barcode Technology in Finnish Market?

- Yes
- No
- May be

11. What is your company's plan regarding implementation of RFID Technology

- Our company is positive and is planning to pilot this project in near future.
- Our company is skeptical and has no sudden plans for implementation.
- Our company is optimistic about RFID but is adopting policy of "Wait and See" for more progress.
- Other (please specify)

12. Have your company in past year attended any training or seminar on RFID technology?

- Yes
- No
- If Yes, Would you like to Specify?

13. What challenge(s) are recognized by your company for the implementation of RFID technology in near future?

- Security Related Threats
- Cost of Implementation
- Privacy concern
- Lack of standardization
- Legal Obstacle
- Other (please specify)

14. Would you like to add something in your own words about the RFID technology?

Fig 16: Attachment 2

Interview 1:

Name: Sami Isomäki

Company: RFID Lab Finland RY

Title: Technology Manager

Date and Time: 28 March 2017 09:00-11:00

Questions:

1. What is the present situation of RFID Technology implementation in Logistical Activities in Finland?
2. How would you recall development of RFID Technology in Finnish Market from last 5-7 years?
3. What are the noticeable advantages mentioned by firms adopting RFID Technology into their operation?
4. To what extent is the implementation of RFID Technology successful in Finnish Market?
5. To what extent is the implementation of RFID Technology successful in Finnish Market?
6. What are the experiences and expectation of companies regarding RFID Technology into their logistical operations?
7. In what way RFID Lab is promoting application of RFID Technology into Finnish Logistics and Supply Chain?
8. How would you predict the growth of RFID Technology in coming days in Finnish Market?
9. Open view.

Interview 2:

Name: Heikki Lahtinen

Company: LIMOWA RY

Title: Project Manager

Date and Time: 04 May 2017 17:20-17:55

Questions:

1. What is the present situation of RFID Technology implementation in Logistical Activities in Finland?

2. In what way companies get benefited from the application of RFID Technology?
3. What are the challenges of RFID Implementation in Finland?
4. What are the expectations and experiences of Finnish companies regarding RFID Technology?
5. Do you see the need of RFID Technology into Finnish Logistics and Supply Chain?
6. What would be the role of LIMOWA for the promotion of RFID Technology into Finnish Logistics and Supply Chain?
7. Open View