A Study on the Potential and Requirements in Shipping Companies with RFID Technology

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Abstract : This study intends to surveyrequirements for port and logistics supply chain management with RFID (Radio Frequency IDentification)technology. Port and logistics supply chain management has become a critical issue due to the necessity of efficiency, visibility, trace-ability, etc. Since the introduction of RFID technology, its performance, reliability, validity, and safety have been a concern in most industries. Particularly, in port and logistics supply chain management, RFID has the potential to track the movement of containers and to provide in-transit visibility toward customers. In thispaper we consider some critical issues related to port and logistics supply chain management, which previously adopted RFID technology. In order to successfully design and adopt RFID technology and utilize it as optimally as is possible in the port and logistics industry, it is necessary to understand the potential of shipping companies and their requirements in adopting RFID technology in port and logistics.

Key words : Port and logistics, RFID, Supply chain management, Shipping companies, Container

1. Introduction

From the time that the initial concept of ubiquitous computing was introduced, by the Palo Alto Research Center two decades ago (Weiser, 1993), various projects and researches have been carried out (Natalia et al., 2005). Those various projects and researches have shown valuable potential in spite of the fact thatubiquitous isn't yet at a plug-and-play stage. Nevertheless, the development of RFID technology marked a significant shift toward being adopted in most industries and proved its possibilities. One representative potential field of RFID technology issupply chain management.

Supply chain management is recognized as an important area for information technology innovation and investment (Bowersox and Daugherty, 1995). Supply chain management has been defined by The Global Supply Chain Forum as theintegration of key business processes from end user through to original suppliers that provide products, services, and information that add value for customers and other stakeholders (Lambert et al., 1998). The adoption of supply chain management and the technologies to accomplish it have become competitive necessities in most industries.

With the implementation of supply chain management, the narrow focus of managers and the adversarial relationships between logistics providers, suppliers, and customers are replaced with strategic alliances and long-term cooperative relationships. Moreover, it creates an environment where suppliers and customers are partners, instead of adversaries (Tan et al., 1998), with the objectives of maximizing competitiveness and profitability for the company as well as the whole supply chain network including the end-customer (Lambert et al., 1998). Furthermore, better information exchanges between supply chain partners are perhaps the key advantagesof an integrated supply chain (Lee et al., 1997 and Levary, 2000).

The use of RFID technologyin supply chain management is expected to increase rapidly in the next few years (Asif and Mandviwalla, 2005). However, initial barriers against widespread adoption include standards, interoperability, costs, forward compatibility, and lack of familiarity at present. Although there are some barriers to adopt in the industrial field, RFID technology has shown valuable potential in various models. RFID technology enables supply chains that will allow information and product flow to inter-relate as the product moves through raw material, manufacturing, distribution, retailing, consumption, waste, and even recycling.

In the port and logistics industry, adopting supply chain management and its technologies is becoming more crucial.

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RFID technology can be used to track the movements of containers, providing in-transit visibility to shippers, customs, carriers, port infrastructure operators, and other interested parties (Lee, 2004). It can enable easy transfer of important information on the contents of the containers, the routing of shipments, and the condition of the containers in transit. Also, RFID can be the basis of sealing technologies for containers to ensure that the containers have not been tampered with or opened without authorization such as TAV (Total Asset Visibility) in the U.S. The TAV network has been deployed in 36 countries worldwide and helps the Department of Defense to Track and identify thousands of containers, providing real-time data on location. The system features anti-tamper tags, event-driven alerts, and virtual inspections and authenticated audit trails (Ioannou et al., 2000).

However, Companies will soon benefit from working with RFID in order to build skills, insights and approaches related to the technology's remaining challenges as well. RFID is concerned not only with organizational problems, but also technological issues (Patterson et al., 2003). For example, lack of worldwide data exchange standards and country-specific frequency allocations is the first. The second is fragmented vendors and lack of collaborations among value chain partners in the market. The price of tags and readers is still high and risky, overloading data on the tags is the third technological challenge. Finally, some businesses are afraid to change work habits and also concerns with privacy are other critical challenges in organizations.

Despite all the challenges above, many issues which cannot be bypassed are converging to make RFID a topic that leading companies will need to address in the very near future. As global sourcing has been embossed, effective supply chain management has become very important to shipping companies. Shipping companies have to improve their supply chain management to be efficient in port and logistics and also they are major customers to port authorities and shippers. Recently, various practical cases can be observed which can be applied in the shipping industry with RFID technology to improve their supply chain management.

Not only companies, but also governments and public research centers have been deploying diverse projects. The ETRI (Electronics and Telecommunications Research Institute) has launched experiments in fields on 433Mhz RFID active tags and prove its practical possibilities and validity (Pyo, 2005). The Ministry of Maritime Affairs and Fisheries is pursuing these projects which focused on efficient port and logistics with RFID technologies. Undoubtedly, still the small percentage of firms at world-class supply chain levels suggests that substantial barriers exist regarding integration of logistics activities

and adoption of supply chain technology. Nevertheless it seems there is no potential limitation of applying RFID technology in port and logistics thus far.

In this paper we aim to understand their current recognitions and requirements of RFID technology, which is the first priority of implementing it in the field. Hence, a literature review related to port and logistics supply chain managementwas undertaken, then questionnaires were prepared which focused on shipping companies. And 12 respondents in targeted shipping companies were surveyed and the results of the surveys were analyzed.

2. Findings from previous literature

In spite of numerous researches on SCM and RFID deployment, most studies have focused on the technological aspects or on the potential of RFID in the future. Particularly there is little research focused on port and logistics applying RFID technology. However, many recent projects or experiments on validating RFID technology in the diverse fields prove its realistic performance. The port and logistics industry is one of the major nationaleconomic competitive markets. Also shipping companies requirebetter service due to expending global sourcing world wide, and they are experiencing strong competition.

Much of this studyseems to overlook some critical issues in importing or implementing RFID technology in the port and logistics industry successfully. The success of RFID deployment in shipping companies not only has to do with technological aspects, but also an organization's requirements. In this study, we investigate researches on applying RFID technology in supply chain management. Then we identify the potential of RFID technology in port and logistics supply chain management and clarify the benefits on importing RFID technology in shipping companies.

It can be deduced from Lee's (2004) study, the reasons can cause companies to import RFID technology. According to his study, the main purposes of importing and application areas are shown in Fig. 1.
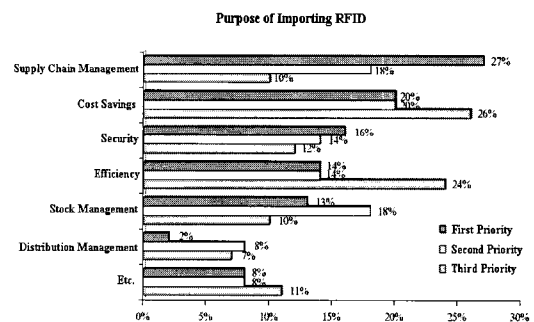

Fig. 1 Purpose of importing RFID

Frankel (2005) has suggested critical technologies can improve maritime operations which are composed ofelectronic seals, satellites services, and so on. In this study he criticized the limitations of those technologies and proposed its possibilities simultaneously. In contrast, government and industry have recognized the need for new technology for transportation and particularly shipping security.

Lee (2004) conducted a survey using a detailed questionnaire given to a set of eight targeted shippers. Its aim was to identify the major challenges faced by leading shippers in assuring supply chain security and maintaining supply chain confidence, to assess the current capabilities of leading companies in addressing the need to provide supply chain security and confidence, and to explore the potential value of RFID. He describes the potential savings from the use of RFID technologies in a trade lane such as Table 1.

Table 1 Potential Savings from RFID based technology

Cost Category	Cost Elements	Comments
Bill-of-Lading Compliance	- Direct labor cost savings - In-transit inventory reduction due to more efficient BOL transmission process	These savings are independent of the amount of inspection carried out at the port of entry, and are a function of how much the current process has already been automated.
Tracking Efficiency	- Reduction in inspection cost - Reduction in pilferage - In-transit inventory reduction due to less inspection	These savings depend on how much reduction of inspection that Customs will give for containers with tightened & monitored security. Pilferage reduction is due to tighter monitoring of the in-transit process.
Supply Chain Confidence	- Safety stock reduction as a result of reduction in the mean and variance of lead time - Safety stock reduction as a result of transparency of advanced lead time information	These savings depend on how much reduction in the mean and variance of lead-time can be achieved with increased visibility. The manufacturer should also have an advanced scientific inventory control system in place to take advantage of such improvements.

Source : Lee, 2004

According to this study the respondents clearly identified the provision of en route visibility as the number one difficulty that RFID can improve. It was expected that some other improvements would be, reduced transit lead-time and uncertainty, reducing customs lead time and uncertainty, and providing and confirming content information (Lee and Whang, 2004). Lee and Whang found that the biggest problemsfaced by shipping companies are uncertainties and lead-time incustoms and transit, as well as the visibility of their products en route from the origin ports to the destination ports.

There is currently worldwide transition in logistics environment induced advanced strategy in port and logistics operations. Ports are not only connecting points between different transportation modes, but also are sites providing integrated logistics services (Kim and Kim, 2003). Through the hub and spoke strategy of Busan and other feeder ports to be logistics centers of Northeast Asia, Korean ports should focus on the effective management of Port and logistics and the establishment of development plans meeting demand (Kang, 2004). In order to maintain competitive power in the recent environment, shipping and logistics firms are required to actively induce logistics information technology and optimize their business processes (Bang et al., 2002).

Table 2 Potential benefits from RFID based technology

Benefits Category	Benefits Elements	Comments
Contents Confirmation	-Direct labor cost savings -Reduction in sending manifest, dangerous cargo lists, bay plan, CLP through EPC global network -In-transit inventory reduction due to efficient manifest transmission	These savings are independent of the amount of inspection carried out at port of entry and are a function of how much current system are automated
Resource Utilization	-Empty transportation of truck -Empty container in stocking area -Utilization of ship space	These benefits depend on how much in-house system has already been developed
Container Condition	-Keep the status of humidity, temperature in container	These benefits depend on how much advanced technology has been developed

Source: Park, 2005

Particularly, it is more important to identify requirements from leading shipping companies. Shipping companies are more concernedwith visible, efficient, and safe supply chain management in port and logistics. As consumer markets become globalized and competitive, many shipping companies agreed upon major strategic alliance groups to strengthen competitiveness and they are affected by the pressure of cutting costs. Integrating supply chain management and information technology is not only a matter of competition but also a matter of survival.

RFID technology has potential benefits for shipping companies. Park (2005) has suggested that the potential benefits of shipping companies from RFID based technology such as Table 2.

3. Questionnaire Survey

We surveyed panel research which was based on a detailed questionnaire completed by a set of 12 targeted shipping companies. 12 shipping companies were represented by world-class domestic companies such as Hyundai, Hanjin, Heunga, Koryo, Namsung, and Dongjin, and international companies such as P&O Nedlloyd, Maersk Sealand, Evergreen, and OOCL. Question items based on Lee's (2004) research for shippers were designed so as to validate the questionnaire, and interviews were conducted with managers in shipping companies and leading academics were interviewed several times.

The respondents of our study are general managers of logistics, distribution managers, and managers of logistics services in the companies, including branch offices. We were supported in collecting the questionnaire by the Korea Ship-owners Association, they sent our questionnaire and an explanation on the research to respondents in each of the 12 shipping companies.

In the questionnaire, we asked our respondents to rank a list of supply chain performance objectives that indicate the importance and priorities of these objectives in their companies such below Table 3.

Table 3 General understanding on Supply Chain Management

What are the priorities of your company regarding the global supply chain management in shipment?		
No.	Description	Rank
1	Monitoring freight location in real time	2.7
2	Increasing logistics flexibility	4.3
3	Increasing customer service	4.8

4	Reducing cost for logistics management	5
5	Reducing custom clearance time	5.8
6	Reducing labor for logistics management	6.2
7	Monitoring freight condition in real time	6.3
8	Reducing foreign-to-domestic transit time	7
9	Reducing product stagnation	7.8
10	Improving corporate image	8.5
11	Early warning for damaged goods	9.3
12	Reducing theft during transit	10.2

The general understanding on supply chain management of shipping companies seem to be common place. The highest ranked objective is monitoring freightlocation in real time. One of the major benefits of RFID technology is RTLS (Real Time Location Systems) which can be expected to fix this problem. Other highly ranked objectives are increasing logisticsflexibility, increasing customer service, and reducing cost for logistics management. Result of the shipping companies recognizingthat SCM is needed to track the movement of containers and raising customer services with reducing logistics management cost.
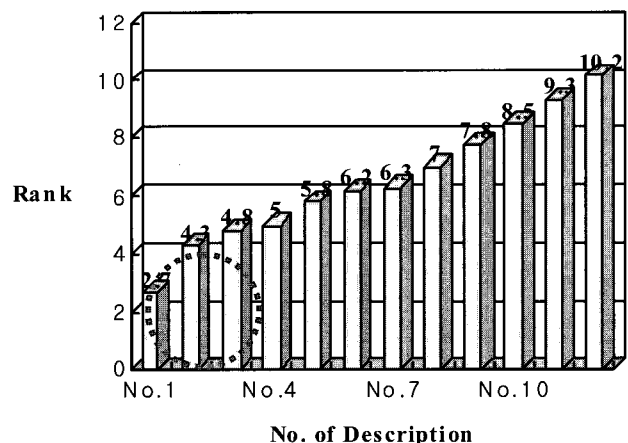

Fig. 2 General understanding on Supply Chain Management

We expected they also have obstruction issues to enhance SCM in their company. So we asked our respondents to rank a list of international shipping problems in global supply chain management such below Table 4.

Table 4 Priorities in barriers to deploy Supply Chain Management

What are the priorities of your company regarding the barriers to deploy global supply chain management?		
No.	Description	Rank
1	Lack of visibility of containers location	3.7
2	Lack of visibility of the condition of container contents	3.8
3	Increased lead time due to transportation time variability	4.5
4	Incorrect quantity due to damage en route	6.5
5	Increased lead time due to time in customs	6.7
6	Time and cost to receive order and confirm shipment contents	6.8
7	Concern regarding whether illegal items were smuggled in your container	8.5
8	Incorrect quantity due to wrong amount shipped	8.7
9	Incorrect quantity due topilferage en route	10.2
10	Concern regarding whether terrorists could use your container	10.5
11	Cost to insure cargo	11

The highest priority of shipping companies seemsto be increasing visibility of the location of containers and visibility of the condition of the contents of containers. However, shipping companies are not only trying to increase the visibility of containers but also reduce lead time. Interestingly, the rest of the objectives are ranked far lower than the top three objectives. It shows clearly the main goal of supply chain management in shipping companies is focused on increasing container visibility and reducing lead time.
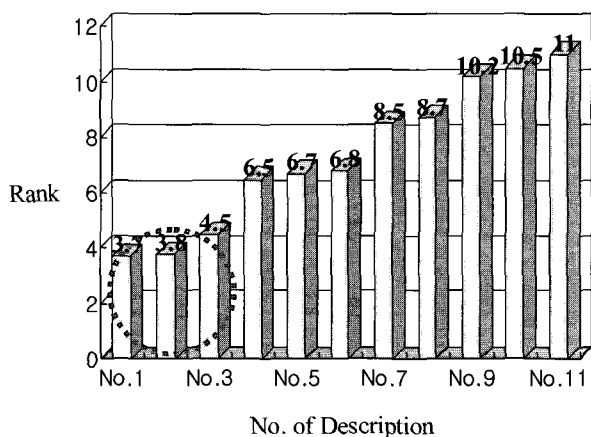

Fig. 3 Priorities in barriers to deploy Supply Chain Management

The emergence of uncertainties in customs and transit, and en route visibility, as the biggest problems faced by shipping companies and shippers, is easily understandable. With the threat of terrorists and other supply chain security initiatives, the uncertainties and the lead times in customs and transit have increased as well.Supply chain security is another issue to improve supply chain management in the port and logistics industry especially in the U.S (Eyefortransport, 2002). The U.S Government and Customs have launched initiatives related to port security which are C-TPAT (Customs Trade Partnerships against Terrorism), SST (Smart and Secure Trade-lane), CSI (Container Security Initiative). SST is one of representative application area for RFID technology.

It is timely and appropriate that we consider security situation in domestic port and logistics. We asked our respondents whether they currently have the capabilities to get information and visibility on a number of areas such as Table 5.

Table 5 Information capabilities of current company

There is necessityof each item below to make sure visibility and condition of container in transit. How much percentage can your company be sure about each item?		
No.	Description	%
1	Scanning when loaded for international transport	66.7
2	Scanning upon receipt at final destination	65
3	Monitoring container location in real time	64.2
4	Proactive reports when the container deviates from the planned route or timing	54.2
5	Immediate reporting if transit time was delayed	48.3
6	Monitoring the condition of container contents in real time	45

Only slightly less than half of the shipping companies have the capability to monitor information regarding the condition of the contents inside containers in real time, or have immediate reports on container transit timing delay. In addition, slightly more than half of the shipping companies have the capability to have proactive reports on container route or timing variations.
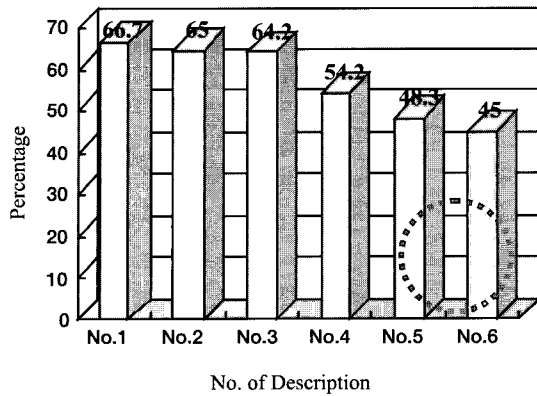
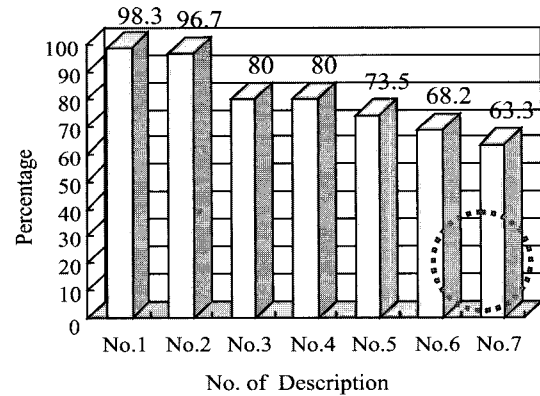Fig. 4 Information capabilities of current company

Fig. 5 logistics management of shipping companies

Interestingly, a little more than half of shipping companies have the capability to have monitored information on container location in real time. This result is relatively much more than other country cases. There is a necessity to survey more details about the capacity to have detail information on container location in real time.

The respondents were then asked whether they currently perform any of the following logistics management actions such as in Table 6. There is no specific measurement so these answers are flexible, but based on their current estimations.

Table 6 Logistics management of shipping companies

How much percentage can your company perform any of following logistics management actions?		
No.	Description	%
1	Advanced notice of contents sent to final destination	98.3
2	Advanced notice of contents sent to customs	96.7
3	Updates of altered delivery information sent to final destination	80
4	Updates of altered delivery information sent to destination custom	80
5	Operating IT systems providing freight & its transit information	73.5
6	Providing web service on freight information to customers	68.2
7	IT systems between your firm and logistics provider share data effectively	63.3

Most shipping companies are able to provide advanced notice of contents sent to final destinationsand customs. And the majority of the shipping companies are also able to provide altered delivery time and contents sent to final destinationsand to customs for the purpose of customs and receiving processes. Hence, there is lack of sharing data between shipping companies and logistics providers using Information Technology.

Note that, in Table 5, there wereless than half of shipping companies who had the capability of having container condition and timing deviations reported, but in Table 6, more than 80% of the companies have the capability to provide delivery information updates to destinations and customs. We can estimate that, they are more confident in performing advanced notice and update information, but they are not confident with security matters. Also, the difference between Table 5 and Table 6 on this issue indicates that, while shipping companies are able to provide such information to the receiving side and customs, the information wasn't comprehensiveenough to provide information on container location and status. Only limited information is currently able to be provided.

Table 7 Priority of RFID technology in shipping companies

Can RFID technologyhelp to address the concerns and problems of international shipping?		
No.	Description	Rank
1	Increasing en route visibility	2.7
2	Monitoring container condition in real time	3.8
3	Reducing customs lead time	4.3
4	Contents sent to customs automatically	5.3
5	Ensuring right quantity received	5.7
6	Reducing custom clearance time	6
7	Preventing damage en route	6.2
8	Preventing pilferage en route	6.3
9	Preventing smuggling	7.7
10	Preventing terrorists actions with container	9
11	Preventing counterfeit container	10.2
12	Reducing insurance cost	10.8

Each respondent was then asked to rank the areas such as in Table 7 in which technology could aid them in regards to priority.Indeed they expect what feature is most urgent when they import new technology.

Not all shipping companies clearly identified the provision of en route visibility as the number one problem that RFID can be of assistance. Some needed a short explanation on how RFID technology can be used in the shipping industry. Then we asked the companies how they recognized the potential, priority of RFID technology could address such problems.
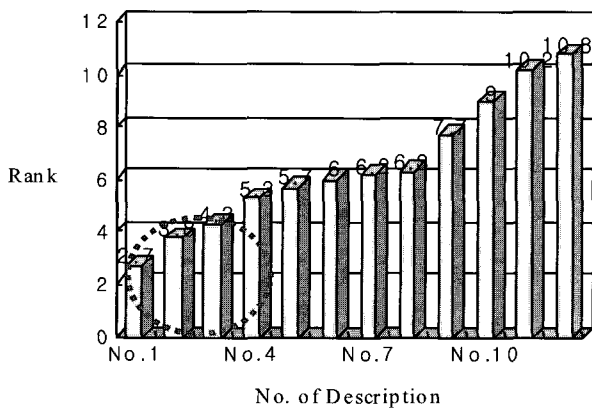

Fig. 6 Potential priority of RFID technology in shipping companies

The first urgent area is increasing en route visibility. The next highest ranked area is monitoring container condition in real time. And other highly ranked areas are reducing customs lead time and sending contents to customs automatically. These results are very similar to the results in Table 6.

Also, each respondent was asked to rank the areas such as Table 8 in which technology could help most effectively. Indeed they anticipate the features that are most effective when they import RFID technology.

Table 8 Effectiveof RFID technology in shipping companies

Which item would you think RFID technology can help most effectively?		
No.	Description	Rank
1	Increasing en route visibility	2.7
2	Reducing customs lead time	3.8
3	Contents sent to customs automatically	4.5
4	Monitoring container condition in real time	4.5
5	Reducing custom clearance time	6.2

6	Preventing smuggling	6.2
7	Ensuring right quantity received	7
8	Preventing damage en route	7.5
9	Preventing pilferage en route	8
10	Preventing counterfeit container	8
11	Preventing terrorists actions with container	8.7
12	Reducing insurance cost	11

While Table 7 is concerned with the potential priority of RFID technology, Table 8 refers to the effectiveness of RFID technology.
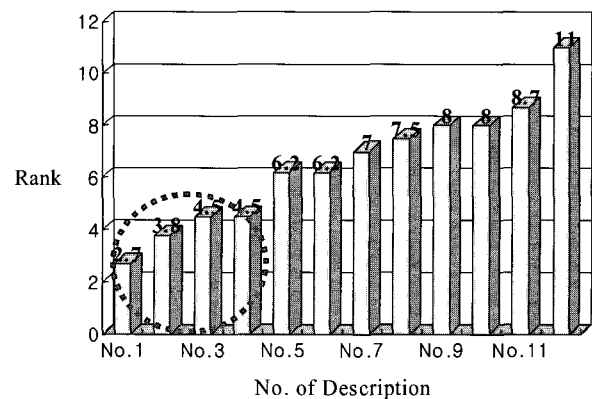

Fig. 7 Effective of RFID technology in shipping companies

Interestingly, the results are the same as discussed in Table 7. The highest ranked area is increasing en route visibility. And the second highly ranked area is reducing customs lead time. Other highlyranked areas are sending contents to customs automatically and monitoring container condition in real time.

There is no difference between the priority and effective of importing RFID technology in the shipping industry. It shows clear goals and expectationsof shipping companies on RFID technology.

4. Implications

While governments and the private sector are working together to try new initiatives to make port and logistics more visible, secure, and efficient, the shipping industry is rapidly exploring the potential of new technologies such as RFID towards the same goals. Most shipping companies agree with the provision of adapting RFID technology cautiously. This study gives a glimpse of how shipping companies coping with the problems of supply chain

management and confidence, and assessesthe effectiveness of RFID accordingly.

This study was based on a panel of leading shipping companies, and although this is not a complete represen- tation of all shipping companies, we think valuable insights have been observed similar to Lee (2004)'s study for shippers previously in the U.S. The biggest performance objectives of shipping companies are increasing en route visibility and reducing lead time. These problems are naturally linked to the increasing threat of supply chain security, and the general cost effective goal of supply chain management.

Currently, the capabilities of shipping companies in providing information to give more visibility to the supply chain are still limited. This study informs the commonly held thought that RFID could be a major technology that improves supply chain management of port and logistics. Also, there was the critical point that not all shipping companies identified the potential of RFID technology. It is a necessary requirement of how governments and private organizations deploy and adapt RFID technology in the shipping industry.

Nevertheless, the results of the survey show thecritical requirements of adopting RFID technology. It would be useful to design and deploy supply chain management and adopting RFID technology in the port and logistics industry. An important implication of this paper would manifest findings in order to avoid trial-and-error cases during its development and implementation.

This study was aim to identify the capability and requirements of shipping companies in implementing RFID technology. Although this study was the first to consider shipping company's views on the potential of RFID technology, there are some limitations. First, there should be further research providing amore in depth study which can be hypothetical and cause-and-effect. Second, not only shipping companies,but port authority and terminals should concentrate on service improvements for port competitiveness. The study needs to integrate perspectives from shipping companies and also terminals.

Acknowledgments

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