

IOT APPLICATION IN AEO-BASED INTERNATIONAL LOGISTICS PROCESS

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ABSTRACT. *As the security of the international logistics is strengthened, advanced countries and international organizations such as the United States and Europe are promoting the certification system. Therefore, it is necessary to provide relevant technical support to the small and medium-sized enterprises. In this paper, we analyze the cases of AEO (Authorized Economic Operator)-certified companies, and summarize the adoption backgrounds and reasons, improvement technologies and systems. In addition, we propose a plan to apply the subject tasks to the AEO standards through IoT application in the international logistics process. This study will help to improve understanding of logistics security system as well as access to the AEO.*

Keywords: International logistics, AEO, Logistics security, IoT

1. Introduction and Related Works. After the September 11 attacks in the United States, security in logistics and trade has been strengthened. Many international organizations are establishing logistics security systems such as 24 Hours Rule, CSI, ISPS, C-TAPT. Also, ISO 28000 has been enacted and implemented by the international organization for standardization [1]. WCO established WCO SAFE Framework and AEO for trade safety and facilitation. In addition, MRA (Mutual Recognition Arrangement) is being implemented to extend AEO globally [2].

AEO system simplifies customs clearance procedures of the companies that meet certain standards. The targets for AEO-certification are exporters, importers, customs agents, freight forwarders, bonded area operators, shipping companies, airlines, and contractors. The certification standard consists of four criteria: compliance with laws, internal control system, financial soundness and security management. Ha [3] analyzed the effect of AEO certification on firm's performance through panel data. Lee [4] identified the company's requirements for logistics security certification and analyzed the priorities. Table 1 shows the trends in AEO related studies.

There has not been a paper in progress that examines the methods prepared by businesses certified and their difficulties. Any empirical study related to the success or the performance of AEO certification cannot be found. Although many international studies focused on the necessity of the system, they could not verify the effects of the AEO.

Meanwhile, as the Internet of Things (IoT) technologies have been used to connect production sites and monitor machines and employees, 47% of logistics companies forecast to have a huge influence of IoT on logistics and supply chain management in the future. In particular, IoT will help improve transportation efficiency, solve the security issues of shipping facilities and staves, and eliminate potential threats by predicting emergency situations [5].

TABLE 1. Trends in AEO related studies

Period	Research trend
Before introduction (~ 2008)	Mainly on the purpose and necessity to be adopted
Immediately after introduction	Expansion plan of AEO, need to increase benefits and preparation for AEO certification
Increased certified enterprises	A study on the mutual recognition system of AEO certification systems

For IoT-based logistics research, Qu et al. [6] proposed an IoT-based real-time production logistics synchronization (PLS) system which enables a smart PLS mechanism with two-level dynamics control. Tu et al. [7] proposed a way to solve the ambiguous situations arising from the natural language used to develop IoT-based production logistics and supply chain systems.

Therefore, this study is intended to analyze the application of international standards and norms about logistics security and safety logistics using AEO for importers and exporters to get logistics security technology. Also, it is designed to secure IoT technologies for applying local import-exporting businesses to related regulations. Combining analysis of AEO-based international logistics process and IoT application on the process in this study will complement the accessibility of the certification system and help the SMEs to understand the logistics security systems.

This paper is organized as follows. Section 2 introduces international logistics process. Section 3 explains the result of analysis about SME's AEO certification. Section 4 describes how to apply IoT technology to international logistics process. Finally, concluding remarks are presented in Section 5.

2. International Logistics Process. International logistics management is complex due to the diversification of export and import procedures, customs clearance procedures, and transportation methods. International logistics is subject to environmental constraints because the area of transportation is large and mass cargo must be transported. International logistics process consists of export and import process. In the export logistics process, products produced by the shipper are delivered, cleared customs, brought into the terminal, shipped, and delivered to the importer. On the other hand, the import logistics process is to arrive at the domestic ports by airline or by shipping, and then to be delivered to the shipper via unloading, bonded carriers, bonded warehouse, and customs clearance. These are shown in Figure 1 and Figure 2 [8].

At the center of the export logistics process, physical movement is done in the direction shown, but information about the goods transmitted by shippers is simultaneously received by forwarders, customs agents, and bonded carriers. In addition, not only the forwarder and the customs agents come into contact with the bonded carriers, but also the exporters requests transport to the bondman. The same applies to the import logistics

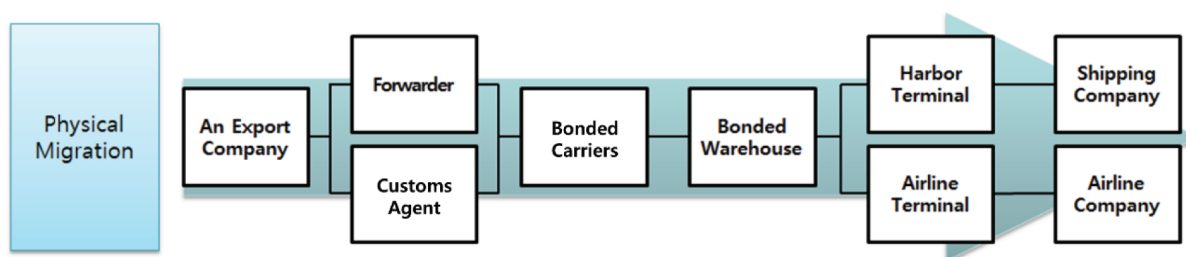


FIGURE 1. Export logistics process

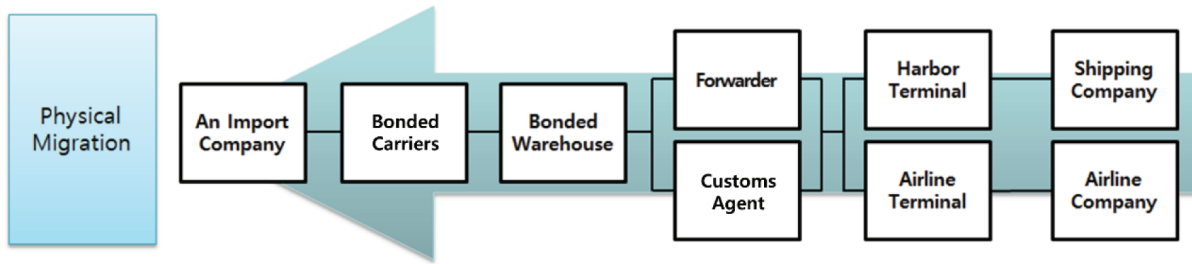


FIGURE 2. Import logistics process

process. Once a cargo enters the port, the shipping/airline companies will send the actual information to the terminal, forwarder, customs agents, and bonded carrier, which can be identified as actual information generated from the export logistics process. In other words, the shipping/airline companies will also give and take information from not only the terminal, but also rest of the process.

The scope of logistics activities is expanding around the world and logistics systems become more complex because exporting and importing processes have different entities depending on the situation and activities for procurement, production, and sales are carried out worldwide. As a result, individual companies are shifting to competition to build a global network to achieve optimization of the entire logistics process rather than partial optimization limited to unit activities by logistics program [9].

3. Case Study of AEO Certification. In this study, we have compared and analyzed 15 cases of SMEs whose AEO certification was successful from 2011 to 2015. First, it is possible to identify which of the AEO assessment subjects have been accredited, as shown in Table 2. Terminal and shipping/airline companies have no AEO certified business, whereas a large number of exporters and customs agents have been AEO certified. In addition, it can be seen that the customs agent is able to perform the role of forwarders and bonded warehouses.

TABLE 2. Distribution of the winning SMEs in AEO competition

	2011				2012		2013				2014			2015	
	A	B	C	D	A	B	A	B	C	D	A	B	C	A	B
Export company	O								O		O	O	O	O	
Import company	O								O			O			
Forwarder				O		O				O					
Customs agent			O	O	O		O	O							O
Bonded carriers						O				O					
Bonded warehouse		O					O								
Terminal															
Shipping company															
Airline company															

The cases have the following adoption backgrounds and reasons. And the key improvement technologies and systems for solving these are summarized in Table 3. We could find that the contents were improved mainly by deploying in-house information sharing, information management, and risk management systems.

- Incorrect information transmission and reception due to human error
- Absence of internal control system
- Increased customer claim as a result of leakage of customer information
- Low performance in operation

TABLE 3. Adoption background and improvement techniques and system

	Adoption backgrounds and reasons	Techniques & System	Authorized criteria
2011-A	- Increase in export claims - Insufficient response to changes in trade environment	- Information system	- Internal Control System 2.3 - Security Management 4.5
2011-B	- Low container handling performance - Securing terminal logistics security integrity	- RFID - OCR system	- Security Management 4.2 - Security Management 4.3
2011-C	- Prevent customers from leaking information - Improved compliance with customer's laws - Lack of staff awareness of AEO	- Information security system - Education and training system	- Internal Control System 2.2 - Security Management 4.5
2011-D	- Manage report accuracy by company - An irregularity in the accuracy of import and export reports	- Risk management system	- Internal Control System 2.2 - Internal Control System 2.3
2012-A	- The need to consolidate vast amounts of data - Export free transportation	- Intelligence intergration system	- Internal Control System 2.3
2012-B	- Difficulty in compliance management with laws due to human error - Increased lead time with manual input - Difficulty in gaining confidence in shipping time	- Information security system	- Internal Control System 2.2 - Internal Control System 2.3
2013-A	- Operation error due to human error - Difficulty in tracking cargo due to the absence of a cargo information system - Insufficient connection with transportation clearance system	- Information system - Intranet	- Security Management 4.2 - Security Management 4.5
2013-B	- Long ash on existing customs clearance system - Insufficient processing of import and export declaration	- Information security system - Access control management system	- Security Management 4.3 - Security Management 4.6
2013-C	- The need for internal and external control - Remove LOSS in Safety Management	- Information security system - Education and training system	- Internal Control System 2.3 - Security Management 4.6
2013-D	- Accurate receipt of information and timely transmission of customs declaration materials - Accurate shipping and transportation management	- Safety management system	- Internal Control System 2.2 - Internal Control System 2.3 - Security Management 4.5
2014-A	- Lack of work manual due to lack of logistics management system - Customs Service Agent Processing Risk	- Integrated logistics system - Access control management system	- Internal Control System 2.2 - Internal Control System 2.3 - Security Management 4.3
2014-B	- Lack of Customs clearance management system for imports and exports - Integrity packaging needs to be guaranteed during transportation	- Information sharing system	- Internal Control System 2.3 - Security Management 4.5
2014-C	- Lack of security: External hacking/No access control - Poor law enforcement	- Access control management system - Information security system	- Security Management 4.3 - Security Management 4.5
2015-A	- Absence of internal control - Human Error of Export Documentation - Loss of goods	- Internal control system - ERP	- Internal Control System 2.2 - Internal Control System 2.3 - Security Management 4.5
2015-B	- Difficulty in risk management through linkage of information between services - Human Error of Risk Management	- Risk management system	- Internal Control System 2.2 - Security Management 4.5

Classifying the best practices of logistics security certification according to the AEO certification standards showed that the businesses focused on internal control systems and security management. Although the overall requirements have been satisfied in both areas, main improvement areas are 'risk assessment and control activities in the field of internal control systems', 'improvements in handling procedures of security management' and 'improvements in facility and equipment management' as shown in Table 3. This means that overall management process was carried out with an intranet and an in-house integrated logistics system for accurate information sharing in complex logistics environments.

The findings are similar to the ones of a study [10], which looked at three AEO certification cases and found that all three firms had no problems with compliance with regulations and financial soundness. Problems were found in internal control systems

and security management. Internal control system indicates insufficient export and import business system, insufficient operation manual system, insufficient logistics security guidelines, inadequate item classification system, inadequate safety management system, and lack of risk assessment procedures. Security management shows insufficient access control, insufficient transaction control, lack of partner safety management system, and inadequate logistics information system.

4. IoT Application by Process. As mentioned above, efforts have been made for AEO certification in a complex international logistics process to increase competitiveness in exports. However, little cases showed the application of IoT technologies. Therefore, this study suggests an application plan of AEO certification using IoT-based integration platform for international logistics and logistics security technologies. We want to help domestic logistics companies develop the IoT-based system and user solution that realizes the cargo information in real time and actively cope with changes in logistics environment of import and export. The information used to be generated according to the movement step for each user and for each logistics facility. Figure 3 shows process flow of shipping and trade using IoT from the viewpoint of the shippers, including exporters and small and medium-sized exporters among the 10 AEO certified companies.

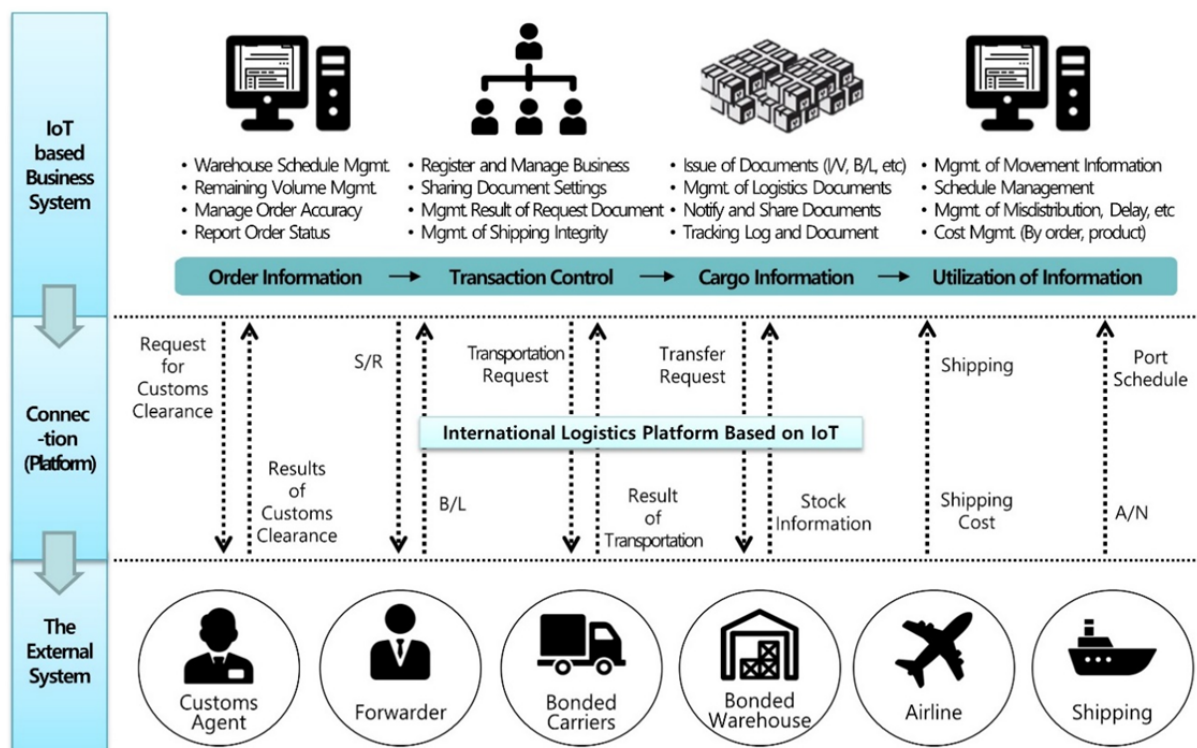


FIGURE 3. Process flow of shipping and trade using IoT

The shippers need to communicate with the operators of the international logistics process – customs agent, forwarder, bonded carriers, etc. – about all their operations under the IoT based system. That is, the shippers information should be converted, stored, processed, linked and provided in a standardized form of IoT technology. Systems should be developed and consolidated to monitor information generated on the network to ensure the visibility of export and import logistics [11]. Additionally, interfacing technology that is able to interlink with external systems could be developed so that operator-related data can be exchanged and processed on line. The shippers can know the handling procedure of the export process in real time. Each individual company can realize the optimization

of the entire logistics process by exchanging information with other operators in real time through IoT-based integration platform for international logistics.

On the other hand, the order information management of the shippers can satisfy the official standard of the internal control system through the management of customs clearance legality and materials for imports and exports, payment and receipts using Big Data. In addition, the utilization of international logistics information can satisfy the official standard of security management through managing the transportation operations within the process using CPS (Cyber Physical System). Table 4 shows the applicable AEO certification criteria and applicable IoT technology according to the work flow of shippers.

TABLE 4. Criteria for AEO certification and IoT-related technologies by the work flow

Work flow of international logistics process	AEO certified criteria	IoT-related technologies
01. Order Information Management		
011. Warehouse Schedule Management	Security Management 4.5.4	Big Data
012. Remaining Volume Management	Internal Control System 2.3.1	Big Data
013. Manage Order Accuracy	Internal Control System 2.3.1	Big Data
014. Report Order Status	Internal Control System 2.3.3	Big Data
02. Transaction Control Management		
021. Register and Manage Business	Security Management 4.1.1	Big Data
022. Sharing Document Settings	Security Management 4.5.2	Cloud
023. Management Result of Request Documents	Security Management 4.5.2	Cloud
024. Management of Shipping Integrity	Security Management 4.5.3	CPS
03. Cargo Information Management		
031. Issue of Documents (I/V, B/L, etc)	Internal Control System 2.3.1	RFID
032. Management of Logistics Documents	Security Management 4.5.3	Cloud
033. Notify and Share Documents	Security Management 4.5.3	Cloud
034. Tracking Log and Documents	Security Management 4.5.4	Cloud
04. Utilization of International Logistics Information		
041. Management of Movement Information	Internal Control System 2.3.3	RFID
042. Schedule Management	Security Management 4.5.4	RFID, Big Data
043. Management of Misdistribution, Delay, etc.	Security Management 4.5.4	RFID
044. Cost Management (By order, product)	Security Management 4.5.4	RFID, Big Data

As shown above, many tasks of shippers can be applied to AEO approved criteria through IoT based international logistics integration platform. The same applies to forwarder, customs agent, bonded carriers, bonded warehouse, loader, shipping/airline companies. Information can be exchanged with other members in real time to proceed through IoT based international logistics intergration platform. This would allow the application of the AEO by satisfying the internal control system and the security management standards.

5. Conclusions. Most countries recognize the importance of international logistics security, establish related systems and implement them. Various problems have prevented the SMEs from understanding not only the systems but also the benefits and procedures of the AEO certification system and from establishing an application plan. In this study, we described the detailed process of international logistics from the viewpoint of the AEO participants. We explored the application of international logistics security system by analyzing the cases of AEO certification. We have complemented the accessibility of the certification system by mapping each task of the operators and the international logistics security system. These could help the SMEs to understand the logistics security systems.

It is necessary to develop an integrative platform for the international logistics using IoT technologies. And the institutional and administrative procedures for the increase of

advantages for the domestic activation of the AEO system and the platform approach of the entrepreneurs should be prepared.

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