RFID-aided System Design for Container Customs Clearance between Guangdong and Hong Kong

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Abstract—**This article will base on Chinese customs clearance process, introduce the RFID-aided system design for container tracing and customs clearance process, and put forward the possible problems and solutions in the future for the container tracing and custom clearance system covering the whole container transportation or connecting the container tracing and logistics customs clearance system between different countries and regions.**

***Index Terms*—RFID, Container, Custom, Customs clearance**

I. Introduction

Since the mid of 1950's the booming of container transportation has reduced the costs in cargo transshipment and increased the efficiency in time, and transportation industry has come into a new phase, which is totally different from the single mode transportation as railway or water transportation [5]. There are now approximately 18 million ETU containers worldwide available [2], each container during the transportation is subject to four to five times of operation (i.e. container loading, vessel loading, unloading, intermediate storage, transportation to the destination). And also each container is subject to three to five times of recycling, which leads to approximately annual throughput of 300 million [1]. This is coincident as the statistics in 2004 by ISL (Institut für Seeverkehrswirtschaft und Logistik), in which it is forecasted that in 2015 the total throughput in global container will reach 600 million TEUs, as shown in Fig. 1.

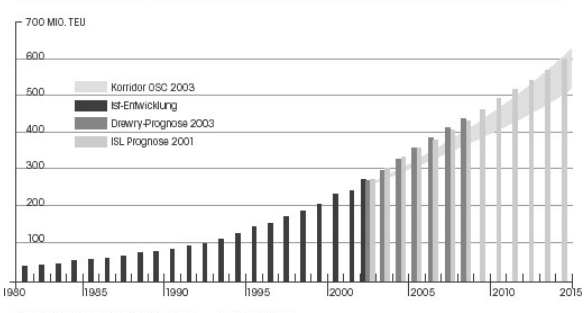

Fig. 1 Forecasting for the developments on the throughput of global containers (Source: ISL 2004)

However since the container has not equipped with automatic recognizable electronic label as RFID (Radio Frequency Identification), currently 35% of the information is not accurate or timely [3], which will not trace the information of who the containers belong to, where the containers are and when the containers arrive, hence it becomes the main bottleneck to influence the efficiency of modern logistics, the profits of cargo distribution and the level of supply chain management.

This article is going to base on the process of harbor logistics in China customs, introduce the RFID-aided container tracing and customs clearance system in Chinese harbors, and to put forward the problems and possible solutions for container tracing and customs clearance system covering the whole container transportation or connecting the container tracing and customs clearance system between different countries and regions.

II. Literature Review

A. RFID (Radio Frequency Identification)

RFID is non-contact automatic reorganization technology. The basic principle is by using of frequency signal and its space coupling and transport characteristics to realize the automatic mechanical reorganization of static or moving articles [8] [9]. The advantages of RFID include:

1) Identification of the moving articles;
2) Multi-target identification at the same time;
3) Non-contact identification;
4) Non-intervention.

RFID can be classified into different systems according to

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different classification standards:

1) According to the applied frequency, there are high-frequency and low-frequency systems;

2) According to whether the electronic tags are battery-powered or not, there are active and passive systems;

B. Application of RFID in container transportation

In general there are two major problems for the application of RFID technology, one is to read multiple tags and another one is to read fast moving articles. However the material of containers has little influence on the reading property when the attached RFID tags are read. During the automatic identification, the moving speed is comparatively low and each container has only one tag. In this case, the application of RFID technology in automatic container identification is ideal.

Currently certain countries and regions have implemented the research and application of RFID in container transportation, for instance China, USA, Germany, Japan and South Korea etc ([12], [4], [1], [10], [13], [14]).

After 911, to strengthen the anti-terrorist, the USA has proposed CSI (The Container Security Initiative) [4] [1], which targets at establishing a system of trade security to protect the global container sea transportation. In 2002, CSI has started to use the information technology to identify the dangerous goods within the container. Through the GPS (Global Positioning System), RFID and sensor technology, during the whole transportation the container security system has ensured the containers are under inspection.

China Merchants Holding International has started to install the SmartChain software platform, transportation security system software and RFID data reader devices in SCT (Shekou container terminal) CCT (Chewan container terminal) [6].

In the summer of 2004, the South Korean government has planned the project of 'Intelligent Container' [11]. And in December 2004 the project was officially promoted. The so called 'RFID sea transportation logistics' project has installed intelligent RFID and sensor in 'Intelligent Containers', which left from Pusan port to the wet coast of the USA and main ports in Europe. During the whole transportation they are under inspection of the security software and the management personnel can obtain all kinds of information in time, so as to enhance the efficiency and security in the international trade between South Korea and the other countries.

At the same time some companies has also developed global container transportation inspection system based on RFID. For instance in January in 2005, GE (General Electronics) security group has released an electronic system concerning the container security market, and implemented a commercial test jointly with Sinotrans (China National Foreign Trade Transportation (Group) Corporation) for ocean transportation.

The American company SAVI and the Australian company Indentec both have developed container transportation inspection system, among which the SmartChain system from SAVI has implemented in the American CSI program. Chinese company INVENGO has also developed RFID-aided container management system [7].

All the facts prove that the application of RFID in container plays a significant role to secure the safety for cargo transportation, improve the efficiency of containers management and facilitate the speed of customs clearance.

III. RFID-AIDED SYSTEMS DESIGN FOR CONTAINER TRACING AND CUSTOMS CLEARANCE

A. The current trade situation between Guangdong and Hong Kong

As world's largest container throughput terminal, Hong Kong terminal possesses the best logistics infrastructure in South East Asia or even worldwide. In 2005 the throughput of container is 21.98 million TEUs [1], among which the cargo from Shenzhen and the area around Pearl River Delta accounts for 85% of the total volume in Hong Kong cargo transportation [15]. The annual truck shipment between the frontier of Guangdong and Hong Kong is 10 million times.

In 2005 the total import and export trade volume in Guangdong province is USD 427.96 Billion, which accounts for 30.1% of the total import and export trade volume in China [16]. Among which the cargo to Hong Kong or the transshipments through Hong Kong account for 40%.

As one of the most important components for global logistics, the customs logistics plays an important role in reducing the trade costs, enhancing the trade efficiency and improving the investment environment etc. The logistics cooperation between Guangdong and Hong Kong emphasizes the further improvement in the customs environment and the facilitation of the 'Da Tong Guan '[1].

At present the harbor logistics customs clearance has developed towards the direction of 'Paperless' and 'One Stop'. On March 29 2004, Guangzhou opened the first electronic port in the nation wide to have realized the one stop service for customs, inspection and quarantine, maritime, frontier and port operation, which has realized the customs clearance process of 'one declaration, one check, and one release'. While the start up of Shenzhen electronic port has closely combined the electronic customs clearance and the construction of Da Tong Guan. Besides all the other local harbors have facilitated the information process in different degree.

China customs has successfully implemented the EDI (Electronic Data Interchange) platform in the harbors and facilitated the customs clearance speed and accuracy. However the process of Chinese customs clearance concerns different joint inspection departments, including customs, immigration office, national inspection, harbor master, harbor management departments, import and export company, customs agent, dock company, shipping agency, forwarder, customs broker and CIQ (China Inspection and Quarantine) etc.

Since so many departments are concerned, big amount of data will be collected, processed, and interchanged. The

[1] Da Tong Guan' is proposed by China Customs, which refers to the mode of customs clearance to realize the integrated network among the shipping agency, shipping company and all related departments in the harbor through the EDI center.

applications of RFID technology will seamless connect the customs clearance procedure and enterprise logistics supply chain, so as to enhance the accuracy and facilitate of the speed of customs clearance.

B. The current customs clearance process between Guangdong and Hong Kong

In this article we will make a brief introduction in the container export customs clearance process. The basic export process of the customs clearance between Guangdong and Hong Kong is declaration – inspection – taxation – release.

1) Declaration

The consigner (export party) prepares the export cargo fully according to the export contract (i.e. time, quantity, quality etc.) and books the space from the transportation company. 24 hours before the loading of the cargo, the consigner should prepare the customs documents for the customs, or consign a customs agent to do the customs clearance procedure.

2) Inspection

The customs bureau receives the declaration from the consigner and base on the audited declaration, to ensure whether the declared content is in coincidence with the actual exporting cargo according to the actual inspection in the exporting cargo.

3) Taxation

According to the corresponding regulation (Customs Law), all the import and export cargo are subject to taxation except certain exceptions. The taxation tariff is according to the customs import and export tariff system. The cargo subjected to taxation will obtain the taxation receipt within 1 day after the acceptation of the declaration and should be customs cleared within 2 hours after the taxation is paid.

4) Release

For general import and export cargo, the custom bureau should seal the 'customs release seal' on the export loading bill after the consigner or the agent declare to the customs and pay the payable taxation and other related fees.

C. RFID-aided system design

The RFID-aided harbor container tracing and customs clearance system is a management system based on active RFID electronic label, combined with EDI, and integrated the container transportation process and container customs clearance process between Guangdong and Hong Kong.

The system is divided into 4 levels, as shown in fig. 2:

1) RFID reading and controlling system
2) RFID middleware
3) EDI
4) Application system

RFID reading and controlling system is the basis level, during the whole container transportation process, each key point will be equipped with RFID chip reader, to read the original data from the RFID chip attached to the container.

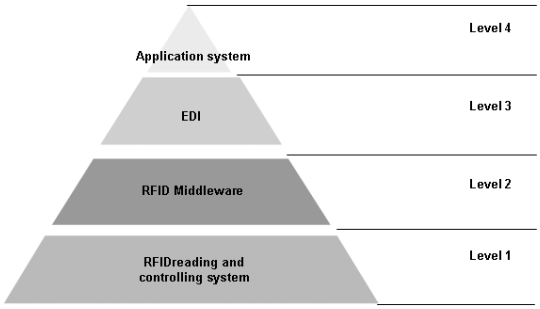

Fig. 2 System model

RFID middleware deals with the original data read from the basis level, so that they will be identified by the current software system and for further use.

The application system will in the end use the processed container related data. The application system includes all the concerned information management system during the whole container transportation and customs clearance, for instance, the custom management system, terminal management system, consigner management system and information management system from other joint inspection departments.

Due to the different development time and technology, different information management system demands different format, therefore all the information requires the third level – EDI to process the information from the level two to the acceptable information format.

All the sub systems are established on the RFID article information collection and EDI platform data centre, including active RFID technology based data collection processing system, unified and integrated EDI platform, harbour yard management and terminal scene management, and the integration and coordination of the interface module among each system and EDI platform.

The system network structure is as shown in fig. 3.

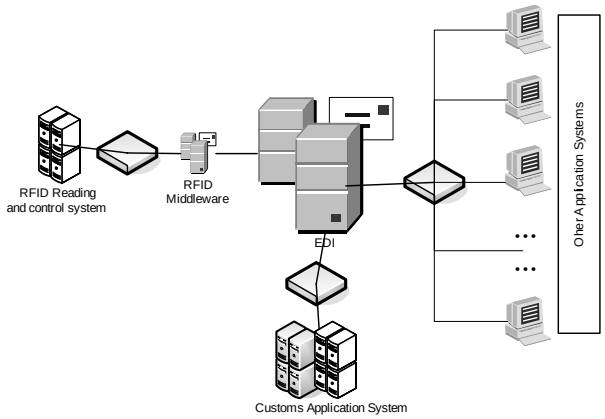

Fig. 3 System network structure

D. RFID-aided system description

With the application of RFID technology, the basic process for customs clearance between Guangdong and Hong Kong is as show in fig. 4 and 5.

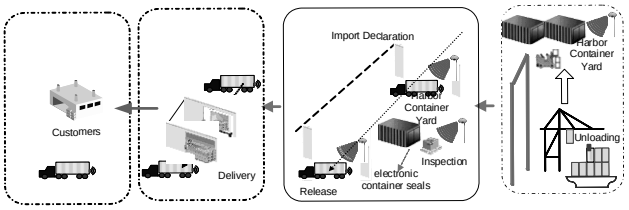

Fig. 4 RFID-aided Chinese harbor container tracing and customs clearance system – import process

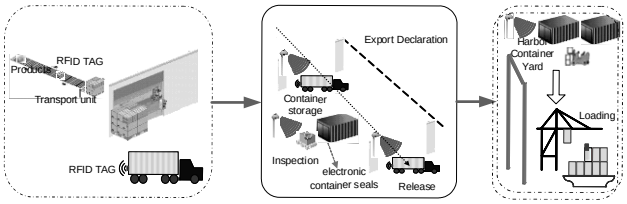

Fig. 5 RFID-aided Chinese harbor container tracing and customs clearance system – export process

1) In the factory, the consigner will manage the small articles with bar codes and pack them into bigger boxes, which are tagged with passive RFID, including the information of quantity, weight, and names of the articles etc.

2) Bigger boxes will be loaded into containers in the yard, which will be tagged with active RFID tags, including the information of quantities, weight, volume, types of the articles and transportation bills etc. These data will be transformed to the customs, national inspection, and customs broker. After customs clearance, the containers will be locked with the electronic container seals, and the electronic RFID tags in the containers will be connected with the container numbers, while at the same time the information will be delivered to the dock, customs, national inspection, shipping agent, forwarder, consigner, shipping company etc.

3) Through EDI the instruction to load the vessel in the container harbor will be delivered to the yard, trailer, and Tally Company. In the yard the containers will be gated in for vessel loading by trailers. The tally company will indicate the forklift to load the containers through wireless terminals, which could identify the RFID tags during the loading of the containers. After the loading to the vessel, the tally company will deliver the loading bill to the dock, shipping agent and shipping company through EDI.

4) The captain of the vessel will take care the manifests. During the sea shipping, the vessel will be controlled by GPS in the world wide, and the information from GPS will be delivered to the frontier, maritime department, shipping company, shipping agent and dock through EDI.

5) Before the vessels arrival to the destination port, the reception shipping agent, dock and yard with receive the manifest information and voyage position through EDI, and plan the unloading and docking schedule. The customs agent of the consignee will deliver the electronic data to the customs broker through EDI for the pre-entry for the customs clearance, and accordingly the shipping agency prepares the manifest for pre-entry of the customs clearance.

6) After the vessels arrival in the destination port, according to the information from the pre-entry for the customs clearance and its own risk estimation system, the customs will indicate the dock to sample inspect the containers through EDI. Then the dock will indicate the wireless terminal according to the instruction from the customs to identify the RFID electronic tags automatically and deliver the required sample containers to the inspection platform for inspection from the customs. Other released containers will be transported by trailers with the identified RFID tags from the gate to the container yard.

7) In the container yard, the containers will be opened and separated or directly transported to the factory of the consignees.

IV. Conclusions and Outlook

The development of customs clearance requires advanced information technology, which not only aims at increasing the operation efficiency, but also strengthening the cooperation between the customs clearance operation. Hence the integration and application of RFID-aided technology for information system will be undoubtedly one of the effective technical solutions.

The RFID-aided custom clearance system will help to realize the transparency of the container information for customs clearance, enhance the container management level in modern harbor customs clearance, improve the whole modern logistics efficiency, and facilitate the data exchange and information integration between the operation in each terminal customs.

Since the harbors in Guangdong and Hong Kong possess advanced technology level, standard management and better operation processing capability, the application of RFID technology between these two areas will not only become good examples for other harbors in China, but also a good reference for other countries in future harbor logistics.

With the extension of RFID application in container transportation and customs clearance, in the future it is no doubt to establish a container tracing and customs clearance system covering the whole container transportation or connecting the container tracing and customs clearance system between different countries and regions, which is of significant meaning to ensure the security of container transportation, decrease the time for customs clearance and facilitate the development of the world economy.

However in the time being there are 3 main RFID standards, they are:

1) ISO standard system

2) EPCgloabal standard system

3) and UID standards system (Japan)

Different country allows different communication frequency for RFID chips, and also different country and region requires different data format in different system. If it is to realize the container tracing and custom clearance system covering the whole container transportation or connecting the container tracing and customs clearance system between different countries and regions, it is necessary to solve the above mentioned questions on RFID standards, frequency and data format.

Regarding the problems of RFID standards and data format, it could be solved through an establishment of a global unified data exchange middleware between different standards, which will deserve a further research as another topic in the future.

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