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Applying RFID to reduce delay in import cargo customs clearance process

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Abstract

The study explores the customs clearance process of import cargos in international air cargo terminals, and constructs a network to analyze cargo, information and human flows in the import cargo process. Then, the study formulates a mathematical model of the customs clearance process-delay, and analyzes delay propagation in subsequent cargos. Moreover, the network of the customs clearance process is reconstructed based on the application of Radio Frequency Identification (RFID). The performances of RFID are evaluated in terms of reductions in shippers' inventory cost and operators' labor cost. A numerical example of Taiwan Air Cargo Terminal (TACT) at the Chiang Kai-Shek (CKS) International Airport is used to illustrate the feasibility of the proposed model. The analysis of cargo processing at TACT shows that cargos arriving earlier at TACT take less waiting time and less clearance time than ones arriving later. RFID application can markedly improve the efficiency of cargo process, and can save the inventory cost and labor cost. A combined strategy that carries out a modified dispatching rule and RFID application at the same time brings the greatest benefit to TACT. The sensitivity analyses show that the total benefit of applying RFID increases as cargo delay cost, terminal handling capacity, and/or storage cost increase, indicating that RFID technology is appropriate for handling those cargos with high value of time.

Keywords: Air cargo terminal; Process-delay model; RFID

1. Introduction

One of air cargo transport advantages is fast delivery which can reduce shippers' inventory level and costs, disperse manufacturing locations, and shorten delivery time. However, air cargo carriers usually charge shippers high transport cost. Therefore, air cargos generally have the features of timeliness, high value, short life cycle, and perishable, such as newspapers, high-tech products and material, biological products, flowers, fruits and vegetables. Due to higher value of time for air cargos than others, time delay incurred in the customs clearance process may degrade air cargos' original functions or reduce their surplus value. Besides, time delay in the import customs clearance process is more serious than that in the export process, thereby increasing the

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storage time of cargos in warehouses. For example, the average storage time of export cargos spends 2 days, but that of import cargos spends 5 days in the warehouses of Taiwan Air Cargo Terminal (TACT) (Institute of Transportation, 1994). As a result, the operation efficiency of the import process significantly affects the process time and delay of air cargos. It is necessary to investigate the components and properties of the import process in depth so as to improve its efficiency.

The customs clearance process of import cargos in air cargo terminals includes complicated procedures and involves many relevant operation units, such as cargo forwarders, customs broker, air carriers, customs, and so on. Therefore, time delay of a particular cargo incurred in any operations of the process not only heavily affects its progress to sequential operations, but also causes delay propagation to other cargos. However, few studies have investigated the customs clearance process in air cargo terminals, especially the characteristics of import cargo customs clearance process. For example, van Oudheusden and Boey (1994) designed an automated warehouse for Thai air cargo terminal. Furthermore, most studies of transport time delay have focused on vehicle arrival delay at terminals of other transportation systems. Notably, Higgins and Kozan (1998) constructed an analytical model to investigate the arrival delay of trains at stations and delay propagation to subsequent trains.

In recent years, Radio Frequency Identification (RFID) technology has been continuously investigated in many empirical and theoretical studies. The development and application of the technology have emerged in many fields. RFID provides the function of wireless sensor to identify simultaneously more products than a traditional bar code scanner, and it is not necessary to scan products within a short distance. RFID makes information acquisition more quickly, and provides more space of data storage than the traditional way. It also avoids such situations as bar code destruction and wetness, which reduce scanning efficiency. Moreover, RFID can alter the data and information stored in tags, speed up product handling, and reduce the labor cost of operation. The functions of RFID have been applied to warehouse operation (e.g. Anonymous, 2003a, 2003b, 2003c), supply chain management (e.g. Anonymous, 2002, 2003d; Brewer, Sloan, & Landers, 1999; DeLuca, 2003; Kärkkäinen, 2003; Roberti, 2003), bogus drug precaution and tracking (e.g. Cottrill, 2004; Greengard, 2003; O'Connor, 2005), and passengers' baggage delivery (e.g. Boyle, 2000; Croft, 2004a, 2004b; Farmer, 2004; Field, 2004; Pilling, 2004). Few studies have investigated the application of RFID on the customs clearance process of import cargos in air cargo terminals. However, the functions of RFID may be utilized to overcome the difficulties involved in the import process, such as complicated procedures and various operation units, and improve cargo-handling efficiency.

This study attempts to construct a network so as to explore the components and properties of the import cargo customs clearance process in Taiwan Air Cargo Terminal (TACT), and formulate an analytical model for investigating the process-delay of cargos. Then, the network is reconstructed due to applying RFID technology, and used to evaluate the benefits of RFID in terms of reductions in shippers' inventory cost and terminal operators' labor cost. The rest of this study is organized as follows. Section 2 constructs the customs clearance network of import cargos and formulates a process-delay model. Section 3 describes RFID application in an air cargo terminal, and then constructs a revised network to further analyze changes in inventory and labor costs due to its application. A numerical example is presented in Section 4 to illustrate the application of the proposed model. The final section presents concluding remarks.

2. Customs clearance network and process-delay model

This study focuses on exploring the customs clearance process of import cargos at TACT in the Chiang Kai-Shek (CKS) International Airport. Among all kinds of import cargos at TACT, those classified as C3 category need to pass the most complicated clearance procedures, so the study takes them as the analyzed objects. Besides, the study constructs a process-delay model based on the customs clearance process of TACT. Fig. 1 illustrates the customs clearance network of import cargos at TACT. In the network, nodes represent procedures, and links represent the relationship of series and parallel connections among cargo, information, and human flows processing. Based on the locations and operation process of procedures, the customs clearance network of TACT can be further divided into six operation parts, as shown in Fig. 1. Furthermore, since the procedure of the manifest transmission shown in Fig. 1 is usually completed before cargos arrive at TACT, it does not influence the process.