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A dock-door assignment problem for the Korean mail distribution center

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Abstract

This paper addresses operational problems of the cross-docking system in a mail distribution center. The center has two types of doors, receiving doors and shipping doors. The assignment of destinations to shipping doors, clustering of destinations to form groups, and determination of the number of groups are major operational problems directly related with the efficiency of the center. To solve the problems, a non-linear mathematical model is developed with the objective of minimizing the travel distance of the pallets in the center. For the model, two solution methods, three-phase heuristic procedure and genetic algorithm, are developed. A lower bound is also found to evaluate the validity of the solution methods. A case with the real world data is solved and a substantial improvement is obtained by the model compared with the current operating system.

Keywords: Dock-door assignment; Cross-docking; Heuristic; Genetic algorithm

1. Introduction

Most logistics companies have several freight (consolidation) terminals where trucks usually transport freights between the terminals. Incoming trucks arrive at the receiving doors of freight terminal with the various items collected from customers (suppliers, manufacturers or other freight terminals). Then each arrived item is sorted in accordance with its destination, and moved onto the shipping door where outgoing truck waits for making delivery to the designated destination. The movements of items from receiving doors to shipping doors within the freight terminal are usually made by fork-lift trucks and the total traveling costs is deter-

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mined by the location of shipping doors. Therefore, we need to find a proper way of assigning each destination to each shipping door so that the total material handling cost of the items is minimized.

The cross-docking problem is a type of the assignment problems for which many studies have been reported in the literature. After Klastorin (1979) proposed an algorithm for the generalized assignment problem, Tsui and Chang (1990, 1992) presented a general model of the dock doors assignment and then developed a solution based on the branch and bound method. Greetha and Nair (1993) presented an efficient method for finding an optimal solution of the cost-minimizing assignment problem. Diaz and Fernandez (2001) proposed a heuristic method based on the tabu search. Kinnear (1997) introduced the definition of the cross-docking and explained the advantage of the cross-docking. Sung and Song (2003) designed an integrated service network for a cross-docking supply chain network.

Fig. 1 illustrates the layout of the Daejeon mail distribution center where cross-docking is a major operation. Once a day, trucks from 22 mail concentration centers arrive at the Daejeon center around midnight. Since the number of arriving trucks exceeds the number of receiving doors, upon arrival, the trucks usually wait in a queue until some receiving door becomes available. At the receiving doors, trucks unload one-by-one the wheeled pallets filled with postal parcels. To each pallet, a tag is attached showing its destination. One shipping door is generally assigned to each destination except those with large amounts of freights, for which more than one is assigned. At present, destinations are clustered into six groups to which group numbers are uniquely assigned. Each arriving pallet is identified by the group number and lined up in the associated queue at the pickup area located near the receiving doors. The electric tractors pull approximately seven pallets of a group at a time from the pickup area and then release them at the shipping area designated for each group. Shipping areas are located at the center of the shipping doors of each group. Currently, destinations are clustered on the basis of the geographical proximity of the destinations. At the shipping area, the wheeled pallets are sorted according to the destination and then loaded into outbound trucks. The assignment of each destination to shipping doors, clustering of destinations to form groups, and the number of groups are important managerial issues. This study deals with the first two issues in the center and finds ways to improve the operating efficiency of the center through the development of mathematical model.

The remainder of this paper is organized as follows. In chapter 2, we develop a non-linear programming model with the objective of minimizing the total travel distance of pallets at the distribution center. Chapter 3 proposes two heuristic solution methods and a lower bound of the solution. In chapter 4, the computational results with the real world data is reported and analyzed. Conclusions appear in Chapter 5.

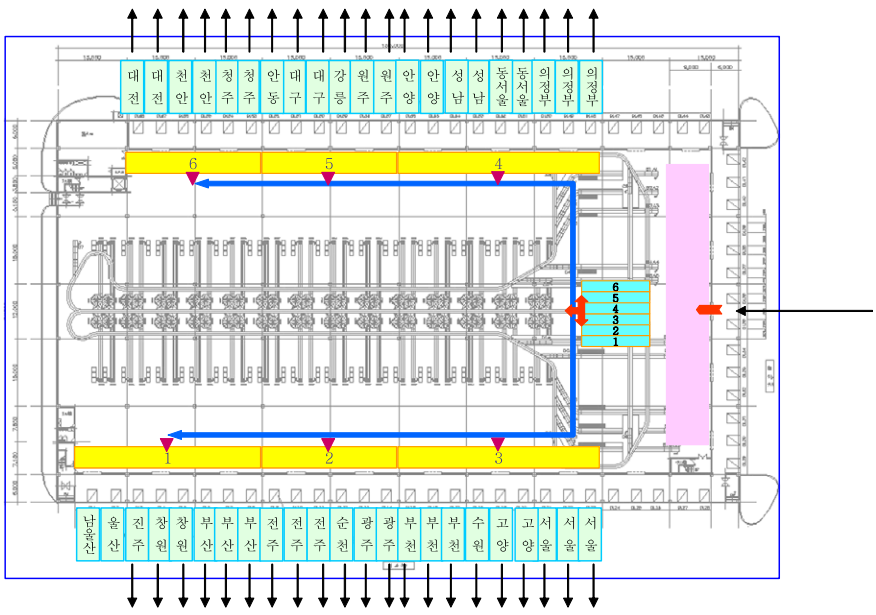

Fig. 1. Layout of Daejeon mail distribution center.