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Study on The Optimization of Collection and Distribution System of Freight Hub Ports: Illustrated by The Case of Shanghai International Shipping Center, China

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Abstract

The development of world-class international shipping centers has proved that there isn't a specific pattern for the development of the freight collection and distribution system. Measures should be taken to give a full play to integrated advantages by generally considering the layout of the collection and distribution system of the port and in the rear. This article, following closely the multi-center tendency of the hub port and the integrated development of regional ports in the improvement of the essential functions of international shipping, presents an initial idea on the construction of the optimization model for the collection and distribution system in which regional ports both cooperate and compete with each other. Establishing a model combining transportation mode selection and route selection would eventually realize the network flow distribution and derive the results for hub port selection made by the hinterland, i.e. the port-hinterland collection and distribution volume and the throughput of the port. Specification and verification of the generalized cost function plays a pivotal role in the improvement of the model. In accordance with the layout of ports for Shanghai international shipping center and based on the optimization model for the freight collection and distribution system of ports with minimized generalized cost, a series of generalized cost functions for road sections of various transportation forms including highway, waterway and railway as well as for transfer hubs were established, and major parameters were defined. The software STAN for freight analysis was used to accomplish the network equilibrium assignment for overall system and data concerning the annual throughput and distribution of major hub ports were thus obtained. The output and data analysis show that Shanghai international shipping center is gradually developing into a multi-center overseas transportation hub, that the overall service capacities for major hub ports have been enhanced and that though the proportion of waterway freight transportation is on the rise, the highway freight collection and distribution system still needs to expand the scope of the transportation organization.

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1. Introduction

In the 1980s, researchers started to pay attention to freight transportation and brought forth the idea that the essential goal of transportation was to bring about effective position shift of people and goods. With the worldwide energy shortage, economic globalization, development of international logistics, global warming and the protection of the ecosystem and environment, the research on the optimization and strategic planning of the freightage network, development of the freight collection and distribution system with the port as its center as well as the optimization of the supply chain has become a hot-discussed topic and focus all over the world. Friesz et al. (1985,1986)put forward the freight network equilibrium model and the generalized spatial price equilibrium model, pointed out that the transportation cost is deduced from the act of the carriers for maximized profits and advanced the concept of spatial price equilibrium involving the carriers. Guelat et al. (1990) pointed out the relevance between network equilibrium and spatial price equilibrium, connecting the spatial economy, productivity layout and the transportation system. Additionally, in the 1990s, he brought forth a multimode multiproduct network assignment model for strategic planning of freight flows involving the generalized cost for the shift of the route and node and developed a specialized software package STAN. This package includes a multimode multiproduct network assignment model and algorithm, is able to reflect the facts concerning freight transportation and multi-mode transportation and has been successfully applied to large-scale freight flow network such as the freight collection and distribution system of Shanghai international shipping center by Zhang et al. (2011).

This article, based on the optimization model for the freight collection and distribution system of ports, quantitatively analyzed various kinds of cost caused by freight collection and distribution from the perspective of generalized cost, realized the modelling for the freight collection and distribution systems of major ports in Shanghai international shipping center, identified the problems of the freight collection and distribution system and proposed optimization methods.

2. Physical Description of The Freight Collection and Distribution System of An Individual Port

2.1. The Process of the Freight Collection and Distribution System of the Individual Port

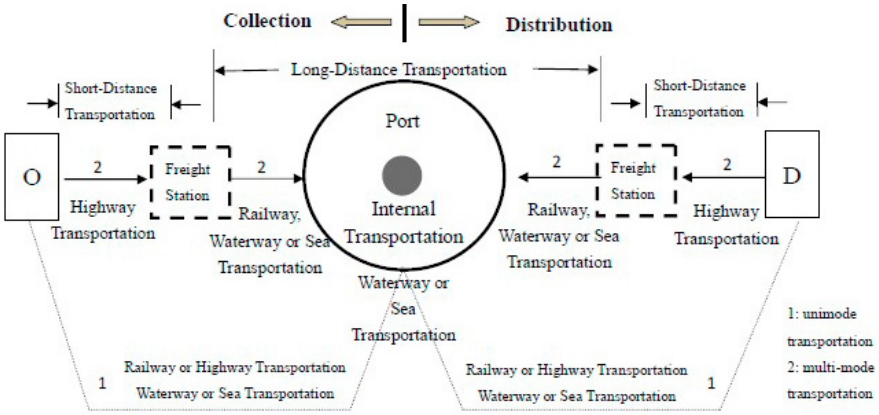

Fig. 1. freight collection and distribution process of individual ports

The freight collection and distribution network constructed between the port and hinterland differs from the regular freight network. It either starts or ends at the port without considering the freight volume of other areas. Therefore, the freight collection and distribution network usually has a radiatory shape. Two forms of freight flow