Chapter 5
The Evolution of Logistics Hubs and a Conceptual Framework for Logistics Hubs Location Decisions

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ABSTRACT

Hubs are special centers that used for switching, transferring and handling freight or passengers in transportation systems. The hub location problem deals with locating hub facilities and allocating demand nodes to hubs in order to route the traffic between origin–destination pairs. Aiming at minimizing the total costs, maximizing utilization of transporters, maximizing the service level, etc., the flow between O–D pairs is dispatched through some selected intermediate logistics centers (called hub nodes) and links connecting the hubs. In this work, a conceptual framework is proposed for hub location decision problem in transportation networks since the previous reviews are out of date. Several models, methods and decision tools are evaluated. Also future trends are added to represent a new point of view for global scale. Since the models and solution approaches are complicated, it is not practical to catch optimum results, and some relevant algorithms will be represented to solve hub models in this chapter.

INTRODUCTION

Today’s business world needs a challenging logistics strategy. This strategy enables managing shipments across globally spread supply and demand nodes within performance expectations. To fulfill the needs of customers around the world, intermodal logistics networks give some opportunities (Arnold et al., 2004; Gooley, 1997). In this network, a parcel may be sent through one or more modes of transportation from the origin to destination node to smoothly by the intermodal containers (Crainic et al., DOI: 10.4018/978-1-4666-8648-9.ch005
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2007; Slack, 1990; Slack, 2001). Existing transportation infrastructure would affect the design and the management of intermodal logistics network and location of transfer points can differ according to the cost structure. (Warsing et al., 2001). Selection of a hub location is one of the hardest efforts in design for the intermodal logistics networks.

For the recent years, a hub network has transformed for intermodal activities. The economy of scale is the primary motivation behind the growth the use of hub based intermodal networks (Slack, 1990). Since an intermodal logistics network is an augmentation of its separate single mode, it is normal that the hub network has developed as the most suitable logistics network structure for intermodal transportation (Bookbinder & Fox, 1998).

In a hub-and-spoke logistics network, the consolidation of shipments between the transfer points enables huge cost savings as expected. This consolidation brings economies-of-scale and density. Economies-of-scale are provided by the putting the less-than-truckload shipments into containerized shipments which reduce the unit transportation cost. The economies of density are provided by high load factors for the road/rail/air shipments through predetermined distances. In this manner, cost structure becomes non-linear since the unit transportation cost is a non-increasing function of the volume shipped. Intermodal rail and air freight have relatively different cost structure from the road transportation costs.

The logistics hub network design requires decision of the number and location of logistics hubs and the assignment of nodes (demand or origin) that are served by each hub. In the context of this chapter, a logistics hub is a transshipment center or facility that receives, consolidates or breaks down, and dispatches parcels. A logistics hub might have access to road, rail, or air terminals to handle the freights that may be operated by other service providers or third parties. The decision of mode (road, rail, or air) for moving freight between origin to destination via hubs is determined by the tradeoff between the service level expected by the customer and the transportation cost burdened. The intermodal flow of freights or parcels is managed through the services offered by the carriers that have capability on each mode (Ishfaq & Sox, 2010).

The performance of a logistics hub network can be based on different metrics such as cost, service level, time, reliability, safety, and flexibility (Beuthe & Bouffioux, 2008). In this research, conceptual framework has been developed through a comprehensive literature review and case studies for logistics hubs. More specifically, the models represented in this research focus on minimizing total network costs while satisfying maximum service levels.

BACKGROUND

One of the trending subjects in facility location researches is the hub location problem. There exist several application areas for the hub location problem in logistics network; therefore, this chapter is focused on representing this problem to researchers. This chapter is composed of three parts: provides literature review, mathematical models/algorithms and solution approaches which are optimizing logistics services such as, movement of people, commodities and information between origin and destination. Each origin-destination pair is connected via one or more hubs (see Figure 1). The freights carried from \( i \) to \( j \) may not be same with the freights carried from \( j \) to \( i \).