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The impact of landbridge on the market shares of Asian ports

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ABSTRACT

This paper develops a mathematical model to quantify the market share of a given port. A Monte Carlo simulation based algorithm is proposed to estimate the port market share. A study is subsequently conducted to explore the characteristics of the landbridge system in China and Southeast Asia, and the impact of the landbridge system on the market shares of Asian ports is evaluated using the proposed approach for three scenarios. The competitiveness of the Malacca and Singapore Straits is also illustrated by analyzing the changes in the market share of Singapore port with respect to value of time.

1. Introduction

Landbridge freight transport seamlessly integrates short-haul truck service (drayage) and long-haul rail service to deliver containerized cargo across a continental mass using rail–road transfer terminals. The North American landbridge system has developed into an efficient and sophisticated transport system which provides a competitive alternative for freight shipments across the Panama Canal. For instance, the North American landbridge system dealt with 1503 million tones of cargo, almost eight times of the 215 million tones of transit cargo handled by the Panama Canal in 2006 (PCA, 2007; FHWA, 2007). These data indicate the significance of landbridge transport in freight transport market. However in China and Mainland Southeast Asia (CMSA) area, a complete and efficient landbridge system has not been established due to four main reasons: (i) border crossing processes between adjacent countries in this region are unavoidable due to breaks of gauge; (ii) there is a lack of official agreements to promote the cooperation among the CMSA countries in freight transport and the simplification of border crossing processes; (iii) current logistics infrastructures in some countries of this region were sub-standardly designed; (iv) missing links widely exist in Myanmar and Lao PDR (UNESCAP, 1996a,b,c, 1999).

As the CMSA landbridge system has not been well developed, 95% of the Eurasian containers are currently shipped using maritime passages via the Malacca and Singapore Straits (MSS) (USCC, 2006). However, this situation could be changed with the implementation of the Trans-Asian Railway and Asian Highway projects. These two projects were initiated by UNESCAP in 1959 and 1960 respectively, but were later hindered due to political and economic obstacles. In the recent years after 2000, in view of the burst of the merchandise trade between Asia and Europe, the two projects start to be put into a fast progress with the aims to develop an accessible and efficient transport network linking the ESCAP countries and to facilitate the development of Eurasian container trade (UNESCAP, 2003a, 1999). Once an efficient landbridge system is built in CMSA, a new intermodal service using the landbridge system will become available for intermodal operators to transport containers from Eastern Asia to Europe. An intermodal operator may represent a shipper himself or an intermediary broker, who makes

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route selection decisions for a shipment through the entire intermodal network (Macharis and Bontekoning, 2004). This new intermodal service will serve as an alternative to the conventional maritime corridor via the MSS. As a result, the MSS would witness a potential decrease in container traffic from the Eastern Asia, especially China – the main engine of the development of global economic – to Europe. The resulting decrease in traffic volume via the MSS may lead to a reduction in the market share of the port of Singapore; on the other hand, ports like the port of Yangon as an access point to the landbridges in CMSA would have an opportunity to expand their market shares.

The potential impact of the landbridge system on the ports in Asia, as described above, can be analyzed by investigating the variations in the market shares of the ports. The market share of a port is generally estimated associated with a study area. Given a concerned study area, the market share of a particular port is defined as the proportion of the container traffic volume handled by the port to the total traffic demand generated in the study area. The port market share can be considered as an appropriate performance indicator that reflects the competitiveness of the port, since it quantitatively measures the scale of container traffic it attracts when vying with other ports. The competition between different ports which are serving the same region can be envisioned by comparing their market shares with respect to the region. The port market share should be estimated based on the container traffic distribution over intermodal routes at a network level. The container traffic distribution is essentially determined by the intermodal route choice decisions of intermodal operators. An intermodal route is characterized by a sequence of links including landbridges and maritime links as well as transfer terminals. A transfer terminal is defined as an interacting point, at which containers are unloaded, loaded and switched between various transport modes such as rail, road and maritime. Examples include rail–road terminals, ports, airports and border crossing terminals.

Given a pair of origin and destination zones and an interested port, an intermodal operator intends to choose intermodal routes from a set of available alternatives to transport a certain number of containers from a shipper located in the origin zone to a receiver located in the destination zone. Of these available alternatives, some may traverse through the interested port, and the containers which are assigned on the intermodal routes traversing through the port and are served by the port's operator are considered as a part of the market quota of the port. When faced with route choice, the personal decision of an intermodal operator is generally made based on the utilities of all candidate routes (Ben-Akiva and Lerman, 1985). As suggested by Meng and Wang (2010), the utility of an intermodal route can be represented by a negative generalized transport cost, which is summed by route transport cost and time multiplied by value of time (VOT). The intermodal route utility can be reasonably formulated as a random variable on account of the uncertainties associated with transport cost and time (Goodchild et al., 2008; Janic, 2007, 2008). As a reasonable decision behavior, an intermodal operator would choose the route with the maximum utility from all available intermodal routes to transport containers. With the randomly distributed route utilities, this assumption would yield a probability of the intermodal operator selecting a specific port to deal with containers. With the use of the port selection probability and the transport demand governed by the intermodal operator, the port market share can be quantitatively estimated.

By analyzing the impact of landbridge on ports, the port operators can make well-informed policy changes to maintain or extend their market shares. Local government authorities that have ports as major propellers of economic development can obtain the knowledge of designing a highly efficient hinterland network to attract more container traffic. A research need thus arises to develop a useful quantitative approach to analyze the impact of the landbridge system on the market shares of the ports located in Asia. To the best of our knowledge, such an approach has not been proposed in past studies. This paper thus aims to meet the research need mentioned above. It can be regarded as a continuation of Wang et al. (2009) and Meng and Wang (2010). In addition, we confine our attention on the container transport from Mainland China (origin zone) to Europe (destination zone), since China has been retaining its lead as the world biggest container trade country in terms of port container traffic for recent years.

The remainder of this paper is organized as follows. Section 2 reviews the relevant past studies and states the contributions of this study. Section 3 describes a modeling approach to estimating the market share of an interested port. Section 4 explicitly investigates the characteristics of the landbridge system in CMSA. In Section 5, three landbridge operational scenarios are analyzed to show the impacts of landbridge on the selected ports located in Asia and the MSS corridor. Conclusions are drawn in Section 6.

2. Relevant past studies

Intermodal freight transport has been attracting many researchers in the past decade and the detailed explanations and classifications can be found in the two review papers: Bontekoning et al. (2004) and Macharis and Bontekoning (2004). These reviews indicate that exploring efficient and economical intermodal transport solutions by integrating rail and road transport services has become a merging research field. Landbridge as an important component of intermodal freight transport has been addressed in many past studies. Rodrigue et al. (2009) classified landbridges into three types: landbridge, minibridge and microbridge, according to their origins and destinations from viewpoint of transport geography. Some researchers have also investigated the problem by focusing on the significance of landbridges for intermodalism as well as the current and future prospects for developing landbridge corridors (Slack, 1990; Shu, 1997; Lee, 2004; Otsuka, 2001). To build an intermodal transport network linking the countries in Asia and the Pacific region, UNESCAP (1999, 2003a) initiated the Trans-Asian Railway and Asian Highway projects, so as to update the obsolete logistics infrastructure facilities by establishing