



Carrying capacity procurement of rail and shipping services for automobile delivery with uncertain demand



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ABSTRACT

The determination of the optimal carrying capacity procurement of rail and shipping services in the automobile intermodal network with unique characteristics is essential to save automobile delivery cost. In this research we develop a two-stage stochastic programming model for the tactical-level decision problem arising in the special automobile intermodal network. Furthermore, we improve the sample average approximation algorithmic procedure to solve the model. We apply the model and solution method to a case study associated with the Shanghai Automobile Industry Corporation. We believe that this study deals with an emerging new research topic with practical significance for the automobile industry.

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1. Introduction

Automobile manufacturers produce automobiles and coordinate the delivery to customers. They have low profit margins nowadays because of the intense market competition in providing low-price automobiles to customers. As a result, the manufacturers have to seek all possible means to cut down costs associated with the production and delivery of automobiles. In particular, there is a large potential for reducing the cost of automobile delivery because as estimated by [Automotive Logistics \(2013\)](#), by 2020 the finished vehicle logistics sector will be worth \$4 billion per year.

Automobile delivery in a large country such as China, India and United States is a complex logistics process including different transport modes and their combinations (intermodal transportation). A large automobile manufacturer usually has several automobile production factories in the large country. Each factory has a vehicle distribution center (VDC) for handling the automobiles produced by the factory. The manufacturer also has vehicle storage centers (VSCs), which are located in different cities of the country with high volumes of customers. For example, the automobile delivery network in China operated by Shanghai Automobile Industry Corporation (SAIC) has a total of 7 VDCs and 11 VSCs as shown in [Fig. 1](#). The 7 VDCs are Shenyang (SY), Yantai (YT), Qingdao (QD), Shanghai (SH), Nanjing (NJ), Chongqing (CQ), and Liuzhou (LZ2). The 11 VSCs are Xinjiang (XJ), Beijing (BJ), Tianjin (TJ), Yuci (YC), Lanzhou (LZ1), Xianyang (XY), Zhengzhou (ZZ), Deyang (DY), Wuhan (WH), Kunming (KM), and Dongguan (DG). The automobile delivery network consists of road, rail ([Fig. 2](#)) and water transportation ([Fig. 3](#)). Automobiles from VDCs are transported to VSCs to serve customers. Automobiles may also be transported from one VDC to another VDC, wherein the latter VDC serves the same function as VSCs. Automobiles can be transported from a VDC to another VDC or a VSC by truck, rail, or ship. Trucks can directly transport automobiles from an

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Fig. 1. Distribution of the 7 VDCs and 11 VSCs.

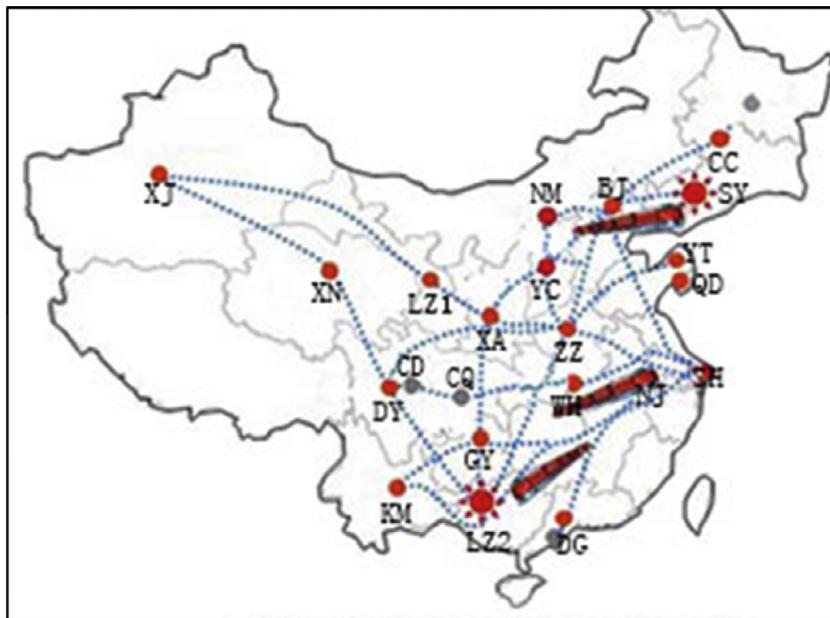


Fig. 2. Rail transportation network.

origin (a VDC) to a destination (another VDC or a VSC). By contrast, trains/ships cannot be that convenient because automobiles have to be transported by truck from the origin VDC to the origin railway station/port, and transported by truck again from the destination railway station/port to the final destination (another VDC or a VSC). Hence, the overall automobile delivery network is an intermodal transportation network that involves road, railway and waterway transportation.

Automobile intermodal networks are different from other general logistics networks in that they have special and complex characteristics. Firstly, on the strategy level planning, the location of the VDCs or VSCs is no longer the decision of a single individual manufacturer, but is the game of decisions between many automobile manufacturers. When the automobile manufacturers locate VDCs or VSCs, they first consider geographical advantages of a city, that is, the city is convenient to

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