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A Study on Multi-Criteria Decision Making for Route Selection in Multimodal Logistics and Transportation Systems

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Abstract

Freight transportation is considered as a crucial part of the logistics and supply chain systems that ensures efficient operation and time of raw product and finished goods. As a result of the globalization of trade, the traditional mode of transportation such as truck transportation is no longer a workable solution. Traffic congestion and environmental problems associated with truck transportation are the main concerns. Accordingly, the European Transport Policy seeks to reduce pollution from road transportation and search for better modes of transportation which are more energy-efficient. Multimodal transportation is currently considered as one of the most important elements of modern transportation systems. Crucially, there are several issues needed to be identified when discussing about the multimodal freight transportation systems. However, the analyzes can be complex due to the fact that there are many factors associated with the multimodal transportation and many interactions between different modes.

The route selection strategy has become the primary focus of the design of the network of the multimodal transportation. The cost and time of transportation and also the associated risks should be considered when choosing the transportation route. However, it is considered as complex multiple objective problems that are characterized by several conflicting criteria, inaccurate and ambiguous parameters and the vagueness of the human thinking.

To overcome these problems, this research develops a five-step decision support framework by utilizing the Multi-Criteria Decision Making (MCDM) tool. The first step helps define the scope of this research by collecting the data of all the routes under consideration. In the second step, the cost and time of transportation of each route are identified according to the actual test data. The third step focuses on the evaluation of the multimodal transportation risks by utilizing the integrated quantitative risk analysis, Fuzzy Analytic Hierarchy Process (FAHP) and Data Envelopment Analysis (DEA) methodology. In the fourth step, the weights of each factor are determined relied on the opinions of the 5 decision makers, who either work in the field of transportation or work as an academic researcher, with a neutral understanding of the risks associated with transportation and with a direct involvement within the transportation process and logistics management for more than 20 years. The significance weight of criteria which attained from Fuzzy Analytic Hierarchy Process (FAHP) can be integrated into a multi-

objective optimization. Lastly, the Zero-one Goal Programming (ZOGP) is utilized to define the optimal multimodal transportation route. This research uses this approach to study the existing routes of coal transportation in Thailand. To validate the model as well as results of this research, a sensitivity analysis is used on each of the Multi-Criteria Decision Making (MCDM) methods under consideration, ensuring accuracy and practicality of the decision support tool.

This research contributes to the improvement of the decision support approach which can be more flexible and can be applied to select the optimal route that can optimize cost, time, and risks of the multimodal transportation effectively. This method can offer guidance to efficiently determine the best route which would improve the logistic system performance. The findings show that the approach can inform the decision makers about the optimal route according to the attributes mentioned above.

Keywords: Multimodal transportation, Route selection, Multi-Criteria Decision Making (MCDM), Risk analysis, Optimization problem.