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COE Activity Report

Research Topic: Comprehensive Evaluation of Transportation Infrastructure Systems Efficiency using Data Envelopment Analysis

Activities done during the period of November 2003 to March 2004 are:

- Review of literatures: I have searched and checked over the papers concerning about development and application of Data Envelopment Analysis (DEA) and studied the basic concept of DEA.
- Data accumulation: Data used in this study were collected from the statistical book of each city, the person-trip survey books, etc., as well as from Internet websites.
- Experimental analysis: Various models of DEA together with a variety of factors used in the models were performed to evaluate the efficiency of the transportation infrastructure systems in each city.
- Paper writing: the results of analysis were summarized and some interpretations that can be drawn from the analytical results were concluded.
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Publication/presentation: The paper written will be submitted to the Conference of Eastern Asia Society for Transportation Study, 2005.

Summary of the study:

The objective of the study is to examine the efficiency of transportation infrastructure systems of the small cities in Hokkaido, and big cities of Japan. In this study, the Data Envelopment Analysis (DEA) is used as a tool for evaluation. DEA is a nonparametric approach used for the estimation of efficient frontiers in economics, which can deal with multiple inputs and outputs problems. Nineteen cities and towns in Japan were selected to be the study sites, which can be divided into two groups, i.e., 1) big cities including Sapporo, Yokohama, Kawasaki, Nagoya, Kyoto, Fukuoka, Kitakyushu, Sendai, Chiba, and Hiroshima; and 2) small cities and towns in Hokkaido including Otaru, Tobetsu, Ebetsu, Kitahiroshima, Eniwa, Chitose, Asahikawa, Hakodate, and Kushiro. I proposed the idea of aggregate evaluation. The decision-making unit (DMU) adopted here is not a certain company or a single infrastructure unit, but the whole transportation infrastructure systems in the city, which includes all road networks (city road, prefecture road and national road) and railway systems (JR, private train, streetcar, subway, monorail, etc.). The profit or output is the mobility of the people in the city (the mobility of goods is not taken into account in this study), while, the costs or inputs are the amount of road and rail systems in city, the environmental burden from transportation activities and the traffic accident. Transportation modes, which support the mobility, are road-using modes (car and bus) and rail-using modes (JR, private train, streetcar, subway, monorail, etc.). Evaluations using a variety of input-output combinations were performed for the sake of comparison purpose. To achieve robust evaluation, different DEA concepts, which are CCR, Inverse DEA, and BCC models, were performed. Using different models and different input-output factors the evaluation results are different. However, some consistent results can be drawn from the analysis. Overall, the efficient cities in term of transportation infrastructure systems found in this study are Kawasaki, Kitahiroshima, and Hakodate. And Asahikawa, Hiroshima, and Kitakyushu are the most inefficient cities. Together with the efficiency scores the ranking and returns to scale are also determined.

The study provides a benchmark for cities to improve their infrastructure systems management. Inefficient cities may look at the efficient cities, which have similar characteristics, then follow them or find the new way to approach the same efficiency level. The study also identifies the weak point of each city, and provides the way to improve efficiency.