The Disaster-Oriented Assessment of Urban Clusters for Locating Production Systems in China

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INTRODUCTION

The choice of location is one of the most important decisions usually taken in the procedure of building any production system (Pavic & Babic, 1991). In order to solve the problem of location choice, Pavic and Babic indentified a group of location indicators, including basic location factors such as transportation costs, production costs, and duration of transport, and additional factors such as bottleneck time, building costs, infrastructure costs, labour costs, weather conditions, expansion possibility, and transportation possibilities. Based on these criteria, Pavic and Babic used the *preference ranking organisation method for enrichment evaluation* (PROMETHEE) method (Mattioli, 2005) to support decision making in location choice. However, there are two concerns about their study. The first concern is that whether those indicators are enough and appropriate in the location choice of production systems. In fact, they have lost some relevant important factors. For example, geographic and geological conditions; environmental pollution; climate change; industrial and technology policies; disaster containment; and emergency services are all necessary considerations before locating production systems. The second concern is that whether the PROMETHEE method is an appropriate approach to effectively and efficiently deal with problems in which structured hierarchies of indicators are used in modelling. In fact, researchers have begun to explore alternatives to overcome the weaknesses of the PROMETHEE method in multi-criteria decision making. For example, Macharis, Springael, De Brucker, and Verbeke (2004) discussed the strengths and weaknesses of the PROMETHEE method and recommended the integration of a number of useful features of the analytic hierarchy process (AHP) method (Saaty, 1980) into the PROMETHEE process; especially in regards to the design of the decision-making hierarchy (ordering of goals, sub-goals, dimensions, criteria, projects, etc.) and the determination of weights. Based on these two concerns, the authors think there are potentials in conducting operations research into the location choice problem by modelling the hierarchies or network of indicators.

There are many types of disasters such as natural disasters like earthquakes, tsunamis, volcanic eruptions, hurricanes, typhoons, tornadoes, floods, subsidence, rest fires, resource shortages, food and agriculture incidents, and so forth; technological disasters like chemical, biological, or radiological hazards, forest devastations, and cyber system disruptions, and so forth; and social disasters like infectious diseases, social chaos, economic crisis, terrorist attacks, and so forth (U.S. Department of Homeland Security [USDHS], 2004). All these natural and man-made disasters can bring widespread crucial destruction and distress to human beings natural or social environment (New Zealand Institute of Economic Research [NZIER], 2004; Redcross.org, 2005; United Nations Children's Fund [UNICEF], 2005). To protect human beings and the built environment from disaster strikes, the best way is to prepare ahead of time and to know what to do (Disaster Preparedness Office [DPO], 2005; Federal Emergency Management Agency [FEMA], 2005) by effective learning from post-disaster assessments (U.S. Agency for International Development [USAID], 1998). For example, the infrastructure risk management process highlights future strategies for managing risk to potable water, electric power, transportation, and other infrastructure systems threatened by earthquakes, tsunamis, landslides, severe storms, saboteurs, and various other hazards (Taylor & VanMarcke, 2005). In this regard, a major disaster-oriented assessment for the Great Lakes in the United States has been put forward (Changnon, 2004; H2ONotes, 2004), and the authors of this article believe it is also an effective approach to coping with any type of disaster due to tremendous natural and social variability. Regarding the location choice problem as mentioned previously, indicators used for major disaster-oriented assessment could actually provide a necessary complement in its modelling.

Based on all previous considerations, this article will focus on a multi-criteria decision-making model for the disaster-oriented assessment of urban clusters in order to facilitate the location choice of production systems in China. The decision-making model will be set up using analytic network process (ANP) method with regard to the disaster-oriented assessment of urban clusters. The significant contributions of this article include a set of criteria applied to the assessment of urban clusters in China, and an ANP model for the location selection of production systems in China. In order to improve the quality of decision making, the ANP model not only adopts commonly used indicators for location choice focusing on production management, but also adopts more indicators focusing on necessary multidisciplinary issues such as geographic and geological conditions; environmental pollution; industrial and technology policy; disaster containment and emergency services; and so forth. This article finally provides an experimental case study to demonstrate the usefulness of the ANP model. The evidence to be presented in this article includes the ANP model for selecting the most appropriate location for a production system; and an experimental case study to demonstrate the usefulness of the ANP model. It is concluded that the ANP is effective in decision-making support to find the most appropriate location for new production systems in China. As a pilot research, the ANP model described in this article needs further improvement based on collabrations from more experts as well as extrapolations from more historical data. It is the authors' expectation that practitioners can use the proposed ANP model to find ideal locations for their new production systems in China; moreover further improvement based on collabrations from more experts as well as extrapolations from historical data are also expected.

BACKGROUND

Currently, there have been about seven urban clusters in China, and these urban clusters are:

- Liaodong Peninsula, including Shenyang, Dalian, Anshan, Fushun, Benxi, Liaoyang, and so forth.
- Jing-Jin-Tang Region, including Beijing, Tianjin, Tangshan, Tanggu, and so forth;
- Shandong Peninsula, including Tsingtao, Jinan, Yantai, Weihai, Zibo, Weifang, and so forth;
- Yangtze River Delta, including Shanghai, Nanjing, Hangzhou, Suzhou, Wuxi, Changzhou, Ningbo, Nantong, and so forth;
- Minnan Region, including Fuzhou, Xiamen, Quanzhou, and so forth;
- South-West Region, including Chongqing, Chengdu, Mianyang, and so forth; and
- Pearl River Delta, including Hong Kong, Macao, Guangzhou, Shenzhen, Dongguan, Zhuhai, and so forth.

Among these urban clusters, Jing-Jin-Tang Region, Yangtze River Delta, and Pearl River Delta have been become the three most important urban clusters, which lead China to develop a more prosperous economy and to participate international economic competitions. Moreover, more and more wealth and economic activities will centripetally converge to urban clusters in China, especially to these three big urban clusters (Chinese Academy of Sciences [CAS], 2005). For example, the Pan-Bohai Bay Region is becaming a new urban cluster with the biggest territory in China (see Figure 1), which comprises Jing-Jin-Tang District, Liaodong Peninsula, and Shandong Peninsula.

Moreover, a new Yangtze River Economic Belt has become a confluence of two dominant cities (including