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A social stakeholder support assessment of low-carbon transport policy based on multi-actor multi-criteria analysis: The case of Tianjin

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ABSTRACT

Based on multi-actor multi-criteria analysis (MAMCA), this paper evaluates the low-carbon transport policies in Tianjin, China. MAMCA is a methodology that is used to evaluate different policy measures by explicitly accounting for the opinions of various stakeholders. This paper refines the model based on social network analysis to measure the weights of stakeholder opinions and applies the model to the case of Tianjin. Six intervention low-carbon transport policies (tax adjustment, pricing adjustment mechanisms, multi-operation mechanisms, environmental propaganda, traffic demand management, and state funding and subsidies) are evaluated based on the aims and objectives of various stakeholders (government supervisory authorities, end users, infrastructure operators, infrastructure suppliers, academics, the traffic management sector, the technology division, and the planning department) using snowball sampling techniques. Overall, the results showed that the most supportive policies are traffic demand management and state funding and subsidies. The MAMCA also provided insights into the position and preferences of stakeholders in relation to the aims and objectives of low-carbon transport policy. As such, the results can assist decision makers in comparing, selecting and adjusting low-carbon transport policies as well as attracting support for policy implementation.

1. Introduction

With rapid industrial development, city expansion, and an increased vehicle population, energy consumption and greenhouse gas emissions are threatening the survival of human beings and the sustainable development of cities. Air pollution is degrading the atmospheric environment of cities. The promotion of low-carbon economies has become a priority in the world. As the political and cultural center of China, the Beijing–Tianjin area has witnessed rapid economic development and a dramatic increase in population and motor vehicles that cause severe traffic jams and air pollution. In January 2013 alone, there were four instances of heavy fog and hazy weather in the Beijing–Tianjin area that endured for a total of 17 days. The duration of the longest episode was seven days. Such instances have again triggered the alarm by indicating severe air pollution. According to relevant statistics, 20% of pollutants that cause foggy and hazy weather are from motor vehicle exhaust emissions. Traffic pollution is clearly the main cause of air pollution in the Beijing–Tianjin area. Therefore, objectives to reduce traffic pollution and further realize low-carbon traffic in the Beijing–Tianjin area have become critical in solving the air quality issue.

As a significant part of any urban infrastructure, a traffic system is a public good that has a wide scope of influence with multiple stakeholders, as well as systematic and comprehensive characteristics.

Thus, low-carbon transport policies constitute an important part of public policy. Many articles have focused on the formulation and evaluation of low-carbon traffic policies. Based on the strategies of low-carbon transport measures, Kazuki Nakamura and Yoshitsugu Hayashi divided low-carbon transport measures into three types: avoid strategy, shift strategy, and improve strategy. The effects of different transport measures on CO_2 mitigation come from different paths: less travel demand from avoid strategy, less car-dependence from shift strategy, and lower emission intensity from improve strategy. The authors also pointed out that, the effects of low-carbon transport measures may vary according to development stages and types of urban land-use transport systems (Nakamura and Hayashi, 2013). In this circumstances, it is vital to choose or select a proper low-carbon transport policy according to specific conditions of a city or a country. Based on this, Most of studies formulate low-carbon transport policy using scenario analysis, focusing on a certain type of system at a single

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level, such as policies related to fuel consumption (Sarabi, 2011), carbon-related taxation (Fu and Andrew Kelly), or giving an overview (Hickman et al., 2011) on a national (Gallagher et al., 2007; Stepp et al., 2009) or city level (Agrawal et al., 2010; Ong et al., 2012). Because of the complexity of the study on transport system, as well as the interaction among the regional circumstances, the status in quo of transport system and packages of low carbon measures including policies, most of the evaluation of low-carbon policy focuses on transport systems (Azadeh et al., 2008) and carbon emission (Dagoumas and Barker, 2010).

It can be seen that different objective circumstances and subjective demands have decisive influences on the selection of low-carbon transport policy. Some paper has taken the viewpoints of participating sectors into consideration during selecting and evaluating low-carbon transport policy (Agrawal et al., 2010). In fact, most studies have noted that among several participating sectors, the government is the most powerful. The most popular topic is about the opinions of end users, which can be obtained through public participation and other mechanisms (Ross Morrow et al., 2010; Zhou, 2012). However, an urban traffic system involves various stakeholders and multiple factors. Because it is a complicated social system, it is difficult to integrate low-carbon transport policies into that system by researching a single aspect of the problem. Thus, this article uses multi-actor multi-criteria analysis (MAMCA) with additional model refinement based on social network analysis (SNA) to analyze and evaluate various low-carbon transport policies under multiple stakeholders and criteria. This research method can be used not only to analyze traffic alternatives from the perspectives of different stakeholders but also to determine the weights of stakeholder opinions based on their capacity to acquire resources and information from the social network, in which way the evaluation on the alternatives could be expected to be more comprehensive and accurate. Because of the positive attributes of MAMCA with model refinement based on SNA, this article uses this technique in its research on low-carbon transport policies. And finally, the method is proven to be effective and thus could provide a reference for Tianjin to develop low-carbon transport policies.

This paper begins by analyzing and defining low-carbon transport policies. After elucidating the applicability of SNA through a literature review, Section 3 uses the SNA method to refine the MAMCA results. Section 4 then evaluates the low-carbon transport policy using the refined MAMCA method. Subsequently, Section 5 presents the results of the evaluation from three perspectives. Finally, Section 6 summarizes the main conclusions of the article.

2. Low-carbon transport policy: literature and policy review

With the aggravated urban pollution caused by traffic development, the formulation of sustainable transport policy and academic researches in this area have become increasingly extensive and in-depth. An increasing number of scholars have begun to collect, summarize, and analyze these policies (Poudenx, 2008; Zhou, 2012) and discuss which types of policy are more effective or universal. Among these researchers, Jiangping Zhou provided a relatively comprehensive and systematic summary of the sustainable transport policies that have been proposed or applied. Working from that summary, this article adds the current low-carbon transport policies that have been implemented (Chen et al., 2006; Feng and Cai, 2012) in China. The results are summarized in Table 1.

Table 1
Implemented urban low-carbon transport policies.

Low-carbon transport policy	Government agencies' program/action
1. Variety of operation management methods	CH
2. Traffic management	CH
3. Pricing, subsidies, incentives, and disincentives	US
4. Technologies	
4.1. Fuels	US
4.2. Vehicles	US
5. Planning and design	
5.1. Land use and transportation integration	US
5.2. Access planning	CH
6. Finance and investment	US
7. Marketing and promotion	CH
8. Environmental advocacy	CH
9. Tax adjustment	CH
10. Public participation	US
11. Safety	US, UK, CA
12. Program evaluation	UK, CA

Abbreviations US: United States, UK: United Kingdom, EU: European Union or intergovernmental agencies within the EU, CA: Canada, and CH: China.

The low-carbon transport policies above address the entire traffic system, including the stages of planning, design, construction and operation, and the policies regulate the traffic system at various levels. This article uses the established traffic system in the central urban area of Tianjin as a case study. To ensure that the survey participants could have a better understanding of our research objectives and express their ideas accurately, these low-carbon policies are all assumed to have short-term or medium-term effects and focused on the operation stage within the traffic system. The definition and detailed measures of each policy could be seen in Table 2. Given this, the article uses the MAMCA method to develop in-depth analysis and research of the following six low-carbon transport policies.

3. Mamca and model refinement based on SNA

Although growing urban environmental issues are attracting an increasing amount of attention to urban traffic pollution and low-carbon transport policies, the management and operational objectives for urban traffic systems tend to be complicated, diverse, and interactional. To better analyze the complicated questions related to such a system, this article uses MAMCA to analyze and evaluate various low-carbon transport policies from the perspectives of multiple stakeholders with different objectives and refines the MAMCA results using SNA.

3.1. Multi-actor multi-criteria analysis

Because of the overlapping influence of multiple objectives in transport policy, multi-criteria analysis (Dimitrios and Tsamboulas, 2007) has been gradually introduced into the analysis and evaluation of transport policy to avoid neglecting some issues while addressing others. With the gradual application of multi-criteria decision analysis (MCDA) (Janic, 2003; Macharis, 2004) in traffic problems, the idea of incorporating multiple stakeholders has been accepted by an increasing number of researchers. Meanwhile, the research of Bana (2001), Scannella and Beuthe. (2003), Keshkamat et al. (2009), Roy et al. (2001), and Labbouz et al. (2008) has suggested allowing more stakeholders to participate in establishing the traffic problem research framework, choosing criteria, and evaluating the results. However, as a larger scale of participants join transport study, MCA method becomes less applicable, in which too much time and effort is devoted to make a dialog