

Countermeasures of Improving Green Transportation of CZT Urban Agglomeration

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Abstract

As the experiment area of two-oriented society in China, Changsha-Zhuzhou-Xiangtan urban agglomeration is required with high level of environment friendliness and resource saving on its transportation system. The transportation of this area has entered into the harmonized development stage of various transport modes and improved capacity and quality. But the green degree of its transportation system still needs to be improved. A comprehensive evaluation on the green degree of its transportation system was made and effective solutions of improving were provided.

Keywords: CZT Urban agglomeration, Transportation System, Green Degree

1. Introduction

CZT urban agglomeration is the comprehensive supplementary reform and experiment area of the construction of resource-saving and environment-friendly society in China, including Changsha, Zhuzhou and Xiangtan three big cities, twelve counties, 50 key towns and 150 designated towns. Located in the central eastern part of Hunan province, CZT urban agglomeration is the combined area of Beijing-Guangdong economic belt, Pan-Pearl River economic zone and Yangtze River economic zone. It has area of 28,000 km², population of 13,256,200 and total economic output of 346, 205,000 RMB in year 2007, which are respectively accounted for 13.3%, 18.9% and 37.6% of the total amount of Hunan's area, population and economic output. With the superior location and transport conditions, good economic foundation, and high level of science and technology development, it is the area with highest urbanization level in Hunan and is the core growth pole of economic development of Hunan. The transportation of CZT urban agglomeration has entered into the harmonized development stage of various transport modes and improved capacity and quality. (Liu Yongzhong, Liu Yuzhen, 2008) The total freight volume of CZT urban agglomeration is 255,537,920 tons in year 2006, accounted for 29.94% of the total freight volume in Hunan province.

With the rapid economic development of this area, the demand of transportation continues to grow. As the experiment area of two-oriented society, CZT urban agglomeration is required with high level of environment friendliness and resource saving of its transportation system. Therefore, it is necessary to evaluate and analyze the present green degree of transportation system in this area, so as to find effective solutions to improve the green degree. Fuzzy-ahp method was used to do this research.

2. The evaluation indicator system of green transportation of CZT urban agglomeration

The green degree of transportation system is the friendliness degree between transportation system and resource and environment. The less negative impact on resource and environment, the higher green degree. Therefore, green transportation is a comprehensive reflection of development and environment friendliness. When we evaluate the impact caused by transportation system, the resource factors, the energy factors, the environment factors, and the transportation performance factors all should be taken into account. Wang Changqiong (Wang Changqiong, 2004) proposed the green degree evaluation indicator system of logistics system from the aspects of environmental performance, resource performance, economical performance and technical performance, which is a comparatively complete measurement method of management and application of green logistics. Pan Wenjun (Pan Wenjun, 2008) put forward the green logistics evaluation indicator system based on recycling economy theory from the aspects of enterprises, regional economy and society. Using these indicator systems for reference, and According to the "3R" rule of green logistics, which is reducing the consumption of resource, reusing the material and product, and recycling the castoff, this article chose 21 indicators and established the indicator system for evaluating the green degree of CZT urban agglomeration transportation system as table 1, which are

environment pollution, energy consumption, resource occupation and transport performance.

3. The fuzzy comprehensive evaluation on green degree of CZT urban agglomeration transportation system

3.1 The determination on weights of evaluation indicators

This article set weight to the factor linked to the green degree of transportation system by Analytic Hierarchy Process. The weights of first layer indicators to target layer and the weights of second layer indicators to first layer indicators are shown in table2:

3.2 Establishing an evaluation grade set

This article identified the grade set of evaluation criteria on green degree of transportation system as:

$$V = \{\text{Good, Above normal, Normal, Below normal, Bad}\}$$

3.3 Establishing fuzzy evaluation matrix

The establishment of fuzzy evaluation matrix was combined professional experts in survey method with professional testing methods. Through the analysis and arrangement of the investigation results of 20 industry experts, the author got the evaluation data of transportation system green degree of CZT urban agglomeration, which was shown by membership degree. The fuzzy evaluation matrixes of environment pollution, energy consumption, resource occupation, and transport performance are as follows:

$$R_1 = \begin{bmatrix} 0.1 & 0.2 & 0.3 & 0.2 & 0.2 \\ 0.1 & 0.1 & 0.3 & 0.4 & 0.1 \\ 0 & 0.2 & 0.3 & 0.3 & 0.2 \\ 0.1 & 0.2 & 0.3 & 0.3 & 0.1 \\ 0 & 0.1 & 0.4 & 0.3 & 0.2 \\ 0.1 & 0.1 & 0.3 & 0.3 & 0.2 \\ 0 & 0.1 & 0.3 & 0.4 & 0.2 \end{bmatrix} \quad R_2 = \begin{bmatrix} 0.1 & 0.2 & 0.3 & 0.3 & 0.1 \\ 0.1 & 0.1 & 0.5 & 0.2 & 0.1 \\ 0 & 0.1 & 0.3 & 0.4 & 0.2 \end{bmatrix}$$

$$R_3 = \begin{bmatrix} 0.2 & 0.2 & 0.4 & 0.2 & 0 \\ 0 & 0.1 & 0.3 & 0.4 & 0.2 \\ 0.2 & 0.4 & 0.3 & 0.1 & 0 \\ 0.2 & 0.3 & 0.3 & 0.1 & 0.1 \\ 0.1 & 0.3 & 0.4 & 0.2 & 0 \\ 0.1 & 0.3 & 0.3 & 0.2 & 0.1 \end{bmatrix} \quad R_4 = \begin{bmatrix} 0.3 & 0.3 & 0.3 & 0.1 & 0 \\ 0.4 & 0.4 & 0.1 & 0.1 & 0 \\ 0.2 & 0.2 & 0.4 & 0.1 & 0.1 \\ 0.1 & 0.3 & 0.3 & 0.2 & 0.1 \\ 0.1 & 0.2 & 0.3 & 0.3 & 0.1 \end{bmatrix}$$

3.3 Comprehensive calculation of fuzzy evaluation

The evaluation vector of environment pollution U_1 is:

$$C_1 = A_1 \cdot R_1 = (0.3771, 0.1848, 0.0375, 0.1744, 0.0618, 0.1106, 0.0538) \cdot R_1 \\ = (0.08469, 0.1589, 0.30618, 0.28615, 0.16408)$$

The evaluation vector of energy consumption U_2 is:

$$C_2 = A_2 \cdot R_2 = (0.6661, 0.2190, 0.1148) \cdot R_2 \\ = (0.08851, 0.1666, 0.34377, 0.28955, 0.11147)$$

The evaluation vector of resource occupation U_3 is:

$$C_3 = A_3 \cdot R_3 = (0.4135, 0.0510, 0.2046, 0.0891, 0.1550, 0.0868) \cdot R_3 \\ = (0.16562, 0.26891, 0.35685, 0.18083, 0.02779)$$

The evaluation vector of transport performance U_4 is:

$$C_4 = A_4 \cdot R_4 = (0.4492, 0.1938, 0.2292, 0.0777, 0.0501) \cdot R_4 \\ = (0.2709, 0.29145, 0.28416, 0.11779, 0.0357)$$

Build high-level fuzzy matrix $R = (C_1 \ C_2 \ C_3 \ C_4)^T$ by using the comprehensive evaluation results C_1, C_2, C_3, C_4 of the four aspects above, combined with its corresponding weight coefficient matrix A , and obtain the final evaluation results:

$$C = A \cdot R = (0.5018, 0.2956, 0.0842, 0.1185) \cdot R \\ = (0.114708, 0.186162, 0.318979, 0.258365, 0.121856)$$

If set the membership grade set of evaluation criteria as:

$$V = \{0.9(\text{Good}), 0.8(\text{Above normal}), 0.7(\text{Normal}), 0.6(\text{below normal}), 0.5(\text{bad})\}$$

So that comprehensive evaluation scores G of the transportation system green degree of CZT urban agglomeration is:

$$G = C \cdot V = 0.691399$$

It can be seen that the transportation system green degree of CZT urban agglomeration is just on the verge of normal level, which needs to be greatly improved.

4. Countermeasures of improving green transportation of this area

According to above mentioned criteria, the score of environment pollution indicators is 0.507096; the score of energy consumption indicators is 0.524615; the score of resource occupation indicators is 0.604561; the score of transport performance is 0.646609. Evidently, the condition of transport performance and resource occupation is better than that of environment pollution and energy consumption in transportation system of CZT urban agglomeration. Due to the increasing investment in transportation infrastructure in recent years, the construction of railway, highway, port and logistics park, the comprehensive network of CZT urban agglomeration has basically formed, with good transport capacity. Therefore, it has made great improvements in reducing transportation cost and shortening transport distance. At the same time, it also has better guaranteed the transport safety, decreased ineffective transport, and increased the rate of joint distribution and rate of multimodal transport. This situation has been reflected by the comparatively high score of transport performance indicators.

However, it can not be ignored that the score of environment pollution indicators is the lowest one in the four kinds of indicators. The growth rate of road transportation in this area is much faster than that of other transportation modes in recent years. But the road transport is the one of highest unit pollutant discharge and energy consumption in railway, water, road and pipeline transport. At present, the domain force of road transport in CZT area is small private business, which is lack of effective control on pollutant discharge and energy consumption. Therefore, the government should help them to improve the management on these aspects, such as using energy-saving or clean fuel powered conveyance, decreasing the energy consumption and discharge amount of solid, liquid, gaseous pollutants.

Water transport is the mode of lowest cost, least occupied resource, and most environment friendliness in water, railway, and road transport. Those bulk commodity of metallurgy, chemicals, machinery, automobile, electricity and paper which needed in the economic development of CZT urban agglomeration are the advantageous resource of water transport. However, due to some reasons, such as the limits of waterway and port capacity, outdated cargo handling equipment, the advantages of water transport in CZT area has not been well developed. In recent years, the frequent occurrence of crisis of aggravated pollution and blocked waterway which caused by low water of Xiang River lead to the great decrease of water transport amount, and even the danger of ban on ships. (Dai Shua, Sun Liying, 2009) This situation brings more pressure on road transport, thus to increase the energy consumption and environment pollution indirectly. Aiming at this problem, government should further improve the conditions of water transport infrastructure, construct CZT port group, expand the function of port, and enhance the capacity of port combined with railway and road. At the same time, the government can integrate the port resource and differentiate the port positioning. For example, to orient Changsha port as container transport and break bulk transport, to orient Zhuzhou port as dangerous cargo transport, to orient Xiangtan port as bulk cargo transport. Government also can guide the forwarders to develop long distance transportation which reflects the characteristic of water transport. Furthermore, government should establish overall linkage of gate close, water drain and maintenance in the whole basin of Xiang River, so as to solve the conflicts between stream flow and ship sailing, and minimize the transportation loss caused by dry season.

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Table1. Evaluation Indicator System of Green Transportation

TARGET LAYER	FIRST-LEVEL INDICATOR		SECOND-LEVEL INDICATOR	
	Indicator Content	Indicator Code	Indicator Content	Indicator code
Green degree of transportation system	Environment Pollution	U ₁	Discharge amount of atmospheric pollutant	X ₁
			Noise level of conveyance	X ₂
			Utilization rate of muffler device	X ₃
			Amount of solid waste	X ₄
			Recycling rate of solid waste	X ₅
			Amount of liquid waste	X ₆
			Recycling rate of liquid waste	X ₇
	Energy Consumption	U ₂	Energy consumption amount of conveyance	X ₈
			Utilization rate of alternative green energy	X ₉
			Recycling rate of energy	X ₁₀
	Resource Occupation	U ₃	Amount of land occupation	X ₁₁
			Proportion of professional transporters	X ₁₂
			Utilization rate of conveyance and transport equipments	X ₁₃
			Recycling rate of discarded and used conveyance and transport equipments	X ₁₄
			Utilization rate of transport package	X ₁₅
			Recycling rate of discarded and used transport package	X ₁₆
	Transport Performance	U ₄	Transportation cost	X ₁₇
			Transport distance	X ₁₈
			Transport safety	X ₁₉
			Rate of joint distribution	X ₂₀
			Rate of multimodal transport	X ₂₁

Table2. Cascaded weight vector of evaluation indicators with merged data

0.1. Matrix with merged data---green degree of transportation system CR=0.0825 weight to the target layer: 1.0000

GD	U ₁	U ₂	U ₃	U ₄	Wi
U ₁	1.0000	2.1500	5.4000	4.5000	0.5018
U ₂	0.6417	1.0000	3.5000	2.8000	0.2956
U ₃	0.2001	0.2950	1.0000	0.7000	0.0842
U ₄	0.2350	0.3950	1.7500	1.0000	0.1185

0.2. Matrix with merged data---environment pollutionU₁ CR=0.0537; weight to the target layer:0.5018

U ₁	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	Wi
X ₁	1.0000	3.4000	7.3000	2.7000	5.8000	3.5000	6.6000	0.3771
X ₂	0.3200	1.0000	5.5000	1.5333	3.3000	1.8500	3.7000	0.1848
X ₃	0.1391	0.1908	1.0000	0.2626	0.6167	0.3167	0.6333	0.0375
X ₄	0.4333	1.0500	4.3000	1.0000	3.0000	2.1000	3.3000	0.1744
X ₅	0.1846	0.3367	2.0500	0.3417	1.0000	0.4667	1.4000	0.0618
X ₆	0.3033	0.6833	3.3000	0.4833	2.2000	1.0000	2.3000	0.1106
X ₇	0.1608	0.3067	1.9500	0.3117	0.8000	0.4500	1.0000	0.0538

0.3. Matrix with merged data---energy consumptionU₂ CR=0.0481; weight to the target layer: 0.2956

U ₂	X ₈	X ₉	X ₁₀	Wi
X ₈	1.0000	3.3000	5.6000	0.6661
X ₉	0.3283	1.0000	2.0000	0.2190
X ₁₀	0.1894	0.5000	1.0000	0.1148

0.4. Matrix with merged data---resource occupationU₃ CR=0.0550; weight to the target layer: 0.0842

U ₃	X ₁₁	X ₁₂	X ₁₃	X ₁₄	X ₁₅	X ₁₆	Wi
X ₁₁	1.0000	6.3000	2.6000	4.7000	3.2000	5.2000	0.4135
X ₁₂	0.1646	1.0000	0.2733	0.4667	0.3583	0.6000	0.0510
X ₁₃	0.4000	4.1000	1.0000	2.5000	1.7000	2.7000	0.2046
X ₁₄	0.2233	2.2000	0.4167	1.0000	0.5083	1.2333	0.0891
X ₁₅	0.3367	3.0000	0.8000	2.2000	1.0000	2.0000	0.1550
X ₁₆	0.1993	2.1500	0.4250	1.2000	0.5000	1.0000	0.0868

0.5. Matrix with merged data---transport performanceU₄ CR=0.0662; weight to the target layer: 0.1185

U ₄	X ₁₇	X ₁₈	X ₁₉	X ₂₀	X ₂₁	Wi
X ₁₇	1.0000	3.0000	2.6000	5.4000	7.0000	0.4492
X ₁₈	0.3617	1.0000	1.0500	2.9000	4.0000	0.1938
X ₁₉	0.4167	1.5333	1.0000	3.4000	4.7000	0.2292
X ₂₀	0.1960	0.3750	0.3117	1.0000	2.0000	0.0777
X ₂₁	0.1517	0.2767	0.2276	0.5333	1.0000	0.0501