Analysis of Influencing the Development of Urban Green Transportation

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Abstract. This paper studies the planning method of urban green transportation under the background of green and sustainable development of urban transportation. Firstly，he research background and significance of green transportation are introduced. Secondly，the relevant theories of urban green transportation are expounded，and the principles and steps of chromatographic analysis are introduced. Finally，taking Zhengzhou City as an example，on the basis of analyzing the transportation development of Zhengzhou city，four indexes of intensity，system，guarantee and characteristics are constructed， and each index level is calculated by using the analytic hierarchy process to determine the factors affecting the development of green transportation in Zhengzhou City.

Keywords: green traffic; Transportation planning; Analytic hierarchy process

1 INTRODUCTION

Green transportation，in a broad sense，is a mode of transportation that uses low pollution and ADAPTS to the urban environment to achieve social and economic activities.

In recent years，in our country's urban green transportation planning study，Sun Xianfei et al，taking the urban traffic of Mudanjiang city as their research object，conducted a study on domestic urban comprehensive transportation system and green transportation. Using research methods such as literature study，case analysis and quantitative analysis，they integrated the concept of urban green transportation into Mudanjiang's urban comprehensive transportation planning. At the same time，the planning framework and path are given[9]. Sun Xiaolei et al. adopted PSR model theory to analyze the development process of green transportation，identified and selected 24 relevant influencing factors from three aspects of pressure，state and response，and used DEMATEL-ISM method to build a multi-level hierarchical structure model of urban green transportation [10].

A lot of studies have been done on urban green transportation planning abroad. Shad et al have studied green transportation for sustainable development. The

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core of green development is the transformation from industrialization to urban ecological civilization. At present, the contradiction between economic growth and environmental degradation, in the context of environmental protection, promoting green transportation is the main means to solve these contradictions [1]. Chunking Bu et al, focusing on green modes of mobility (such as bicycle and vehicle sharing), are highly committed to maintaining a savvy vehicle framework model through a simplified approach, which was created under smart city planning [2]. Taking the urban traffic of Copenhagen as an example, Bu Shutoff et al. analyzed the development status of local bicycle traffic from three aspects: infrastructure construction, laws and regulations, and personal traffic awareness. At the same time, they summarized the key points of bicycle traffic, hoping to provide some inspiration for the development of urban bicycle traffic [3].

2 PLANNING RESEARCH BASEND ON GREEN TRANSPORTATION -- TAKING Zhengzhou CITY AS AN EXAMPLE

2.1 Overview of Zhengzhou

Zhengzhou, alias Commercial capital, Green City, the capital of Henan Province, is located in the south of the North China Plain of the Yellow River downstream, located in the hinterland of China, the total area of the city 7567 square kilometers, based on Baidu index survey to the city center urban built-up area of 744. 15 square kilometers, urban built-up area of 1342. 11 square kilometers. Zhengzhou traffic is relatively developed, is the central Plains area of the transport hub, is the main domestic transport hub. By the end of 2001, the total road mileage of Zhengzhou (excluding 620 rural roads, 1412. 065 km) was 5897. 554km, and the road density was 79. 2 km per 100 square kilometers[6][7].

2.2 Ahp

Clear objectives: When building the hierarchical structure model, the analytic hierarchy process is used to judge the weights.

When using analytic hierarchy process to build a system model, there are four steps as follows: The first step is to create a hierarchical structure model; The second step is to construct the judgment matrix; The third step is to carry on the hierarchical single sort and consistency test; The fourth step is the total hierarchical ordering and its consistency test.

Construct a judgment matrix: If the factor A_k is associated with a_1, a_2…… a_i or a_1, a_2……a_j, then the judgment matrix of A_k is obtained through pairwise comparison, as shown in table 1.

Table 1. Conventional judgment matrix.

A_k	a_1	a_2	…	a_j
a_1	a_{11}	a_{12}	…	a_{1i}
a_2	a_{21}	a_{22}	…	a_{2i}
…	…	…	…	…
a_i	a_{i1}	a_{n2}	…	a_{ij}

In the table: $a_{ij} > 0$, $a_{ij} = 1 / a_{ij}$. a_i represents row i, a_j represents column j, and aij represents the elements of column j in row i, where i and j are valued according to the order of the judgment matrix.

Single hierarchical ranking and consistency test, but in order to verify whether the constructed judgment matrix is reasonable, it is necessary to carry out random consistency index CR detection, see formulas (1) and (2).

$$CR = \frac{CI}{RI} \tag{1}$$

$$CI = \frac{\lambda - N}{N - 1} \tag{2}$$

In: λ represents the maximum eigenvalue of the judgment matrix $\lambda_{\max}$; RI represents the average of the random consistency index of the same order, Table 2 lists the values; N represents the order, depending on the order of the judgment matrix[5].

Table 2. RI Value rule table[5].

N	1	2	3	4	5	6	7	8	9
RI	0. 00	0. 00	0. 86	0. 95	1. 12	1. 24	1. 32	1. 42	1. 45

Further, the maximum eigenroots and eigenvectors are solved by geometric average method, and the detailed process is shown in formulas (3) to (6).

First, the matrix is normalized and the product of each row of the judgment matrix is calculated, as shown in the formula (3).

$$M_{\mathrm{i}} = \prod_{\mathrm{j}=1}^{n} a_{ij}, (i = 1, 2 \ldots n) \tag{3}$$

In formula (3), represents the element in row i and j represents the element in column j; a_{ij} represents the element in row i and column j, Mi represents the product of row i of the constructed matrix.

Secondary computation M_i The sum of the roots of the equation of the NTH degree w_i for standardized solutions， see equations (4) and (5) respectively.

$$\overline{w_i} = \sqrt[N]{M_i} \tag{4}$$

$$W_i = \overline{w} / \sum_{i=1}^{n} \overline{w_i}, (i = 1, 2, 3 \dots n) \tag{5}$$

In： M_i Represents the product of each row of the judgment matrix， i represent i line element， N represents the order of the judgment matrix， W_i represents the canonical eigenvector.

Final $\lambda \max$ the maximum value (maximum feature root) is calculated see formula (6).

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)}{nW_i} \tag{6}$$

In： $\lambda \max$ represents the maximum feature root，AW is the product of the desired matrix and the normalized eigenvector of the matrix. Hierarchical total ranking weight calculation

3 CASE-STUDY

3.1 Establishment of Evaluation Index

Only the strength indicators are calculated，and the other indicators are not calculated at one time，goal level A：Zhengzhou，criterion layer B：(1-6)，index level C：1 Comprehensive energy consumption of operating vehicles in Zhengzhou. 2 Comprehensive energy consumption of public transport vehicles in Zhengzhou. 3 Parking problem in Zhengzhou. 4 CO2 emissions from vehicles in operation in Zhengzhou. 5 The proportion of green transportation in Zhengzhou. 6 Traffic road environment of Zhengzhou[8].

3.2 Construct Judgment Matrix

According to the scale table of the judgment matrix in table 3 and the scores of the survey experts， the following judgment matrix is obtained， as shown in Table 3 and the comparison matrix is shown in table 4.

Table 3. Judgment matrix scale table.

Implication	scale
The i factor is as important as the j factor	1
Factor is slightly more important than j factor	3
I factor is slightly more important than j factor and ifactor is slightly more important than j factor	5
The i factor is more important than the j factor	7
I factor is absolutely more important than j factor	9
The median of two adjacent judgments	2，4，6，8
Reciprocal	If the importance of the j and i factors is compared， the scale $a_{ij}=1/a_{ji}$

Table 4 shows the comparison matrix between the strength indicators of criterion layer B1 and those of indicator layers C1-C6.

Table 4. B1corresponding C1-6Comparison matrix.

B1	C1	C2	C3	C4	C5	C6
C1	1．00	1．00	1．24	3．01	1．66	1．00
C2	1．00	1．00	1．24	1．66	1．01	1．01
C3	0．80	0．81	1．00	1．34	0．81	1．00
C4	0．33	0．60	0．75	1．00	2．00	1．10
C5	0．60	0．99	1．23	0．50	1．00	0．61
C6	1．00	0．99	1．00	0．90	1．63	1．00

3.3 Single Hierarchical Arrangement

First，the normalized calculation of the feature vector is carried out (the following is the calculation process of the B1 intensity index，the calculation method of B2，B3 and B4 is the same as that of B1，so it will not be repeated).

$$M_1=\prod_{j=1}^{6}a_{ij}=1\times1\times1.24\times3.01\times1.66\times1=6.20$$

$$M_2=\prod_{j=3}^{6}a_{ij}=1\times1\times1.24\times1.66\times1.01\times1.01=6.20$$

$$M_3=\prod_{j=3}^{6}a_{ij}=0.8\times0.81\times1\times1.34\times0.81\times1=6.20$$

$$M_4=\prod_{j=4}^{6}a_{ij}=0.33\times0.60\times0.75\times1\times2\times1.1=6.20$$

$$M_5=\prod_{j=5}^{6}a_{ij}=0.6\times0.99\times1.23\times0.5\times1\times0.61=6.20$$

$$M_6=\prod_{j=6}^{6}a_{ij}=1\times0.99\times1\times0.99\times1.63\times1=6.20$$

The root of the equation of the NTH degree is calculated according to formula (4) $\overline{w_i}$:

$$\overline{w_1} = \sqrt[6]{6.20} = 1.36$$
$$\overline{w_2} = \sqrt[6]{2.10} = 1.14$$
$$\overline{w_3} = \sqrt[6]{0.70} = 0.94$$
$$\overline{w_4} = \sqrt[6]{0.33} = 0.83$$
$$\overline{w_5} = \sqrt[6]{0.22} = 0.78$$
$$\overline{w_6} = \sqrt[6]{1.45} = 1.06$$

And further use the formula (5) for B1 eigenvector $\overline{w_i} = (\overline{w_1}\ \overline{w_2}\ \overline{w_3}\ \overline{w_4}\ \overline{w_5}\ \overline{w_6})^T$ normalization, the calculation process is as follows.

$$W_1 = \frac{\overline{w_1}}{\sum_{i=1}^{n} \overline{w_1}} = \frac{1.36}{1.36 \times 1.14 \times 0.94 \times 0.83 \times 0.78 \times 1.06} = 0.24$$

$$W_2 = \frac{\overline{w_2}}{\sum_{i=2}^{n} \overline{w_2}} = \frac{1.14}{1.36 \times 1.14 \times 0.94 \times 0.83 \times 0.78 \times 1.06} = 0.19$$

$$W_3 = \frac{\overline{w_3}}{\sum_{i=3}^{n} \overline{w_3}} = \frac{0.94}{1.36 \times 1.14 \times 0.94 \times 0.83 \times 0.78 \times 1.06} = 0.16$$

$$W_4 = \frac{\overline{w_4}}{\sum_{i=4}^{n} \overline{w_4}} = \frac{0.83}{1.36 \times 1.14 \times 0.94 \times 0.83 \times 0.78 \times 1.06} = 0.14$$

$$W_5 = \frac{\overline{w_5}}{\sum_{i=5}^{n} \overline{w_5}} = \frac{0.78}{1.36 \times 1.14 \times 0.94 \times 0.83 \times 0.78 \times 1.06} = 0.13$$

$$W_6 = \frac{\overline{w_6}}{\sum_{i=6}^{n} \overline{w_6}} = \frac{1.06}{1.36 \times 1.14 \times 0.94 \times 0.83 \times 0.78 \times 1.06} = 0.14$$

Where W_1 to W_6 are the normalized feature vectors.

It is known that the eigenvector after B1 normalization is : $W=\begin{bmatrix}0.24\\0.19\\0.16\\0.14\\0.13\\0.14\end{bmatrix}$. $B1W=\begin{bmatrix}1\cdots1\\ \vdots\ddots\vdots\\ 1\cdots1\end{bmatrix}\begin{bmatrix}0.24\\0.19\\0.16\\0.14\\0.13\\0.14\end{bmatrix}=\begin{bmatrix}1.45\\1.18\\0.99\\0.91\\0.84\\1.11\end{bmatrix}$, The maximum characteristic root is shown in formula(6) $\lambda_{\max}=\sum_{i=1}^{6}\frac{(AW)_i}{nW_i}=1.45+1.18+0.99+0.91+0.84+1.11=6.48$ Finally, consistency test is carried out according to the maximum feature root, as shown in formula (1): $CI=\frac{\lambda_{\max}-N}{N-1}=\frac{6.48-6}{6-1}=0.99$, because the order of B1 is N=6, as determined by table 3. $RI=1.24$, further calculation $CR=\frac{CI}{RI}=\frac{0.09}{1.24}=0.07\le 0.1$ it passes the consistency check. After consistency test.

Table 5. Single sort result of indicator layer[4].

B	C1	C2	C3	C4	C5	C6
Value	0．24	0．19	0．16	0．14	0．13	0．14

3.4 Hierarchical total sort

On the basis of satisfactory single hierarchical ranking, and the weight value of criterion layer to target layer is obtained, as shown in table 6 .

Table 6. Criterion layer weight value.

Criterion layer	Strength index B1	Systematic index B2	Guarantee index B3	Characteristic index B4
	0．352	0．272	0．234	0．142

Table 7. Hierarchical total sort consistency check[5].

index level	Strength index	Systematic index	Guarantee index	Characteristic index

Criterion layer weight value	0．352	0．272	0．234	0．142
CI	0．009	0．007	0．006	0．008
RI	1．42	0．95	0．95	1．12

$$CR = \frac{\sum_{i=1}^{n} B_i CI_i}{\sum_{i=1}^{n} B_i RI_i} = \left(\frac{0.352 \times 0.09 \times 0.272 \times 0.07 \times 0.234 \times 0.069 \times 0.142 \times 0.08}{0.352 \times 1.42 \times 0.272 \times 0.95 \times 0.234 \times 0.95 \times 0.142 \times 1.12} \right) = 0.07$$

CR=0．07<0．1，So pass the consistency test．The values in the above formula are derived from Table 7． Data in Tale 7 RI value comes from Table 2.

Finally，on the basis of passing the consistency test，the final result of the total hierarchical ranking is calculated according to the weight value of the criterion layer and the weight value of each factor of the indicator layer.The weight values of the indicator layer are derived from Table 5， as shown in table 8．

Table 8. Hierarchical total sort weight

Criterion layer	Weight	Index level	Weight	Comprehensive weight
Strength index	0．352	1 Comprehensive energy consumption of operating vehicles in Zhengzhou	0．24	0．0845
		2 Comprehensive energy consumption of public transport vehicles in Zhengzhou	0．19	0．0669
		3Parking problem in Zhengzhou	0．16	0．0564
		4 CO2 emissions from vehicles in operation in Zhengzhou	0．14	0．0493
		5The proportion of green transportation in Zhengzhou	0．13	0．0458
		6 Traffic road environment of Zhengzhou	0．14	0．0634

The priority weight of each element of each level to an element of the previous level is called the weight value. Before the total hierarchical ranking， the consistency test calculation of the maximum feature root and the total hierarchical ranking should be carried out first to determine whether the calculation results pass the consistency test． This process is to calculate the weight value layer by layer from high to low，mainly using the linear weighted sum method，and finally sort according to the weight of each factor for the total target．

4 CONCLUSION

Through the use of analytic hierarchy process，the intensity index factors that have the greatest influence on the weight value of the development of urban green transportation in Zhengzhou are analyzed in terms of the main problems affecting urban green transportation in Zhengzhou：The comprehensive energy consumption of vehicles in Zhengzhou city is high，the pollutant emission problem of transportation vehicles in Zhengzhou city，urban road congestion，and the comprehensive transportation hub facilities are backward、Zhengzhou green travel proportion problem，Zhengzhou city parking problem.

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