Study on fuzzy comprehensive evaluation of integrated development of transportation and postal service in Hunan Province

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Abstract: Based on the data collection of Hunan Province, this paper uses SPSS software to analyze the correlation between the data of the two industries, and concludes that the development of the two industries presents the characteristics of integration. According to the characteristics of the integrated development system of the two industries, the analytic hierarchy process (AHP) was selected, and four evaluation indexes were selected from the development direction with higher integration degree of the communication and postal services. By calculating the weights of the four indexes, the comprehensive development evaluation system was established. According to the established index system and the fuzzy comprehensive evaluation method, the scoring results of the four indexes are calculated to provide countermeasures and suggestions for the integrated high-quality development of transportation and postal industry in Hunan Province.

1. Preface

For the implementation of national superior related government organization of rural economic revitalization strategy, logistics, development, integration "mailed" spirit and requirements, at the same time make full use of the historical opportunity of the integration of urban and rural passenger transport pilot in our province, it is necessary to transport and the postal service industry in our province fusion high level development of deep exploration, put forward the development of the province "fusion" mailed , in order to guide the smooth development of "delivery and postal integration" work. In China, from the perspective of the development of transportation, postal and financial services, Tian Shuai hui [1] et al. proposed the Logistic model based on the integrated development of transportation and postal services to carry out the correlation degree classification, and found that the planning and deployment of Chongqing is not high, the resource integration and development degree of the two industries is not high, and the level of information resource interconnection is low. Ouyang Yi hui [2] proposed and summarized the current situation and existing difficulties of the development of rural postal logistics, and analyzed the development situation faced. On this basis, he proposed policies to promote rural postal logistics relying on the transportation platform[3], from rural logistics development foundation is weak, the background of logistics facilities are relatively weak, in order to promote transportation and postal express delivery in rural areas to strengthen cooperation, put forward: emphasis on resource sharing, to highlight the inter-departmental coordination and break down barriers of postal transportation integration development system and mechanism, and pay attention to the standardization construction, support the development of fusion, convenient for the people. Yan Wei [4] concluded the shortcomings
of current tourism industry integration by comparing the traditional measurement methods of tourism integration, established the evaluation index system and evaluation method of integrated development by AHP method, confirmed the degree of integration of Jiangsu and the national tourism industry, and proposed the solution.

2. Analysis of present situation of two industries in Hunan province

2.1. Development status of transportation industry
Province transportation system met the national development strategic opportunity, traffic infrastructure construction as the province's leading construction of national economy development to traffic infrastructure construction, optimize network structure, make transportation system more mature, greatly changed the traffic landscape, formed a connection inside, covering urban and rural comprehensive transportation system, with perfect functions, It is the foundation of the province's high-quality economic and social development[5]. In this province traffic transport economy report, having relatively stable development rhythm. During the period of 2020, the passenger transport volume was 2,440.98 million tons, railway 45.54 million tons, highway 2.182.36 million tons, civil aviation 110,000 tons and pipeline 10.89 million tons, with year-on-year increases of 5.4%, 1.8%, 6.7%, -4.6%, 12.3% and 2.9%, respectively.

2.2. Postal industry development status quo
Up to now, the province has a total of more than 40 brand delivery enterprises, more than 100,000 employees. Each brand enterprise establishes its own network and operates independently. Mail, express transportation mainly road transport, aviation, railways, form the three-dimensional transportation network, in recent years, with the rapid development of rural logistics and express delivery industry, the development of rural logistics and express delivery industry has huge potential and development space, but is subject to the rural logistics market demand characteristics of highly dispersed, seasonal, express service network covers only the villages and towns, Unable to go deep into the village group, the villagers are not convenient to receive and send.

2.3. Correlation analysis of transportation and postal services
By analyzing the correlation between the transportation and the postal industry in Hunan province, it is found that the development status and trend of the transportation and the postal industry in Hunan province and Chong Qing city have roughly the same characteristics, which can be compared horizontally. With reference to the research on integrated development of transportation and postal services in Chongqing, optional postal business volume and freight volume are taken as variables of the two industries, and SPSS is used to conduct correlation analysis[1]. The index data of the two industries are shown in Table 1 below.

| Year | Postal business volume (100 million yuan) | Year-on-year growth | Cargo volume (10,000 tons) | Year-on-year growth |
|------|------------------------------------------|---------------------|---------------------------|---------------------|
| 2015 | 104.15                                   | 37.66%              | 214130                    | -3.16%              |
| 2016 | 143.37                                   | 34.37%              | 207364                    | 9.24%               |
| 2017 | 192.64                                   | 28.86%              | 226522                    | 2.03%               |
| 2018 | 248.24                                   | 28.85%              | 231110                    | 2.02%               |
| 2019 | 321.79                                   | 29.62%              | 190958                    | 17.37%              |
| 2020 | 429.22                                   | 33.38%              | 202011                    | 5.8%                |
Correlation analysis mainly evaluates the degree of correlation between elements through correlation coefficient. If the value is greater than 0, it is positive correlation; otherwise, it is negative correlation. General correlation coefficient Person coefficient, Spearman coefficient and Kendall rank correlation coefficient were used to measure the correlation between variables [6]. In this paper, the development level of the transportation and postal industry in Hunan Province is taken as the variable, and the correlation coefficient between them is calculated by using SPSS software. The two variables in the paper are continuous variables, and the Person coefficient analysis is applicable. Through the use of SPSS software calculation, it is concluded that the transportation and postal industry in Hunan Province have a trend of consistent development, through the analysis of the system calculation results in Table 2.

|                              | Postal business volume | Cargo volume  |
|------------------------------|------------------------|--------------|
| Postal business volume       | Pearson The correlation| 1            | 0.742**      |
| Significance (bilateral)     |                        | 0.004        |
| N                            |                        | 13           | 13           |
| Cargo volume                 | Pearson The correlation| 0.742**      | 1            |
| Significance (bilateral)     |                        | 0.004        |
| N                            |                        | 13           | 13           |

Note: ** indicates a dominant correlation at the level of 0.01

3. Establishment of evaluation index system for integrated development of transportation and postal service

3.1. Selection of evaluation indexes

Refer to, Chong Qing mailed fusion development research[11] and the fusion of transportation and postal express delivery on deepening, for promoting the development of the rural logistics quality opinions[13] and other relevant literature information gathering, and combining with the characteristics of the second chapter concludes that the development of evaluation index system of screening, And establish the hierarchy chart of the evaluation index structure1.
3.2. Determine the weight of evaluation index

3.2.1. Evaluation index judgment matrix
Mailed fusion quality we will influence the development of n with level index to compare the upper level index, get matrix table, you can see from the table the characteristics of the judgment matrix, because it is in the same level of indicators to compare to the importance of the level indicator, to judge the relative importance to provide a certain basis for each level indicators. In order to get an accurate numerical matrix, combined with the development status of Hunan Provincial Communications and Postal Industry, professional teachers were invited as a scoring group. Through the form of network meeting, the Saaty1-9 scale method was used to score the importance of each index of layer B and layer C in the paper hierarchy index system, and the following table 3 was obtained.

| C layer       | score | D layer | score |
|---------------|-------|---------|-------|
| Resource      | 8.4   | D1      | 6.8   |
| sharing       |       | D2      | 7.1   |
|               |       | D3      | 8.6   |
| Facilities    | 7.2   | D4      | 7.3   |
|               |       | D5      | 7.0   |
|               |       | D6      | 6.4   |
| Service       | 5.6   | D7      | 6.2   |
| innovation    |       | D8      | 6.0   |
|               |       | D9      | 5.4   |
| Smart green   | 7.5   | D10     | 6.8   |
|               |       | D11     | 7.7   |

Note: Data are mean, with a maximum score of 10

Through the combination of the numerical scoring of the above scoring group and the N-hierarchy judgment matrix, the specific numerical values and the same level of indicators are compared with each
other to obtain a Consistency test of matricestion value, and then the numerical value is used to construct a hierarchy index judgment matrix form. Taking the "resource sharing" judgment matrix as an example, the matrix Z Table 4 is obtained.

| Table 4. Resource sharing level index scoring |
|-----|-----|-----|-----|
| C1  | D1  | D2  | D3  |
| D1  | 1   | 1/5 | 1/9 |
| D2  | 5   | 1   | 1/3 |
| D3  | 9   | 3   | 1   |

According to the matrix standard table of judgment elements in the above scaling method, the relative important relationship of each index in the criterion layer can be judged.

3.2.2. Determine the relative weight coefficient of evaluation indexes

According to the above index judgment matrix of resource sharing hierarchy, the single ranking and index ranking of other criterion layers can be similarly worked out successively. The ranking is to sort the importance of the index in the criterion layer, and the weight value of the index should be calculated after the ranking, which can be obtained by solving the eigenvalue formula.

\[ CL = \lambda_{\text{max}} \]  
\[ C_{ij} = \frac{c_{ii}}{\sum_{i=1}^{n} c_{ij}} \]  
\[ L_i = \frac{L_i}{\sum_{i=1}^{n} L_i} \]

Combined with the resource-sharing matrix in the price index system, the weight table of the index layer where resource sharing is located can be calculated through formulas and steps. Similarly, according to the establishment method of the judgment matrix of the index layer, the corresponding judgment matrix and matrix weight table can also be established in the criterion layer, as shown in Table 5 below:

| Table 5. Criterion layer judgment matrix |
|-----|-----|-----|-----|-----|
| B   | C1  | C2  | C3  | C4  |
| C1  | 1   | 0.14| 0.2 | 0.11|
| C2  | 7   | 1   | 3   | 0.33|
| C3  | 5   | 0.33| 1   | 0.2 |
| C4  | 9   | 3   | 5   | 1   |

3.2.3. Consistency test of matrices

After the establishment of the hierarchy evaluation index system and the weight calculation of each hierarchy index, it is necessary to carry out the test to calculate the consistency formula for each index in the previous judgment matrix. The formula is as follows

\[ CR = \frac{CI}{RI} = \frac{\lambda_{\text{max}} - n}{n - 1} \]  
\[ \lambda_{\text{max}} = \frac{1}{n} \sum_{i=1}^{n} \left[ \sum_{j=1}^{n} \frac{a_{ij}}{L_j} \times L_j \right] \]

According to the formula, the maximum eigenroot of the judgment matrix was first calculated, and the corresponding numerical calculation was substituted into \[7\] to obtain \( \lambda_{\text{Max}} = 3.03 \), and then substituted into the second formula to calculate \( CI = 0.015 \). Correspondence check is carried out by the consistency index R.I. checklist. When \( n = 3 \), Ri is about 0.57, so the ratio of the first formula is less than
0.1, then the allocation of the "resource-sharing" judgment matrix is reasonable, and the weight set can be adopted. In the same way, we can also find out whether the judgment matrix of the other three criteria layers is reasonable. Through the above calculation, the weight table of the evaluation indicators for integrated development of transportation and postal services in this province can be obtained, as shown in Table 6:

|   | D1  | C1 | C2 | C3 | C4 |
|---|-----|----|----|----|----|
| D1 | 0.016 | 0.174 | 0.104 | 0.107 |
| D2 | 0.066 | 0.048 | 0.035 | 0.024 |
| D3 | 0.163 | 0.017 | 0.017 | 0.030 |

4. Fuzzy comprehensive evaluation and analysis

4.1. Fuzzy evaluation object and standard

The first step of fuzzy evaluation is to determine the set of evaluation objects. Firstly, the fuzzy evaluation of each index layer is carried out respectively, and then the comprehensive evaluation is carried out with the weight of criterion layer. The set table of evaluation objects in Table 4 is established, such as: C1 is the criterion layer, and the index layer below it is (D1, D2, D3), and other evaluation object sets are successively established. After the establishment of the evaluation object set, the evaluation result set for the evaluation of the evaluation object is made immediately, which is the language set that the evaluator can give the evaluated things in Table 7.

|   | good | better | general | Not good | poor |
|---|------|--------|---------|----------|------|
| 95~86 | 85~76 | 75~66 | 65~56 | 55~0 |

4.2. Membership matrix establishment

To select the membership matrix is calculated, and expert scoring or other way to get accurate numerical score of evaluation objects, and digital process, the evaluation factors to adopt brainstorming, build scoring team on WeChat, distribution rating questionnaire, after statistics and calculate the score. Set membership matrix of the Ri and the Ri = {ri1, ri2, ..., rim} (Ri is the membership degree of each index in the scoring table corresponding to the ith index in the index evaluation factor, where rij means the ratio of the number of people choosing the Mi grade of the ith index to the total number of people [8]. Its membership table is equivalent to its membership matrix. Then, according to Chapter 4, the weight set of the index layer of "resource sharing" is obtained. The fuzzy compound operation is carried out with the two, GC1=L1*R1, which is equivalent to using matrix operation. It is concluded that its specific membership degree GC1=(0.4,0.3,0.2,0.06,0.04). Similarly, the membership degree set of the other three criterion layers can be obtained, and the criterion layer fuzzy matrix for the evaluation of integrated development of communication and mail in Hunan Province can be obtained, as shown in Table 8:

|   | GC1 | GC2 | GC3 | GC4 |
|---|-----|-----|-----|-----|
| GC1 | 0.4 | 0.3 | 0.2 | 0.06 | 0.04 |
| GC2 | 0.24 | 0.17 | 0.27 | 0.2 | 0.12 |
| GC3 | 0.05 | 0.25 | 0.49 | 0.17 | 0.04 |
| GC4 | 0.04 | 0.13 | 0.33 | 0.4 | 0.1 |

4.3. Evaluation and analysis

According to the above table 8, the evaluation fuzzy matrix of each indicator in the index layer can be obtained. Combined with the weight set of each criterion in the criterion layer, the evaluation fuzzy
matrix of each criterion can be obtained through matrix multiplication (0.1762, 0.198, 0.308, 0.2376, 0.085). Then, we can calculate according to the matrix. Taking the membership degree set of the criterion layer as a row of moments, the scoring situation of each index of the criterion layer can be obtained. The "resource sharing" score is $P_1*GC_1=74.6$, the "facilities and equipment" score is $P_2*GC_2=77.1$, the "intelligent green" score is $P_3*GC_3=72$, and the "service innovation" score is $P_4*GC_4=71.1$. Finally, the situation of the integrated development of communications and postal services in Hunan Province can be obtained by multiplying the evaluation fuzzy matrix of the criterion layer and the rating table matrix. The score was 73.68.

5. conclusion
Based on the data collection of traffic and post industry in Hunan Province, and with the help of correlation analysis, this paper concludes the characteristics of integrated development. Secondly, according to the characteristics of the selected AHP method to establish the evaluation index system, and then combined with the fuzzy comprehensive evaluation method to evaluate, Hunan Province and the integration of development at the general level. In view of the evaluation index score, the following suggestions are put forward to improve the development: formulate a good system planning, do a good job in scientific overall design, and promote the integration of the two to develop further towards high quality. We should make efficient use of the existing traffic network structure, encourage the sharing of resources between the two, and promote their integrated development. Accelerate the popularization and application of information equipment in counties and townships. Accelerate the implementation of packaging standards in logistics in line with environmental standards.

References
[1] Tian Shuai Hui, Xu Tong, Wang Xu. Research on the Integration Development of Transportation Industry and Postal Industry Based on Logistic Model -- Taking Chongqing as an Example [J].Journal of Chongqing University (Social Science Edition), 2019, 25(06):14-23.
[2] Ou Yang Yi hui, Research on Countermeasures of Promoting Rural Postal Logistics Development in Transportation Industry [J].Logistics Forum, 2018, 40(3): 160-163
[3] Interpretation of Opinions on Deepening the Integration of Transportation and Postal Express and Promoting the High-quality Development of Rural Logistics [J].Jilin Communications Science and Technology, 2019 (03) :5-6.
[4] Yan Wei. Empirical Research on the Integration Degree of Tourism Industry Based on AHP-Fuzzy Comprehensive Evaluation Method [J].Ecological Economy, 2014, 30(11):97-102.
[5] Deng Jing and Chen Gan Hang. On the basis of "foundation". Hunan Daily, Cialis 08-28 (1)
[6] Yuan Ding Ning. Research on Coordinated Development of Urban Traffic System and Economic System [D]. Changsha University of Science and Technology, 2014.
[7] Meng Yun Wei, Chai He Jun, Wang Yang .Traffic Evaluation and Management of Zhong Hua Cong tai Intersection in Handan City [J]. Traffic Standardization, 2007(Z1):178-182.
[8] Han Ling Hua, Yao Guo Zhang. Evaluation of public service platform of smart tourism: A case study of Jiangsu Province [J]. Journal of Nanjing University of Posts and Telecommunications (Social Science Edition), 2014, 16(03):72-80.