INFLUENCING FACTORS OF HIGH-SPEED RAILWAY PASSENGERS' TRAVEL CHOICE BASED ON ROUGH SET

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Abstract: Inter-city traffic is a large complicated system, solving the inter-city traffic problems lies in the reasonable allocation of the methods of transportation, and its core is to satisfy the need of high-speed railway passenger travel. By using rough set theory, this paper calculated the single factor weight and multi-motion weights for the 5 main influencing factors of High-speed railway passengers' choice of travel, and cleared out the interaction and contacts between the various influencing factors, provided scientific decision support for the construction of high-speed railway and the actual operation management.

1 INTRODUCTION

Nowadays, aviation, high-speed railway, inter-city railway, highway have a fierce market competition. In this situation, passengers' choice of travel will be related to operation efficiency of the different ways of transportation directly. With the development of social economy and people travel more and more frequently, how to satisfy people's demand for travel in the best way of transportation and the most reasonable arrangement is the most important problems of high-speed railway operation, also one important guiding principle of high-speed railway's development. But the existing research of passengers' travel choice are most qualitative analysis of behavioral characteristics at specific travel stage, Quantitative research is limited to that such as PDL passenger share rate estimation, The share rate of research are most based on the random utility theory analysis, the division of the way of transportation is a basic work, and no one has determine the importance degree of the influencing factors of travel choice. Therefore, this paper applied the rough set theory method, established the model to calculate the single factor weight and multi-motion weights of high-speed railway passengers' travel choice, and revealed the mechanism of traffic modes' selection when high-speed railway passenger travel, provide scientific decision support for the construction of high-speed railway and the actual operation management.

2 COMBINATION WEIGHT OF MULTIPLE ALGORITHM BASED ON ROUGH SET

According to rough set principle, a knowledge representation system S could be built by describing research objects' attributes and attribute values, that is

$$S = (U, C \cup D, V, f)) \quad (1)$$

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In this equation, $U=\{x_1,x_2,\ldots\}$ represents the set of research objects; $C=\{c_1,c_2,\cdots\}$ and $D=\{d_1,d_2,\cdots\}$ represent the sets of research objects' condition attributes and decision-making attributes, in addition we have $C\cup D=A$ and $C\cap D=\phi$;V is the set of attribute values; $f:U\times A\to V$ is an information function, it endows every research object's each attribute with an information value.

The importance of a condition attribute c_i could be expressed as

$$Sig_{C-c_i}(c_i)=1-\frac{Card[Pos_{C-c_i}(D)]}{Card[Pos_C(D)]} \quad (2)$$

In this equation, $c_i\in C$; i=1,2,3,…,n; n represents the number of elements in the condition attribute set; $Pos_C(D)$ represents the object set in which all elements from U could be divided into the equivalent categories of relation D according to the classification information $U/(C-c_i)$; $Card[\ ]$ represents the set's cardinal number, which means the number of elements in the set.

The weight of every condition attribute could be gained through executing normalized process on the importance of each according to equation (2), which is

$$W_{c_i}=\frac{Sig_{C-c_i}(c_i)}{\sum_{k=1}^{n}Sig_C(c_k)} \quad (3)$$

According to the definition of Rough Set principle, equation (2) and (3) could be extended to get the combination weight of several condition attributes $c_i,\cdots,c_j$, namely the combination weight of multiple, which represents the influences on decision-making result when multiple condition attributes combine and interact on each other.

$$W_{(c_i,\cdots,c_j)}=\frac{Sig_{C-(c_i,\cdots,c_j)}(c_i,\cdots,c_j)}{\sum_{i=1}^{n}\sum_{j=i}^{n}Sig_{C-(c_i\cdots c_j)}(c_i\cdots c_j)}(i\geq j,i=1,2,\cdots,n,j=i,\cdots,n) \quad (4)$$

Besides,

$$Sig_{C-(c_i,\cdots,c_j)}(c_i,\cdots,c_j)=1-\frac{Card[Pos_{C-(c_i,\cdots,c_j)}(D)]}{Card[Pos_C(D)]} \quad (5)$$

In this equation, $Sig_{C-(c_i,\cdots,c_j)}(c_i,\cdots,c_j)$ represents the magnitude of the combination of several condition attributes; $Pos_{C-(c_i,\cdots,c_j)}(c_i,\cdots,c_j)$ represents the set of all the objects which could be accurately divided into equivalent categories of relation D according to the classification information $U/C-(c_i,\cdots,c_j)$.

According to equation (4) and (5), two or more condition attributes could be combined together, thus the combination weight of multiple can be calculated applying basic theory of Rough Set principle.

The biggest advantage of adopting the calculation method of combination weight of multiple based on rough set to analyze the combination of several condition attributes' influences on systems' decision-making is that not only single attribute's effects have been taken into consideration, but the interactions among attributes and their influences on decision-making have also been considered, so one-sidedness and limitations of calculating one single attribute's weight could be avoided. Therefore, this method is especially fit for the research on influencing factors of High-speed railway passengers' travel choice.

3 THE EXAMPLE OF INFLUENCING FACTORS OF HIGH-SPEED RAILWAY PASSENGERS' TRAVEL CHOICE BASED ON ROUGH SET

3.1 Factors' Selecting

High-speed railway system consists of High-speed railway operation, High-speed railway facilities and High-speed railway management policy. As a subsystem of the transportation system, it's most important function is to satisfy passengers' travel demand. Therefore, this paper used the concept that high-speed railway is service in "person" as a starting point, and the influencing factors of passengers' travel choice as the breakthrough point, to research high-speed railway and the influencing factors of passengers' travel choice. Through data analysis and investigation, this paper determined high-speed railway passengers' travel choice index system, including five influencing factors of high-speed railway passengers' travel choice and one factors for evaluation of the result, as table 1 shows. Among them, the five influencing factors are the ticket price satisfaction, the train's start time satisfaction, the train's speed satisfaction, the taking

environment satisfaction, the high-speed railway safety level, one factors for evaluation of the result is the overall satisfaction for high-speed railway.

3.2 Knowledge Expression of Influencing Factors

As table 1 shows, influencing factors of High-speed railway passengers' travel choice not only include the Humanness co-constructs factors such as time and price, but also the comfort level and safety.
Based on rough sets theory, taking the 863 passenger questionnaire record at the Spring Festival period in 2009 as a research collections of objects, setting as $U=\{x_1,x_2,x_3,x_4,x_5...x_{861},x_{862},x_{863}\}$, then using c_1, c_2, c_3, c_4, c_5 to represent the ticket price satisfaction, the train's start time satisfaction, the train's speed satisfaction, the taking environment satisfaction and the high-speed railway safety level, And constituting condition attributes set of influencing factors of High-speed railway passengers' travel choice as $C=\{c_1, c_2, c_3, c_4, c_5\}$, meanwhile, using the overall satisfaction d to constitute decision attribute set D. Thus, constructing a two-dimensional decision-making information table to describe influencing factors of High-speed railway passengers' travel choice knowledge expression system, table 2 shows part of the constructed decision table.

Table 1: High-speed railway passengers' travel choice index system.

Target	Criterion	Index
Influencing Factors of High-speed Railway Passengers' Travel Choice	Passengers Characteristics	Sex
		Age
		Education Degree
		Vocation
		Monthly Income
	Price	Travel Expense Bearing Way
		The Ticket Price Satisfaction
		If fares improve will choose of transportation
		Ticket Price
	Taking Time	The train's start time satisfaction
		Running time increases will choose of transportation
		The Train's Speed Satisfaction
		Time to the Station
		Time for Ticket
		Time for Waiting the Train
		Time for Travelling
		Distance
		Time for Midway Trasfer
		Time from Station to House
	Taking environment	The Taking Environment Satisfaction
		The High-speed Railway Safety Level
		The Overall Satisfaction
		Taking Type

Table 2: Influencing factors of High-speed railway passengers' travel choice knowledge expression system.

number	Condition attribute					Decision attribute
	c1. the ticket price satisfaction	c2. the train's start time satisfaction	c3. the train's speed satisfaction	c4. the taking environment satisfaction	c5. the high-speed railway safety level	d. the overall satisfaction
1	3	5	2	4	5	5
2	5	4	4	4	4	4
3	3	3	2	5	5	5
4	4	4	4	4	5	5
5	4	4	4	4	4	4
6	2	4	1	3	6	4
7	3	4	3	5	6	3
8	3	4	1	4	4	4
9	2	4	6	5	6	6
10	4	3	1	5	2	4
...	...	...	...	...	...	...
862	3	3	2	6	5	4
863	2	4	2	3	5	3

3.3 CALCULATION

3.3.1 The Actual Calculation Results of Single Influencing Factors of High-speed Railway Passengers' Travel Choice Shows in Table 3

Table 3: Single influencing factors of High-speed railway passengers' travel choice.

Influencing Factor	Importance Degree	Weight
c1. the ticket price satisfaction	0.251	0.196
c2. the train's start time satisfaction	0.267	0.207
c3. the train's speed satisfaction	0.273	0.213
c4. the taking environment satisfaction	0.263	0.205
c5. the high-speed railway safety level	0.231	0.179

3.3.2 Multi-motion Weights Shows in Table 4

Table 4: Multi-motion weights.

Influencing factor	Importance degree	Weight
c_1, c_2 the ticket price satisfaction, the train's start time satisfaction	0.554	0.0996
c_1, c_3 the ticket price satisfaction, the train's speed satisfaction	0.552	0.0991
c_1, c_4 the ticket price satisfaction, the taking environment satisfaction	0.533	0.0958
c_1, c_5 the ticket price satisfaction, the high-speed railway safety level	0.519	0.0933
c_2, c_3 the train's start time satisfaction, the train's speed satisfaction	0.586	0.1054
c_2, c_4 the train's start time satisfaction, the taking environment satisfaction	0.585	0.1052
c_2, c_5 the train's start time satisfaction, the high-speed railway safety level	0.550	0.0989
c_3, c_4 the train's speed satisfaction, the taking environment satisfaction	0.587	0.1056
c_3, c_5 the train's speed satisfaction, the high-speed railway safety level	0.555	0.0998
c_4, c_5 the taking environment satisfaction, the high-speed railway safety level	0.541	0.0973

3.3.3 Calculation Result Analysis

The actual calculation results of single influencing factors of High-speed railway passengers' travel choice shows, by large to small, the influencing factors weights of travel choice are the train's speed satisfaction, the train's start time satisfaction, the taking environment satisfaction, the ticket price satisfaction and the high-speed railway safety level. This paper uses the original data from the Spring Festival transportation period questionnaire. Passengers in this period are most students to return hometown and working-class that work outside. For the eager to go home for the Spring Festival, they have high requirements on the travel speed that the time they have to take to get home; they also have high requirements on the train's start time that whether the train is late. As the saying goes that " be thrifty at home and spend liberally while travelling". They also hope to get a better taking comfort. Relatively speaking, in the Spring Festival period, passengers are not too sensitive to the ticket price and safety.

The actual calculation results of Multi-motion weights shows, the Combination weights of speed and taking environment is the highest, then speed and start time. the Combination weights of start time and taking environment is third. The result indicates that in the Spring Festival period, passengers are satisfied to the shorter time and the better taking environment mostly, the union is the main determinants that passengers choose high-speed railway.

4 CONCLUSIONS

According to Rough Set theory, we could not only calculate one single attribute's weight but the combination weights of two or more of them. To combine the calculations of single weight and combination of multiple for comparison and analysis, we could analyze the condition attributes themselves and their relationships more accurately and objectively. Thus, the Rough Set Theory is extraordinarily appeal to the analysis of factors affecting High-speed Railway passengers' travel choices.

The calculation results of one factor or the combination of two or more of them that affects High-speed Railway passengers' choices of travel shows that High-speed railway passengers regard the speed as the most important factors when choosing travel mode. Next to speed are the time of departure and the environment. Though the weight of single factor of departure time is higher than that of the environment, the calculation of combination of multiple factors shows that the combination of railway speed and environment influence the most in passengers' travel choices.

REFERENCES

Fan Zhi-ping, Zhang Quan, Ma Jian.1998. An integrated approach to determining weights in multiple attribute decision making . *Journal of Management Sciences in China*. 1998,1 (3) : 50-53.

Pawlak Z.1991. *Rough Sets: Theoretical aspects of reasoning about data* . Boston, Kluwer Academic Publishers. USA., 1st edtion.

Hao Cheng, Li Jing, Li Xue-mei, Li Xue-wei.2008.. Research on the combination weight of multiple benefit factor s in urban rail transit project based on rough set. *China Railway Science.* 2008,11(6):121-125.

Miao Duo-qian, Wang Jue.1999. An information representation of the concepts and operations in rough set theory. *Journal of Software.* 1999,10 (2) : 113-116

Xue Zhan-jun.2008. The strategic significance of chinese high-speed railway's development. *Science and Technology Innovation Herald*. 2008,(21):55