DECISION MODEL OF THE CONTAINER TRANSPORTATION MODES BETWEEN CHINA'S HINTERLAND AND HARBORS

You-heng HUANG
Associate Professor
School of Traffic and Transportation Engineering
Central South University
22 South Shaoshan Road, Changsha, Hunan, 410075 PRC
Fax: +86-731-2655326
E-mail: huang.you.heng@163.com

Ling-yun ZHOU
Master Student
School of Traffic and Transportation Engineering
Central South University
22 South Shaoshan Road, Changsha, Hunan, 410075 PRC
Fax: +86-731-2655326
E-mail: zlycsuzlycsu@163.com

Dong-wen ZHOU
Senior Engineer
Hunan Xiangtong Logistics Co., Ltd
175 Wuyi Road, Changsha, Hunan,
410075 PRC
Fax: +86-731-2621549
E-mail:dongwen310@sina.com

Abstract: There are some choices of transportation route schemes for imported and exported container transportation of China's hinterland through coastal harbors. Meanwhile, it is necessary to make a comprehensive comparison of multiple qualitative and quantitative decision factors in schemes. However, the influence degrees to schemes of these decision factors usually vary with such changes as time, space, etc. and different demands of policymakers. According to the multipurpose fuzzy mathematics decision-making theory and the centralized and evacuated transportation feature of containers between China's hinterland and coastal harbors, by introducing varied weight factors, a fuzzy decision model of container transportation routes between China's hinterland and coastal harbors is constructed, which is based on varied weight factors and can reflect dynamically importance degrees of related decision factors. Thus, the optimized route scheme between China's hinterland and coastal harbors can be gained through the application and solution of the model problem.

Key Words: Container transportation, Route, Varied weight, Factor, Decision

1. INTRODUCTION

With construction and development of several years, the comprehensive transportation distribution and management system such as railway, highway, and inland water in China are gradually improved perfectly. Also, not only the management level and the throughput of all the main coastal harbors that are in charge of the transportation task of the international

containers are greatly improved, but also centralized and evacuated transportation system including the transportation ways such as railway, highway, inland water, etc. and the imported and exported container transportation networks which are connected one by one are in its primary formation in the harbors' hinterland. All these have built a good platform for the imported and exported container transportation of China's hinterland, which generally indicates the no-coastal provinces, municipalities or autonomous regions of Heilongjiang, Xinjiang, Inner Mongolia, Gansu, Ningxia, Tibet, Shaanxi, Shanxi, Hunan, Hubei, Henan, Sichuan, Guizhou, Yunnan, Jilin, Jiangxi, Anhui, Chongqing and Qinghai of China.

For the reason that different types of goods, boxes, destinations, amount and directions of the transportation and the differences of specific demands and the continuous prosperity exist in the container transportation market, in addition, China's hinterland has a large area and costal harbors' hinterland is large, all these factors objectively offer the possibility that the centralized and evacuated organization modes between the hinterland and the harbors have multiple choices. Meanwhile, under the dealing ways of trade such as FOB, CIF, CFR, etc., the delivery places that the two parties commonly agree are all harbors. After the imported and exported containers are transported to harbors, the next transportation is arranged by the party that takes over the containers. Therefore, there are many transportation route schemes available for how to export the containers from a certain hinterland to the harbors or how to import the containers from the harbors to a certain inland destination, the comparison and selection among all the schemes thus constitutes the transportation route decision issue. As for how to get the optimum scheme, a suitable method is needed to make a comprehensive, reasonable and comparative study of such factors as security, economy, convenience, speed in order to make a decision, while in these factors, there are both qualitative ones and quantitative ones. Therefore, such kind of problem is a fuzzy decision problem. The policymaker often deals with it in two kinds of simple situations during the process of solving this kind of problem, however, the two kinds of situations are not completely comprehensive or relatively comprehensive: one is that a decision is made not according to real data and existing scientific method and step, but only according to the understanding and judgment experience of similar things; the other is that final choice is made by extremely depending on real data and inference of mathematics formula, without considering qualitative factors. Both the two kinds of decision ways are extreme and one-sided, and the results of them are often not the best ones. The wide application of the fuzzy mathematics theory has offered a scientific way to solve the transportation route decision issue, that is, the fuzzy decision model of imported and exported containers transportation routes between China's hinterland and coastal harbors, based on the varied weight, are constructed according to the transportation features of imported and exported containers between the hinterland and the harbors, which dynamically reflects the importance degrees of such decision factors as transportation costs, time, security, reliability, etc., thus the most optimized route decision schemes under different emphasis points are gained.

2. THE ANALYSIS OF THE MAIN FACTORS ABOUT THE COMPARISON AND

SELECTION BETWEEN CHINA'S HINTERLAND AND THE HARBORS

No matter it is from the harbors to the hinterland or from the hinterland to the harbors, while choosing the container transportation route scheme between the hinterland and harbors, its overall goal of optimizing schemes is that the least transportation costs and the shortest transportation time are needed for transporting containers to the destinations safely on time. The factors of confirming the transportation route scheme are numerous, but after summing up, simplifying and abstracting all these factors, 4 indexes which play a key role in choosing the schemes are confirmed as following: transportation costs; transportation time; transportation security; transportation reliability. Among them, the first two items are quantitative factor indexes and the last two items are qualitative factor indexes.

1) Transportation costs

Transportation costs is an important component of forming cost of goods, the level of which directly influences the profit states of enterprises and the competitiveness of products in the market. It is one of the key factors to choose transportation route and is the focus for such transportation ways as railway, highway and inland water to compete in the market of transportation. In China's transportation market, the transportation price of the railway is relatively stable and has not any relation with the transportation market demand basically. And the transportation costs all maintains basically on the same level over a certain period no matter the containers of a certain railway line on their starting trip or returning trip. While the transportation costs of the highway and inland water container transportation fluctuate according to market conditions, and the market-based degree is very high, especially for the container transportation of the highway, different transportation costs exists on the same transport line according to different direction and different time, some even up to more than one time. Therefore, while choosing the route, different schemes will produce different transportation costs that is basically required and this factor usually becomes a primary one in scheme decision.

2) Transportation time

Any transportation of products has its requirements for time. The size of transportation time greatly concerns the circulating speed of the products and the turnover of current funds. And the transportation time is closely related to such factors as transportation way, transportation distance, etc. Containers delivered from the hinterland to harbors usually involve such kind of problem in the aspect of transportation: the transportation time should be linked up with the lading time of arrived liner ships. More fees such as storing fees, keeping fees should be paid if the containers are delivered relevantly more ahead of time; the consignor will bear greater or even irretrievable losses because of breaking a contract if the containers are delayed to reach the harbors and can't be loaded into the ship on schedule. In the case that the consignor prepare the goods according to the trade contract and have abundant time to apply to customs and transact consignment procedure, factors like transportation time will not often become the factor paid the utmost attention to while choosing the scheme of transportation route. But if the delivery time that the contract stipulates is a little urgent, and huge compensation or other

losses will be faced once breaking the contract, in a situation that other conditions do not change, the transportation time factor may rise to a primary one in the process of route decision.

3) Transportation security

To guarantee the security of the containers, delivered goods and the bills enclosed during the process of transporting is the basic requirement for transportation, and also it is a primary condition that must be considered while drafting all the transportation schemes that are prepared to be chosen. Even if the goods have already been insured before starting shipment and the insurance company will make compensation if some transport accidents happen, but so long as the transport accidents happen, it will involve several problems like honoring the agreement according to the contract and making a claim about the damages in the accidents. So these kinds of risks must be evaded as much as possible in the course of practical operation. The security in the course of container transportation depends on the station's loading and unloading technology and operation management level, types and technological state of conveyances, the technological grade of the transportation route (channel) and public security of social environment. Railway transportation isn't affected by weather phenomena and seasonal variation and can be operated under all-weather situation, while the transportation security of the highway, inland water can't. Because various kinds of new and high technology including the application of security technology are widely used in the field of transportation, various kinds of security operation of different transport ways can basically meet the demands of the transportation market. But according to the statistical conditions of the transport accidents, railway transportation is better than highway transportation in security, while highway transportation is better than inland water transportation.

4) Transportation reliability

Here "transportation reliability" has two kinds of meanings: one is the reliability of obtaining the necessary transportation capacity during a certain period of time for different transportation route schemes; the other is the punctuality of reaching the destination on schedule according to the plans or transportation contract for different transportation route schemes, while choosing the transportation route schemes, it is necessary to make an investigation and analysis about the possibility degree of gaining transportation and the punctual condition of transportation. In China's transportation market, although the tense situation of the transport capacity has greatly been alleviated, there exist obvious differences in various kinds of transportation supply-demand relationship displayed on the market: the transport capacity of the railway is in short, and its satisfying rate of market demand is less than 80%, besides, the delivered deadline is seldom promised generally, and its reliability is relatively bad; highway transportation has developed quickly, there are high level of highways connecting with each other at the main harbors and their hinterland, and highway's reliability is the best one because of its flexibility, convenience and punctuality; the inland water transportation is affected by different water levels in different seasons and weather condition and its reliability generally lies between railway transportation and highway transportation.

3. THE DESCRIPTION OF THE DECISION MODEL OF THE TRANSPORTATION ROUTE ISSUE

As for m schemes available such as $b_1, b_2, \cdots, b_m$ (namely the transportation route scheme suitable for choosing), there are n evaluation factors such as $a_1, a_2, \cdots, a_n$ (transportation time, transportation cost, transportation security, transportation reliability, etc.), respectively corresponding to the factor varied weight $w_1, w_2, \cdots, w_n$ and every scheme $b_j (j = 1,2,\cdots m)$ in reserve has one index eigenvector $f_{ij} (i = 1,2,\cdots, n; j = 1,2,\cdots, m)$ corresponding to n evaluation factors $a_i (i = 1,2,\cdots n)$ and the membership degree of its eigenvalue is r_{ij} to individual appraisal factor "excellent". To utilize a method that weighted relative warp interval is minimum to choose the optimum scheme, first, it is necessary to calculate the ideal scheme, then to choose the available scheme that is the most close to the ideal scheme as the optimum scheme according to the maximal membership degree principle, and the standard value vector of the ideal scheme is:

$$f^0 = (r_{11} \vee r_{12} \vee \cdots \vee_{1m}, r_{21} \vee r_{22} \vee \cdots \vee r_{2m}, \cdots, r_{n1} \vee r_{n2} \vee \cdots \vee r_{nm}) \quad (1)$$

$$= (f_1^0 \wedge f_2^0 \wedge \cdots \wedge f_n^0)$$

And the eigenvector of each available scheme that is the most close to the ideal scheme is illustrated as: $R_j = (r_{1j}, r_{2j}, \cdots, r_{nj})^T$, the weight of the decision factor:

$$W = ((1+\varepsilon_1)w_1, (1+\varepsilon_2)w_2, \cdots, (1+\varepsilon_n)w_n)^T.$$

Among them: $\varepsilon_1, \varepsilon_2, \cdots, \varepsilon_n$ and $w_1, w_2, \cdots, w_n$ are respectively the varied weight factor and constant weight items of each factor index. And Hamming closing degree (Yu and Wang, 2000) with weight is used to describe the quality degree of the scheme in reserve, namely:

$$N(f^0, R_j) = 1 - \sum_{i=1}^{n} W_i (f_i^0 - r_{ij}) \quad (2)$$

If $T_j = \max[N(f^0, R_j)], 1 \le j \le m$, scheme b_j is an optimum scheme.

4. THE PROCEDURES OF THE COMPARATIVE SELECTION OF THE SCHEMES

4.1 Calculating the Membership Degree of Quantitative Factor Index

When the index value f_{ij} of factor index i corresponding to scheme j is a quantitative index, the comprehensive decision-making method quantitative index should be adopted to confirm the membership degree of the factor index (Zhang and Peng, 1999), assumption:

$$r_{ij} = \begin{cases} 0.1 + \dfrac{f_{i\max} - f_{ij}}{d} & \text{if } f_i \text{ is a minus index} \\ 0.1 + \dfrac{f_{ij} - f_{i\min}}{d} & \text{if } f_i \text{ is a plus index} \end{cases} \tag{3}$$

In the formula, d is a grading value $d = \dfrac{f_{i\max} - f_{i\min}}{1 - 0.1}$, r_{ij} is the membership degree of factor item i to scheme j in reserve. Plus index is a factor index when the higher the index value is, the better the scheme will be; Minus index means the lower the index value is, the better the scheme will be.

In n×m dimensional space, n evaluation values of m schemes makes up a fuzzy evaluation matrix R:

$$\mathrm{R}=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix}$$

4.2 Confirming the Membership Degree of Qualitative Factor Index

As for the confirmation of the membership degree of qualitative factor index, a qualitative index comprehensive decision method is adapted to make an evaluation, when every factor index value f_{ij} is a qualitative index, the evaluation of the fuzzy matrix R can be made by experts. The specific way is that the factor index is to be divided into seven grades (worst, worse, bad, general, good, better, best), and the evaluation value (Li and Shi, 2004) can be given according to the standard illustrated in table 1.

Table 1. The Table of Evaluation Standard

Remark	Worst	Worse	Bad	General	Good	Better	Best
The evaluation value	0.05	0.20	0.35	0.50	0.65	0.80	0.95

When the actual judgment remark of the membership degree of factor index is lying between

two borders upon grades, any intermediate value can be chosen between the two border upon grades.

4.3 Confirming the Weight of Every Factor Index

It is necessary to confirm the importance degree of every factor to the schemes in reserve while using the fuzzy mathematics method to carry on a decision. And the importance degree, namely, is the corresponding factor weight value of n evaluation factors: $w_1, w_2, \cdots, w_n$. The confirmation to weight directly concerns the evaluation result of the final scheme, which is one of the most key problems while adopting the fuzzy mathematics method. The commonly used methods of confirming the weight are: Delphi method, Paired Comparisons method, Analytic Hierarchy Process, Matrix Operation method, Principal Factor Analysis method, etc. (Wang and Liu, 2000) , among which one can be chosen to confirm the relatively fixed weight value of every factor under certain conditions.

However, each factor index in the available schemes has dynamic features because of its changing with time, space and other related situations. Therefore, the result of the weight value that is gained according to a certain method before perhaps cannot totally reflect the changed situation. In addition, different policymakers may have different decision preferences and requirements.

In order to dynamically reflect the different importance degrees of each factor index to each transportation route scheme, the varied weight factors of every factor index $\varepsilon_1, \varepsilon_2, \cdots, \varepsilon_n$ should be given a corresponding value. The weight set with varied weight of each factor, namely $W = ((1+\varepsilon_1)w_1, (1+\varepsilon_2)w_2, \cdots, (1+\varepsilon_n)w_n)^T$, can be gained, which is used to show the dynamic features of the evaluation factors. At this time, the varied weight is no longer a weight in general meaning. Actually, it signifies the change tendency and the policymaker's preferences under the existing condition.

4.4 Calculating Hamming Closing Degree with Weight to Confirm the Optimum Scheme

To make a calculation according to formula (2), and get the result $T_j = \max[N(f^0, R_j)]$, then scheme b_j is an optimum scheme.

5. ACTUAL DECISION CASE

5.1 The Transportation Section and Schemes of the Case in Reserve

The transportation section of the containers, sent from the Changsha region and loaded and exported via Shanghai Harbor, is chosen as a case of route scheme. There are mainly three reasons for choosing the Changsha→Shanghai section as a typical case: 1) Changsha is the capital of Hunan Province, one of provinces in the middle part of China and a typical hinterland, which neither belongs to the frontier nor coastal regions, and Changsha is far away from Shanghai and the distance between them is more than 1,500 kilometers.2) As the starting point, Changsha is not only connected with Shanghai and other places through trunk railways and high level of highways in landway but also connected with Shanghai Harbor by the through transport of the Xiangjiang River and the Changjiang River in inland waters, then there are many kinds of available transportation ways between Changsha and Shanghai.3) The container throughput of Shanghai Harbor is maximal in China, and Shanghai Harbor is linked with every big harbor in the world by sea routes, the imported and exported containers in the Changsha region are transported by railway, highway and inland water, then transshipped via Shanghai Harbor. And the traffic volume of the containers is more than 80% of its total volume.

To make the comparison of the schemes convenient under the same requirements, the consignment starting points of all transportation route schemes are ensured as the railway station, the highway transfer station or the inland port, where containers are loaded in Changsha, but not the containers' incasing sites of the exported goods or the exported enterprises' warehouse sites, the terminal is the quay of Shanghai Harbor. The container transportation routes between Changsha and Shanghai is illustrated in Figure 1.

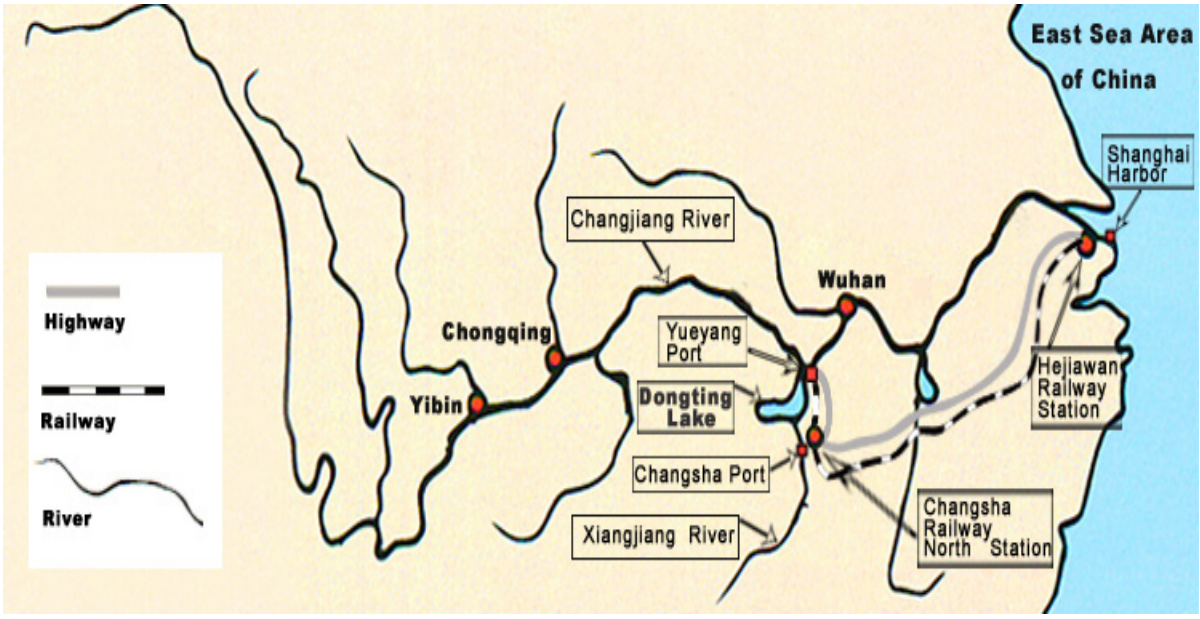

Figure 1. Container Transportation Routes between Changsha and Shanghai

Through the market research of container transportation in Changsha→Shanghai section,

there are 5 following transportation route schemes mainly that were used in this section.

Scheme b_1: the railway + highway transportation route scheme, namely after the exported containers being sent at Changsha North Station, then they are transported to Hejiawan Station of Shanghai by railway, then transshipped on container trucks. Again they are transported to Shanghai Harbor by the short-distance road transport, and then transshipped into the seacraft.

Scheme b_2: the whole highway transportation route scheme, namely after the exported containers are loaded on container trucks in Changsha and transported to Shanghai Harbor by highway, and then transshipped into the seacraft.

Scheme b_3: the whole inland water transportation route scheme, namely after the exported containers are loaded into the ship in Changsha Port and transported through the Xiangjiang River, by way of Tongting Lake and Yueyang, to Changjiang River, then transported to Shanghai Harbor through the Changjiang River and transshipped into the seacraft.

Scheme b_4: the railway + inland water transportation route scheme, namely after the exported containers are loaded into the train in Changsha North Station, transported to Yueyang Port by railway, transshipped into the inland water vessel, and then transported to Shanghai Harbor through the Changjiang River and transshipped into the seacraft.

Scheme b_5: the highway + inland water transportation route scheme, namely after the exported containers are transported to Yueyang Port by highway, transshipped into the inland water vessel, then transported to Shanghai Harbor through the Changjiang River and transshipped into the seacraft.

Because the distance between Changsha and Yueyang is only about 170 kilometers, the through transportation mode, with which containers are transported to Yueyang from Changsha through railway or highway, transshipped into an inland water vessel and then transported to Shanghai Harbor in scheme b_4 and scheme b_5, has a lot of uncertain factors such as transportation link, transportation costs and time, which hardly has any advantage in every factor index in comparison with other three schemes. In the container market of the section, scheme b_4 and scheme b_5 are not considered usually except for special conditions.

Therefore, the case only chooses scheme b_1, scheme b_2 and scheme b_3 as schemes in reserve to be compared, after two quantitative indexes of transportation costs and

transportation time of the three schemes in some period are calculated and two corresponding qualitative indexes of transportation security and transportation reliability are judged by experts, then the index values of schemes in reserve have been educed in table 2.

Table 2. The Index Values of Schemes in Reserve

	Scheme b_1	Scheme b_2	Scheme b_3
Transportation costs	￥3100 RMB /TEU	￥8300 RMB /TEU	￥2500 RMB /TEU
Transportation time	4 days	3 days	7 days
Transportation security	Better	Between "better" and "good"	Good
Transportation reliability	Worst	Best	Better

5.2 Calculating the Membership Degree of Every Factor Index

According to Table 2, the two indexes of "transportation costs" and "transportation time" are quantitative and minus indexes, so their membership degrees are calculated according to the formula (3). The two indexes of "transportation security" and "transportation reliability" are qualitative indexes, so their membership degrees are calculated with corresponding assessed values of fuzzy comments, then the fuzzy matrix R is got:

$$R=\begin{bmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \\ r_{41} & r_{42} & r_{43} \end{bmatrix}=\begin{bmatrix} 0.91 & 0.10 & 1 \\ 0.78 & 1 & 0.10 \\ 0.80 & 0.7 & 0.65 \\ 0.20 & 0.95 & 0.80 \end{bmatrix}$$

According to the formula (1), the index standard value vector of an ideal scheme is $f^0=$ (1,1,0.80,0.95).

5.3 Confirming the Weight of Every Factor Index

With Delphi method, through the consultation investigation of two experts engaged in the Third Party Logistics, two experts engaged in international freight agency business and two experts engaged in transportation for imports and exports enterprises, and they are invited to evaluate every index weight. The result that the constant weight values w_1, w_2, w_3, w_4 of the 4 factor indexes of transportation costs, transportation time, transportation security and transportation reliability are 0.41, 0.22, 0.11, 0.26 respectively after the data of assigning the

weight are collected and processed. After introducing varied weight factor, the weight value is:

$$W = ((1+\varepsilon_1)w_1, (1+\varepsilon_2)w_2, (1+\varepsilon_3)w_3, (1+\varepsilon_4)w_4)^T$$

$$= (0.41(1+\varepsilon_1), 0.22(1+\varepsilon_2), 0.11(1+\varepsilon_3), 0.26(1+\varepsilon_4))^T$$

5.4 Calculating Hamming Closing Degree to Confirm an Optimum Scheme

Calculate Hamming closing degree of every scheme with formula (2), the result is got as following:

for scheme b_1, $N(f^0, R_1) = 1 - \sum_{i=1}^{n} W_i (f_i^0 - r_{i1})$

$$= 0.720 - 0.037\varepsilon_1 - 0.048\varepsilon_2 - 0.195\varepsilon_4$$

for scheme b_2, $N(f^0, R_2) = 1 - \sum_{i=1}^{n} W_i (f_i^0 - r_{i2})$

$$= 0.620 - 0.369\varepsilon_2 - 0.011\varepsilon_3$$

for scheme b_3, $N(f^0, R_3) = 1 - \sum_{i=1}^{n} W_i (f_i^0 - r_{i3})$

$$= 0.746 - 0.198\varepsilon_2 - 0.017\varepsilon_3 - 0.039\varepsilon_4$$

When the weight of every factor index is constant weight and varied weigh factors are not considered, namely if $\varepsilon_i = 0 (i = 1, 2, 3, 4)$, then $T_j = \max[N(f^0, R_j)]$=max[0.720,0.620,0.746] =0.746=T_3, namely, scheme b_3 is an optimum scheme, scheme b_3 is better than scheme b_1 and scheme b_1 is better than scheme b_2.

According to the actual market conditions of container transportation from Changsha to Shanghai, the Xiangjing River and the Changjiang River have better conditions to be open to navigation, which are navigable for a thousand-ton cargo ship. And their transportation capacities are big and their transportation costs is cheap relatively. Besides, the inland water transportation has already become the main channel of the foreign trade transportation of Hunan Province. Changsha Port was classified as one of the main ports of 23 inland waters in China by the China Ministry of Communications in 1995. After the first stage project of new Changsha Port went into operation in July of 2003, the transportation conditions of the port

has been improved greatly, the port played an important role in water-land through transport and transportation pivot platform for imports and exports of foreign trade, which became the main feeder port of Shanghai Harbor which is the largest port of China and was classified as one of the main ports of 28 inland waters of China again in 2004(Hu, 2004). In the actual transportation market, a majority of containers from Changsha to Shanghai are transported by using scheme b_3. Though the railway transportation has advantages and characteristics of the all-weather transportation and cheap transportation costs rate, the railway transportation capacity from Changsha to Shanghai is too limited to satisfy market demands. The transportation reliability of the scheme b_1 is not ensured and met, so a lot of policymakers often want to make a choice, but dare not or cannot make a choice. The highway transportation conditions from Changsha to Shanghai are good, generally because of the long transport distance and high transportation costs, scheme b_2 is forced to consider being adopted only when scheme b_3 or scheme b_1 can't be adopted because of the limitations of some objective conditions.

If varied factors are evaluated, there are differences to some extent in the gained result of the scheme compositor. For example, one policymaker has special requests or partialities for "transportation time" and "transportation reliability", then suppose $\varepsilon_1 = 0, \varepsilon_2 = 0.6, \varepsilon_3 = 0,$ $\varepsilon_4 = 0.6$ (the evaluation of this group of varied factors can be interpreted like this: the two importance degrees of " transport time " and " transport reliability " factor indexes are given an increase of 60 percent at one time under other changeless conditions). After a calculation, the Hamming closing degrees of the scheme b_1, scheme b_2 and scheme b_3 are 0.599, 0.620 and 0.604 respectively, namely that scheme b_2 is better than scheme b_3, scheme b_3 is better than scheme b_1 and scheme b_2 is an optimum scheme. This result also has confirmed that in order to make sure that containers are transported to Shanghai Harbor from Changsha on time and as soon as possible, one policymaker chooses the whole highway transportation as the optimum scheme of achieving his aim most possibly under urgent conditions (such as the condition of catching up with the lading time of the arrived liner ship without enough time of stocking up or with the required goods arrival date of trade contracts which is relatively short).

6. CONCLUTIONS

According to the multipurpose fuzzy mathematics decision-making theory and the centralized and evacuated transportation feature of the containers between China's hinterland and coastal harbors, the results got through the research are as follows:

1) A fuzzy decision model of container transportation routes between China's hinterland and coastal harbors is constructed, which is under the restriction of multiple qualitative and quantitative decision factors and based on varied weight factors.

2) The introduction of varied weight factors, which can reflect dynamically importance degrees of related decision factors, adapts the fuzzy decision model to the dynamical changes of the decision factors and surmounts the static judgment and decision limitation of fuzzy problems in the condition of constant weight.

3) With actual case analysis, the decision model of the container centralized and evacuated transportation modes between China's hinterland and harbors is basically identical to the actual conditions of container transportation market.

4) Generally speaking, the method of constructing the model and the application of varied weight can be utilized and generalized to other similar fuzzy decision problems.

To make the decision model have higher and more general value of practical use, the work which should be done is as follows: a constant weight database of factor index is set up, data are gathered with Delphi method or other methods in a large range and the varied weight of every decision factor in the model is assigned by professional personnel, and then the introduced different varied weight factors are evaluated according to the concrete conditions. Thereby the result of solving it will reflect the rationality and pertinence of the result better, and moreover, it will also offer the basis of the scientific decision for policymakers to choose transportation route schemes under different conditions.

REFERENCES

Hu, F.J. (2004) Proclamation of the list of China's main ports and Changsha Port being one of China's main ports, http://www.csonline.com.cn/news/chsh/t20041116_2630 50.htm

Li, W.H. and Shi, H. (2004) Fuzzy decision analysis based on varied weight for transportation of air-materials, **Logistics Technology, Vol.137, No.2,** 44-46.

Wang, C.S. and Liu, L.Z. (2000) Fuzzy evaluation study on transaction conditions' rationality for railway dangerous cargo container freight station, **Railway Freight Transport, Vol.107, No.5,** 40-42.

Yu, N.H. and Wang, Y.R. (2000) Dynamical fuzzy decision model based on varied weight for

multifactor objects, **Journal of Shenyang Architectural and Civil Engineering University, Vol.16, No.4,** 272-274.

Zhang, Y. and Peng, Q.G. (1999) Multi-purpose fuzzy decision making method in selection of reservoir's normal water level, **Systems Engineering--Theory & Practice, Vol.19, No.12,** 99-107.