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Research Article

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Fast railway freight product structure based on transport efficiency

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ABSTRACT

The main target market for rail transport should be aimed at a stable and expanding bulk cargo transport market, intermodal and international freight transport market share. Constantly developing the "white goods"(that is so called goods are higher profits but lighter) market and the fast railway freight product. However, freight product structure is not so adaptive to fluctuation in the market, that impacts the improvement of transport efficiency. Therefore, more attention should be paid to the development of freight transport product structure adjustment and new products. In this paper, through the AHP applied to adjust the capacity allocation and cargo organization based on the transport enterprise benefit as the goal so as to respond to market fluctuation, meet the transport demand, and maximize the transport efficiency.

Key words: Fast railway Freight Products; Transport Efficiency; Analytic Hierarchy Process

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INTRODUCTION

1. Overview of domestic and international fast railway freight products

1.1Overview of international fastrailway freight products

Fast railway freight products are typically divided by the difference from the perspective of the train speedin foreign countries.

SNCF freight organizations mainly include permutated direct transport, intermodal transport, assembly-type transportation, parcel and LTL modes. In addition, all abovedeveloped into fast freight products.Mostly, SNCF fast freight trains originating or multistep direct trains usually travel at nightand arrive in the next morning. This species of train is time-sensitive and strict compliance deadline shipped to ensure goods put on the market in time[1].

German railway freight products are mainly as follows.Fixed “point to point” continuous integral trains, unit trains,singlegroup trains and so on providing appropriate logistics services.Developing specialized transport solutions depending on the nature of the goods. Also developing container transport, humpback and pallet transport as the main form of intermodal transport for a wider range of radiation and highertransport efficiency[2].

1.2Overview ofdomestic fast railway freight product

The definition of fast railway freight transport is temporarilynot unified in theory so far, though they are similar.In this paper, fast railway transport is aimed atdelivering high profits goods and meeting the delivery deadline in a safe, fast, punctual and convenient way.

With the construction of China's industrial structure adjustment and high-tech growing, the goods sources shift from the traditional single-category, low-value, and bulk freight to the multi-category, high-value, and low-volume.Thus, it requires more flexible, timeliness, and rapid during transport. With the development oflogistics, highway transport impact on rail freight market, China's railway freight products are constantly developing.

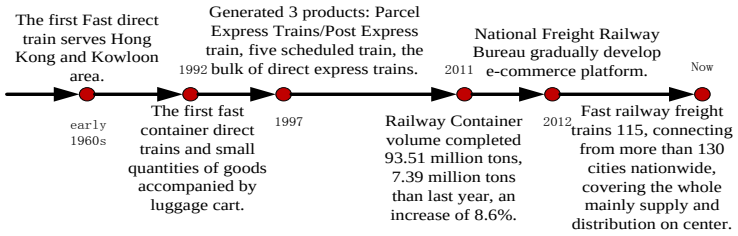


Figure1.Development of domestic fast railway freight products

2. Analysis ontransportation efficiency of fast railway freight products

Fast railway freight product is to transport the high-value goods and commit to the delivery deadline. It will effectively improve the speed of delivery and delivery punctuality by implementing the process of organizing the transport of goods standardized and procedural in a more secure, fast, punctual and convenient way[3].Fast freight transportation products include container transport, five scheduled trains, parcel trains, etc. The effect on transport efficiency is various from each product. Table 1 shows the shipping rate of freight product[4].Table 2 showsanalysis on the railway freight product efficiency.

TABLE1.Shipping Rate of Freight Product(Section)

business type	rate No.	base price 1		base price 2	
		unit	standard	unit	standard
entire car	1	Yuan / ton	8.50	Yuan / ton km	0.071
entire car	3	Yuan / ton	11.80	Yuan / ton km	0.084
entire car	6	Yuan / ton	24.20	Yuan / ton km	0.129
LTL	21	Yuan / 10 kg	0.188	Yuan / 10 kg km	0.0010
container	20 ft	Yuan / box	449.00	Yuan / box km	1.98
container	40 ft	Yuan / box	610.00	Yuan / box km	2.7

TABLE2.Part of the Freight TransportProductsEfficiency

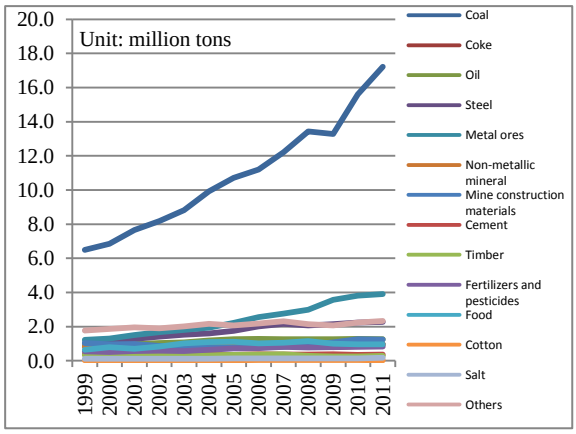
economic	1. Packaging simplification and saving large packaging costs. 2. Helps to reduce the damage and improve freight transport quality. 3. Reduce operating costs and transportation costs. 4. Greatly improving the loading and unloading efficiency so as to improve transport capacity.	1. Point to point direct trains which clearly defined depart and arrive time, and the entire transport costs. 2.Buyoutpricing system makes price more reasonable. 3. Discount for renting more cargos and transport more goods. 4.Safe and high quality.Settling claim as soon as transportation problem occurred.	1. Adopting buyout pricing. Thus the price is reasonable and unit price lower than the ordinary ones. 2.Taking full advantages of long-distance rail transport.
social	1. Improving the transshipment effectively in order to achieve through carriage. 2. Container carriers also compress the transshipping time between the two modes of transport.	1. Fast, efficient, and run by strict time. Travelling 1000 km (one-way 600 km) in two days or more. 2. Transport planning is relatively strict and helps to improve transport efficiency. 3.Simplicity.All the formalities can be done in just onecounter.	Parcel trains contract out the organization of goods sources. The railway department is responsible for just transport.Providing peoplewith more employment opportunities.
examples	In the past, clothing exports was piled up by hand and took at least 10 steps to board from the producing departments.After the implementation of container mounting, hanging clothes in the manufactoryand direct export in containers.Packaging and ironing processes savemuch labor costs, materials and more valuable time[5].	80942/80941 trains run round trips between Shenzhen and Changsha which cost 24 hours.Saving at least 3 days than the original trains which through marshalling station and operate uncertain time. Price of heavy shipping boxes fell by 30%[6].	1999, the parcel trains operating number increased to 8.The revenue reached 870 million Yuan.With the growing of goods sources, the parcel trains operated another 6 pairs in 2000. The revenueshowed a rising trend in each year from 2000 to 2007[7].

3.Impact on transport efficiency of railway freight product structure

Railway freight product structure is constraint byperiodic freight transport demand, the capacity of track, track condition, freight organizational modes and public welfare. Currently,domestic railway freight products include original railway freight products, bulk cargo direct trains, fast freight products, container shipping and special goods transport.The dominant products including: technical through train, district train, detaching and attaching train,and exchange train.Freight products accounted for the subordinate position include: parcel express train, package express train, “five scheduled” train, rapid freight train, coal (oil) direct train, originating direct train, empty cargo direct train, heavy freight train and so on[8].

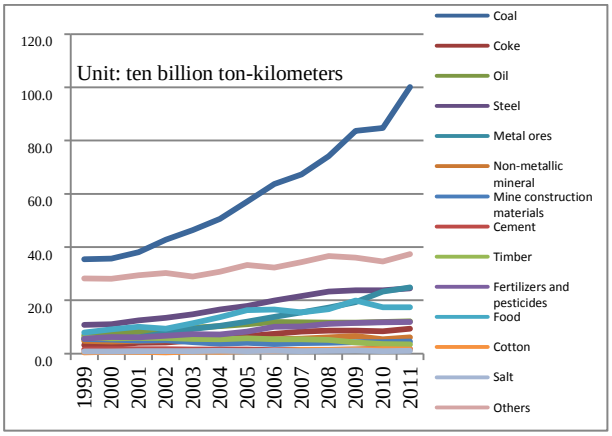
In recent years, as the national economic structure adjustment and economic growth is slowdown.Transport demand

structure has greatly changed in the whole society.Railway freight transportation products also changed accordingly. National railway freight points category volumes and freight turnover as shown in Figure 2, 3.



Data source: China Statistical Yearbook 2000-2013

Figure 2.1999 -2011 National Railway freight sub category changes (missing 2012 data)



Data source: China Statistical Yearbook 2000-2013

Figure 3.1999 -2011 National Railway freight turnover of category changes (missing 2012 data)

The charts above show:(1) 1999 to 2011, the largest is the coal railway freight volume and followed by the food and chemical fertilizers, etc.(2) Bulk materials such as coal transport volume increased year by year, of which the coal cargo and turnover growth is faster. Other goods (excluding package) cargo and freight turnover also increased year by year.

Railway freight volume declines in year 2012 due to national industrial and energy structure adjustment. In addition, railway freight products gradually misfit to the market.

For the moment, overwhelmingly dominant products and lower-occupied proportion of secondary products poses a current situation of railway freight transport products structure in China.Development of fast railway freight product proceedingslow, which share a lower proportion of freight product structure.Thus, it leads to a small share in the freight transport market of small batch but high-value.Railway freight product structure lags behind, cannot effectively to adapt to market changes, to meet the fluctuation of the transport demand, and limit the improvement of transport efficiency.Although the bulk cargo is still the main object of railway transportation, due to the production efficiency of original freight products (such as district train, train detaching and attaching, exchange train) is low.Resource usage is larger and accounts for a large proportion in the freight product structure anddirectly affect the overall ability of the railway transportation. As a result of unconducive to improvement of transport efficiency.

4.Transport efficiency optimization modelling of railway freight product based on AHP

Aimed at solving the issues above, using the AHP to adjust the allocation and freight organization mode in order to respond to market changes, meet the demand of transportation, and maximize of transport efficiency.

It is analyzed the relationship between the basic elements andtransport efficiencysystem.Establishing a hierarchical structure including destination layer, criterion layer, sub-rule layer, and solution layer as shown inFigure 4.A is the destinationlayer. B is the criterion layer. C is the sub-criteria layer. D is the solutionlayer.

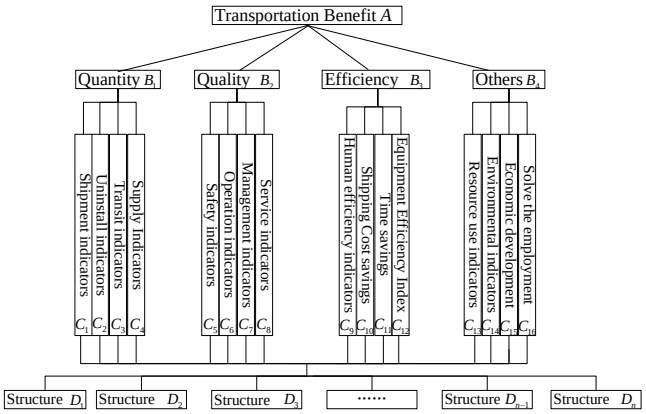


Figure4. Hierarchical Structure of Transport Efficiency

According to the hierarchical structure above, the importance of each element on the same level in the hierarchy of a previous were compared comprehensively criteria to judge. Then, it is calculated by the judgment matrixrespectively, by comparing elements for the relative weight of the upper criteria and testing for consistency of judgment matrix. Finally, compute synthetic weight of each factor on the system goal, and various sorting options. Calculation process as described below.

Establish judgment matrix H_{A-B} of criterion layer*B* on the destination layer*A*.

$$H_{A-B}=\begin{bmatrix} b_1/b_1 & b_1/b_2 & b_1/b_3 & b_1/b_4 \\ b_2/b_1 & b_2/b_2 & b_2/b_3 & b_2/b_4 \\ b_3/b_1 & b_3/b_2 & b_3/b_3 & b_3/b_4 \\ b_4/b_1 & b_4/b_2 & b_4/b_3 & b_4/b_4 \end{bmatrix}$$

Where: H_{A-B} is the judgment matrix of criterion layer*B* on the destination layer*A*.$b_i$represents the i-th indicator of $B_i$in criterion layer. Among them, $i \in \{1,2,3,4\}$.

Judging each element matrix elements are normalized by the upper square root method:

$$\overset{A-B}{W_i}=\left(\prod_{j=1}^{4}\left(b_i/b_j\right)\right)^{\frac{1}{4}}$$

Then use the normalized vector obtained important degree of the vector:

$$\overset{A-B}{W_{i^1}^{0}}=\frac{\overset{A-B}{W_i}}{\sum_{i=1}^{4}\overset{A-B}{W_i}}$$

Finally, testing the consistency, calculating the consistency index $C.I.$:

$$\overset{A-B}{C.I.}=\frac{\overset{A-B}{\lambda_{\max}}-4}{4-1}\quad \overset{A-B}{\lambda_{\max}}=\frac{1}{4}\sum_{i=1}^{4}\frac{\sum_{j}^{5}\left(b_i/b_j\right)\overset{A-B}{W_j}}{\overset{A-B}{W_i}}$$

Calculating synthetic weight of criterion layer *B*ondestination layer:

$$\overline{W_{i_2}^{0}}=\sum_{i_1}^{I_1}\overline{W_{i_1}^{0}}\cdot W_{i_2}^{0i_1}=\overset{A-B}{W_i^0}=\frac{\overset{A-B}{W_i}}{\sum_{i=1}^{4}\overset{A-B}{W_i}},i_2=i$$

Establishing judgment matrix H_{B_i-C} of sub-criteria layer *C* on *B*.Calculating the relative weights of the criteria are being compared by the judgment matrix. And test the consistency.

$$H_{B_i-C}=\begin{bmatrix} c_{j_i}/c_{j_i} & c_{j_i}/c_{j_i+1} & \cdots & c_{j_i}/c_{j_i+k_i-1} & c_{j_i}/c_{j_i+k_i} \\ c_{j_i+1}/c_{j_i} & c_{j_i+1}/c_{j_i+1} & \cdots & c_{j_i+1}/c_{j_i+k_i-1} & c_{j_i+1}/c_{j_i+k_i} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ c_{j_i+k_i-1}/c_{j_i} & c_{j_i+k_i-1}/c_{j_i+1} & \cdots & c_{j_i+k_i-1}/c_{j_i+k_i-1} & c_{j_i+k_i-1}/c_{j_i+k_i} \\ c_{j_i+k_i}/c_{j_i} & c_{j_i+k_i}/c_{j_i+1} & \cdots & c_{j_i+k_i}/c_{j_i+k_i-1} & c_{j_i+k_i}/c_{j_i+k_i} \end{bmatrix}$$

Where: H_{B_i-C} is the judgment matrix ofsub-criteria layer *C* on thecriterion layer B.c_j represents the j-th indicator of $C_j$insub-criteria layer. Among them, $j\in\{1,2,3,\cdots,16\}$ .j can be represented by the combination of k_i and j_i . $k_i\in\{3\mid i=1\}\bigcup\{3\mid i=2\}\bigcup\{3\mid i=3\}\bigcup\{3\mid i=4\}$, $j_i\in\{1\mid i=1\}\bigcup\{5\mid i=2\}\bigcup\{9\mid i=3\}\bigcup\{13\mid i=4\}$.

The judgment matrix *H*is normalized: $\overset{B_i-C}{W}_{i^2}=\left(\prod_{j^2=1}^{k_i+1}\left(c_{j_i+i^2-1}/c_{j_i+j^2-1}\right)\right)^{\frac{1}{k_i+1}}, i^2, j^2\in\{1,2,\cdots,k_i+1\}, i\in\{1,2,3,4\}$

Find the importance degree vector in destination layer: $\overset{B_i-C}{W}_{i^2}^{0}=\dfrac{\overset{B_i-C}{W}_{i^2}}{\sum_{i^2=1}^{k_i+1}\overset{B_i-C}{W}_{i^2}}$

Testing the consistency: $\overset{B_i-C}{C.I.}=\dfrac{\overset{B_i-C}{\lambda}_{\max}-k_i-1}{k_i-2}$ $\overset{B_i-C}{\lambda}_{\max}=\dfrac{1}{k_i+1}\sum_{i^2=1}^{k_i+1}\dfrac{\sum_{j^2}^{k_i+1}\left(c_{j_i+i^2-1}/c^{t}_{j_i+j^2-1}\right)\overset{B_i-C}{W}_{j^2}}{\overset{B_i-C}{W}_{i^2}}$

Calculating synthetic weight of sub-criteria layer C on destination layer:

$$\overline{W_{i_3}^{0}}=\sum_{i_2}^{I_2}\overline{W_{i_2}^{0}}\cdot W_{i_3}^{0i_2}\ W_{i_3}^{0i_2}=\overset{B_i-C}{W}_{i^2}^{0}, i_2=i, i_3=j_i+i^2-1$$

Similarly, establishing judgment matrix $H_{C_j-D_l}$ of solution layer *D* on the sub-criteria layer *C*.Calculating the relative weights of the criteria are being compared by the judgment matrix.And test the consistency.

Finally, sort the synthetic weight $\overline{W_{i_4}^{0}}$ of each factor of solution layer *D* on destination layer.The larger the synthetic weightrepresents, the better the solution is.Analyzing the transport efficiency influencing on freight product structure optimization based on this principle.

CONCLUSION

Through it is compared of different species of freight product solutions. At present, the market pays more attention to pursuing costs saving, time saving and other efficiency factors.Therefore, demand of fast freight product is increasing as well as the quantity and species growing.

To summarize the article content, we can get the following conclusions:

(1)The high-speed railway network is gradually improving. In the condition of the separation of passenger and freight transport, the track capacity of the existing network to be released and improved.Railway freight transport can deliver high-value goods while meet basic transport demandby surplus capacity.

(2)Currently, bulk freight market is increasingly blanddue to the policy implications while high-value products freight market growing continuously.Increasing the proportion of fast freight products in the transportation of the product structure appropriatelydue to the demand for high-value goods is larger and more social welfare.

(3)China Railway Corporation put forward the implementation of "door to door" transportation strategy tostrengthen the railway in collection and distribution at both ends of the service consideringimproving the quality of service It provides a good transport organization service for the intercity freight express train operation. Increase the quantity of intercity freight express train at the same time of designing the freight product structure.

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