

Study on the Pricing and Path Scheme Comparison of Transit Freight

Yang Kang¹, Lixia Wang², Jiawei Ge³ and Xuefeng Wang⁴

¹Student, College of Transport and Communications, Shanghai Maritime University, Shanghai, CHINA

²Student, College of Transport and Communications, Shanghai Maritime University, Shanghai, CHINA

³Student, College of Transport and Communications, Shanghai Maritime University, Shanghai, CHINA

⁴Professor, College of Transport and Communications, Shanghai Maritime University, Shanghai, CHINA

¹Corresponding Author: 183115337@qq.com

ABSTRACT

This paper aims to optimize the transportation network and transportation organization strategy of Transport through China, enabling operators to obtain greater profits, improving the efficiency of transit freight transport, and solving the problem of transportation pricing and route selection of transit goods. In this paper, the growth trend of transit transport demand is firstly determined. On this basis, the ultimate goal is to maximize the transport profit of the operator. In-depth analysis is made from the perspectives of transport income and transport cost. In addition, through combing existing international transportation routes, the overall transit network map of transit China to central Asian and European countries is drawn. In order to achieve the goal of minimizing transportation expenditure, the model of comparing freight routes is established. The customer is also classified by matrix model. Finally, with the transit transportation from Japan, Korea and other countries as examples, the model in this paper is verified, and the optimal transportation path is obtained through software solution. Compared with the current scheme, it has saved operating costs.

Keywords-- Transit Freight, Pricing, Customers Classifying, Path Scheme Comparison

The gradual implementation of the initiative has further promoted trade flows and capital flows between markets in Asia, Europe and Africa. In 2016, the volume of container transfers between China and Russia increased by 86%, and 74 per cent of goods from China to Europe passed through Russia., up by 33% compared with 2015. The alataw pass port is located in china, but at the forefront of the western section of the new Eurasian continental bridge. It is directly connected with the border port of kazakhstan by railway or highway, and mainly undertakes the flow of goods from central Asia, west Asia and Europe to China. According to the official statistics of alashan pass in 2016, the freight volume of railway ports and highway ports showed a double growth, with import and export cargo of 7468,000 tons and 236,200 tons respectively, up by 20.6% and 33.2% year-on-year.

As an important form of international cargo transport, transit transportation, on the one hand, can promote the complementarity of international resources, and on the other hand can drive the economic development of some regions and ports along the routes. For example the new asia-europe continental bridge as an important international cargo transport channel, every year a large number of transit goods are transported through it, animated the economic growth of the coastal port cities and Midwestern provinces such Shanxi, Gansu, in China, and improved the efficiency of the entry and exit operation of each site, also attracted more goods transported through the road and shipped along the port, bringing more supply of goods to the port. In addition, for the constantly updated and increasingly complex transportation network, operators tend to choose the traditional transportation routes, which is not reasonable. The flow of some transit channels tends to be saturated, which increases the transportation time of goods in the

I. INTRODUCTION

1.1 BACKGROUND & SIGNIFICANCE

In recent years, due to the deepening of international trade and the steady progress of economic globalization, the import and export activities of China and its neighboring countries have become more and more active, and the demand of neighbor countries for transit transportation through China has become more and more remarkable. In recent years, President xi jinping proposed the belt and the road strategies in international activities.

road, reduces the overall transport efficiency of the road network, and also causes the excessive expenditure of transportation costs. Faced with the dynamic and changing transport market, the price of railway combined transport is relatively fixed and lacks flexibility, which makes it difficult to adapt to the increasingly competitive transport market.

In current academic researches about transit transport, most based on optimization of one or local transportation routes while considering maximization of transportation benefits and minimization of transportation costs. This paper based on the overall road networks of transit transport to price, to compare the path and to classify customers. Therefore, based on previous studies, this paper will sort out the transportation routes of different transportation modes, draw the overall road network, propose competitive pricing strategies, select the optimal transportation path, and refine customer ratings to reduce transportation costs and help operators to formulate transportation strategies more clearly and rationally, which is significant.

To sum up, Comparative study on the pricing of transit cargo transport and its route scheme, not only helps to promote the development of China's international transport, conforms to the national strategy "One Belt And One Road", as well as redistributes the existing distribution of transit goods, improving the efficiency of transportation and promoting the further development of transit transportation, and also promote economic growth.

1.2 LITERATURE STRUCTURE

The remainder of this paper is structured as follows: The previous studies on the transport pricing and the path of goods in transit are discussed in Section 2. Section 3. describes the methodology with details on parameters, data source and calculation model. The cases of cargo transport through china are studied in Section 4. Section 5 summarizes the major conclusion and perspective.

II. LITERATURE REVIEW

Michail Litvinenko, Ramūnas Palšaitis[1] regarded transit transport as transporting goods through other countries. The development of transit transport is seen as having a direct relationship with the institutions and organizations of its infrastructure. Transit transport income enters the national budget in various forms of taxation to stimulate national economic development and transit transport were evaluated at the macro and micro levels. Liu W, He M, Sun Y[2] qualitatively analyzed the particularity of transit transport demand, and probed into the main factors affecting the transit freight demand of China's foreign trade and its changing trend. It was concluded that the inconvenience caused by the system elements and the relatively high transit cost and transit risk

were the most important factors affecting the increase of transit transport demand. Nuzzolo A, Crisalli U and Comi A[3] For the road transport of transit goods, a model system is proposed to present the international traffic flow of the road through partial shares, which allows the simulation of export, import and distribution to estimate the traffic flow of goods. The modeling system is specified by the total variables and calibrated through data collected in Italy, including data collected through road surveys. Ramūnas Palšaitis, Darius Bazaras, Gintautas Labanauskas[4] studied on the transit freight of Lithuania and Latvia, compared the advantages and disadvantages of the two sides qualitatively from the perspective of port and railway activities. On the one hand, Russia's tariff policy is the main factor affecting the distribution of port goods, while there existing difference between two countries' infrastructure. Bulis A, Škapars R.[5] further described the position of Latvia in logistics performance index and freight process service by SWOT analysis. It was concluded that the advantages of transit transport of goods in Latvia stemmed from geographical location, skilled staff and experience in working with Russia and Belarus. The disadvantages include inadequate capacity to handle cargos through latvia-russia border, poor infrastructure (especially roads), excessive reliance on the economic situation of partner countries, and a lack of technical expertise. Almetova Z.[6] introduced an improved bary center method used to determine the location of transfer stations, served as multi-modal transport logistics center. The coordinates of centers are determined according to the minimum annual total cost of transportation, storage and redistribution of goods. The paper analyzed the different integration of traffic between directions and regions, improving the efficiency of cargo transport by reducing excessive transportation, to make transit transport unproductive operation. U. BRÄNNLUND.[7] Used the Lagrangian relaxation algorithm to optimize the operating profit, considered the line capacity constraints. Anghinolfi D etc.[8] They proposed a planning method to provide cargo rapid transport request in the railway terminal network, used two MIP heuristics, and carried out a test by taking into account the practical problems. Xie Y [9] studied the optimal strategy of air container inventory sharing and coordination of multi-modal transport, in the centralized model, the optimal delivery strategy was solved by considering the marginal profit. Martín E [10] Focused on the optimal storage pricing of imported containers, sensitivity analysis was conducted by numerical experiments Crevier B etc.[11] Took into account the competition with road freight transport, the optimization model was transformed into a dual problem solution.

Research on the path of goods in transit. Wilmsmeier[12] pointed out that attention should be paid to the interaction between the international transport corridor and the port quay of the land transport terminal, to link the

land multimodal transport and the sea in the same corridor. Šakalys R, Batarlienė N [13] investigated the interactive mechanism for the development of new services and goods at the East-West and North-South international transport corridor intermodal terminals, Further invested and identified factors affecting the efficiency of corridor operations, including the interaction of information flows (along corridors), cooperation activities among intermodal transport terminals, etc. In addition, it was proposed to synchronize different gauges through the deployment of major intermodal terminals, discussed the function of multi-modal transport terminals in delivering multi-modal transport goods along international transport corridors, considered the problem of multimodal transport interface sales theoretically. Sui M, Shen F, Wei H [14]. According to the development trend and demand of modern information logistics, they proposed to use the powerful function of spatial analysis and detailed geographic data preparation, to determine the shortest path of vehicles, to assist in the planning and designing transportation routes, and comprehensively considering the factors such as operation time, road condition and transportation cost to determine the optimal path dynamically. Ireland P [15] For the north American railway network, the optimal block scheduling algorithm and the space-time network algorithm are adopted to simulate the use and allocation of empty vehicle scheduling for Empty

train scheduling.

III. METHODOLOGY

3.1 ESTABLISHMENT OF PRICING MODEL

According to the market competition determinism, the changes of the transportation market's supply and demand are the main factors influencing the transportation pricing. The interaction between supply and demand, on the one hand to adjust the balance of market, on the other hand to balance the stability of freight rate. Secondly, the pricing of alternative transport services should be referred to when determining freight rates for selected routes, which mainly refers to the price of the transport run by other operators in this paper. Transit freight model based on the theory of the revenue management follow uniformed Freight pricing, considering transportation cost accorded to the transportation path, based on the total kilometer to determine the basic price. Comprehensive consideration of market supply and demand volatility, customer nature, cargo nature, volume, etc. Referring to the price of alternative transport services to maximizing profits and to divide Transportation price into basic Freight rate (P_o) and actual Freight rate (P). Basic freight rates are mainly affected by transit routes, market changes and alternative modes of transport:

$$P_o = P_1 \theta_1 \theta_2 (D/S) \quad \theta_1, \theta_2 > 0 \quad (0.1)$$

P_1 —Basic price refers to the transit expenses determined by transport kilometer

θ_1 —Supply and demand equilibrium coefficient

θ_2 —Cargo property adjustment factor

D, S —Represents the demand and supply of the route for a given period of time

Q is used to represent the service price of alternative transportation mode under the same conditions in a specific time period, and μ_{max} is used to express the upper limit adjustment coefficient of the freight transport

mode in the specific period of time. μ_{min} denotes the lower limit adjustment coefficient of freight rate in the period, and in general, the value of μ is between 0.99 and 1.1. The basic freight P_o has the following limitations.

$$\mu_{min} Q' \leq P_o \leq \mu_{max} Q' \mu_{min}, \quad \mu_{max} > 0 \quad (0.2)$$

When determining the actual freight rate P , the customer and the carrier's own factors, such as the length

of transit, freight volume and transport capacity, should be considered.

$$P = \varepsilon \gamma \omega P_o \quad \varepsilon, \gamma, \omega > 0 \quad (0.3)$$

ε refers to the adjustment coefficient of the customer's cargo turnover in a specific period of time, which is mainly determined according to the customer's actual demand and actual transport distance. γ represents the freight capacity, mainly depending on the customer's freight volume and the operator's vehicle volume. ω refers to the value adjustment coefficient of the customer in a

specific period, which depends on the nature of the customer, such as the distance of transportation and the long-term cooperation of large customers or short-term cooperation of small customers.

Constraint 1: effect of alternative mode of transport prices

$$\mu_{min}Q' \leq P \leq \mu_{max}Q' \quad \mu_{min}, \mu_{max} > 0 \quad (0.4)$$

Constraint 2: transportation pricing must meet the upper and lower limit prescribed by the railway administration.

$$P_{min} \leq P_o \leq P_{max} \quad (0.5)$$

$$P_{min} \leq P \leq P_{max} \quad (0.6)$$

To sum up, in a specific period of time, when the carload is taken as b and the total number of vehicles is taken as A, the maximum total expected profit that can be obtained by transporting goods to the customer is R:

$$\max R = \sum_{t \in T} \sum_{i \in I} (P_i - Z)[q_i / b] b d_i \quad (0.7)$$

$$p_0 = p_1 \theta_1 \theta_2 (D / S) \quad \theta_1, \theta_2 > 0$$

$$p_1 = \varepsilon \gamma \varpi p_0 \quad \varepsilon, \gamma, \varpi > 0$$

$$\sum_{t \in T} \sum_{i \in I} [q_i / b] = A \quad A \text{ Non-negative integer}$$

$$\mu_{min}Q' \leq P_o \leq \mu_{max}Q' \quad \mu_{min}, \mu_{max} > 0$$

$$\mu_{min}Q' \leq P_i \leq \mu_{max}Q' \quad \mu_{min}, \mu_{max} > 0$$

$$P_{min} \leq P_o, P_i \leq P_{max}$$

In the above formula, P_i represents the actual transport pricing of customer i ; Z represents the transport cost of goods per kilometer per unit; q_i represents the actual transport volume; d_i represents the actual transport kilometer.

3.2 ESTABLISHMENT OF PATH COMPARISON MODEL

Model hypothesis and symbolic description

The assumptions of the model:

(1) In the whole transportation, the whole batch is adopted.

(2) The transport speed of different transport modes is fixed and unchanged, that is, it will not change with the volume of freight.

(3) The number of transshipment at each transport node is at most once, and the operation is limited to the node

(4) No changes in volume caused by damage or loss of goods are taken into account.

(5) Discarding flow limitation of the transportation section and operational capacity constraints of the traffic hub.

Symbol description:

V —the set of all nodes, $V \{v_0, v_1, v_2, \dots, v_n\}$

C —the total cost of goods transported along the shortest path in all routes

T —the total transport time along a certain route

T —the set of transport modes

Q —the total volume of the cargo

C_{ij}^k —unit freight of goods transported in k mode between node v_i and v_j

D_{ij}^k —the distance between node v_i and v_j for cargo transportation in k mode

X_{ij}^k —the transport coefficient, which is transported from node v_i to node v_j in k mode, is set as 1 when transported in k mode, otherwise 0.

h_{ik}^l —transfer fee charged per unit of goods at node v_i when the mode of transport changes from k to l .

Y_{ik}^l —at node v_i , denotes whether the mode of transport is changed from k to l . When a transfer occurs, its value is 1; otherwise, it is 0.

S_k —transportation speed of k modes

- b_i^{kl} —the transit time required for unit cargo when the transport mode is changed from k to l at node v_i .
- $T1, T2$,—the upper and lower limit of the transportation period specified by the customer
- t —The absolute value of the difference between the actual total transport time of and the agreed time limit
- Tq —other time, including customs clearance time, waiting time in transit, etc.
- Cq —other expenses
- W —Inventory management expenditure per unit of goods per unit of time
- α —0-1 variable that measures whether the goods arrive at their destination ahead of time

2.Establishment of model

In this paper, a path comparison model will be established to minimize the transportation cost , taking into account the customer demand and transportation mode. Generally, the transportation demand of transit goods changes periodically. During a certain period, the flow of transportation demand is relatively stable. The transportation route from the starting station to the destination station is determined by the frontier station and the route station. Therefore, the selection of transport routes can be transformed into the selection of transit stops

and border station.

When goods are transported in a single mode of transport and the transit site is considered only, the transport process can be represented as figure 1-1. O_1 and D_1 are the departure station and the terminal station respectively. M is the number of transit times throughout the transport process. Set T is used to represent the transit stations that may be passed in the transportation. r1, r2 and rm represent the number of border stations available for the first, second and mth cross the border, respectively.

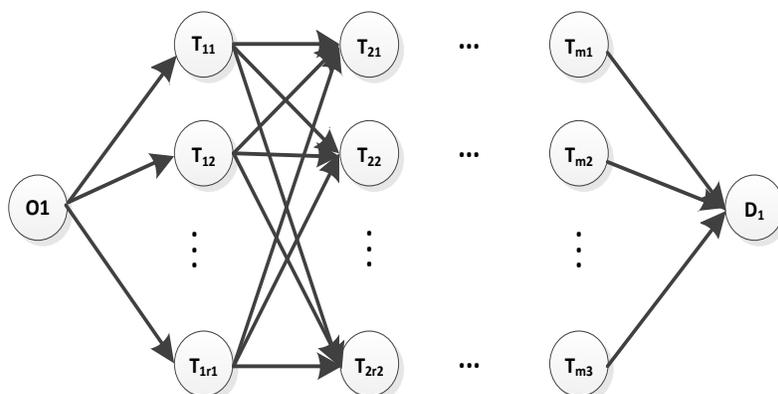


Figure 1-1. Transportation network in a single mode

In order to achieve the minimum freight cost, it is assumed that there are n1 paths between O_1 and D_1 . Cu

represents the freight cost of path u , so the minimum freight cost can be expressed as:

$$C = \min_{1 \rightarrow n1} \{Cu\} + Cq = \min \{ \sum_{i=1}^{m+1} c_i d_i Q \} + Cq \tag{0.8}$$

When considering at least two modes of transport and all possible nodes along the route, the road network structure is complicated, but the specific transport process remains the same. The total freight is composed of In-

transit fee, transit fee and other expenses, besides it is determined by unit freight, volume and distance. Therefore, it can be expressed as:

$$\sum_{v_i \in V} \sum_{v_j \in V} \sum_{k \in K} c_{ij}^k d_{ij}^k x_{ij}^k Q \tag{0.9}$$

In the formula, x_{ij}^k is the variable 0,1, which is used to measure whether node V_i . and node V_j are

transported in the way of k, and it is limited to only one mode of transportation on each section.

$$x_{ij}^k = \begin{cases} 1 & \text{true} \\ 0 & \text{false} \end{cases} \tag{0.10}$$

$$\sum_{k \in K} x_{ij}^k = 1 \quad i, j = 1, 2, 3, \dots, n \tag{0.11}$$

Total transit fees for a route:

$$\sum_{v_i \in V} \sum_{k \in V} \sum_{l \in K} h_i^{kl} y_i^{kl} Q \tag{0.12}$$

y_i^{kl} as the coefficient to measure whether a transfer occurs at node V_i , satisfying the constraint that any node other than the endpoint can realize a transfer at

most, and the transportation path is consistent before and after the transformation.

$$y_i^{kl} = \begin{cases} 1 & \text{true} \\ 0 & \text{false} \end{cases} \tag{0.13}$$

$$\sum_{k \in K} \sum_{i \in K} y_i^{kl} \leq 1 \quad i = 1, 2, 3, \dots, n \tag{0.14}$$

$$x_{ij}^k \bullet x_{ju}^l = y_i^{kl} \quad i, j = 1, 2, 3, \dots, n \quad k, l \in K \tag{0.15}$$

Other expenses incurred in the transportation process come from inventory management of the goods, which can be determined according to the transport time. Similarly, the total transport time of goods is mainly composed of the in-transit time, transit time, and other time, including the waiting time for the transit shipment

and customs clearance. The in-transit time is determined by the distance and the operating speed of different transport vehicles, and the transit time is positively correlated with the freight volume. Therefore, the total transport time can be expressed as:

$$T = \sum_{v_i \in V} \sum_{v_j \in V} \sum_{k \in K} (x_{ij}^k d_{ij}^k / s_k) + \sum_{v_i \in V} \sum_{k \in K} \sum_{l \in K} b_i^{kl} y_i^{kl} Q + Tq \tag{0.16}$$

In order to realize that the goods can arrive at the place of receipt within the time required by the customer,

the total time should not exceed T_2 which is the latest time of receipt requested by the customer.

$$T \leq T_2 \tag{0.17}$$

If the goods arrive at the destination within the period specified by the customer, it is the ideal transportation state. Sometimes, in order to pursue the efficiency of goods turnover, or to make the goods arrive at the place of receipt before the agreed time T_1 , the cargo inventory needs to be kept for a period of time until the

customer comes to pick up. Then, the inventory management cost of that period can be expressed as $\alpha \omega Q t$, in which, when the goods arrive at the destination ahead of time $\alpha = 1$, otherwise $\alpha = 0$

$$t = \begin{cases} T_1 - T & T < T_1 \\ T \in [T_1, T_2] & \end{cases} \tag{0.18}$$

Transportation cost is the decisive factor influencing path selection. This paper aims at minimizing

the total transportation cost to establish a route comparison selection model:

$$c = \left\{ \sum_{v_i \in V} \sum_{v_j \in V} \sum_{k \in K} (c_{ij}^k d_{ij}^k Q) + \sum_{v_i \in V} \sum_{k \in K} \sum_{l \in K} (h_i^{kl} y_i^{kl} Q + \alpha \omega Q t) \right\} \tag{0.19}$$

$$\sum_{v_1 \in V} \sum_{v_j \in V} \sum_{k \in K} (x_{ij}^k d_{ij}^k / s_k) + \sum_{v_1 \in V} \sum_{k \in K} \sum_{l \in K} b_i^{kl} y_i^{kl} Q + Tq \leq T_2$$

$$x_{ij}^k, y_i^{kl} \in \{0,1\}$$

$$\alpha \in \{0,1\}$$

$$t \in \{T_1 - T, 0\}$$

$$\sum_{k \in K} x_{ij}^k = 1 \quad i, j = 1, 2, 3, \dots, n$$

$$\sum_{k \in K} \sum_{l \in K} y_{ij}^k \leq 1 \quad i, j = 1, 2, 3, \dots, n$$

$$x_{ij}^k \bullet y_{ju}^{kl} \quad i, j = 1, 2, 3, \dots, n \quad k, l \in K$$

3.3 CUSTOMERS CLASSIFICATION MODEL

Taking the actual price paid by the transport demander and the cost of transit transport operators as the measurement standards, the two-dimensional matrix of customer value classification was constructed, and the customers were divided into three categories: high efficiency type, transaction type and low efficiency type. Nowadays, in order to reduce operational risks, enterprises need to prevent the impact of the uncertainty on the realization of goals and the increase of costs, leading to the failure or disintegration of cooperation in the supply chain

and the occurrence of various uncertainties and accidents. Therefore, many enterprises carry out refined and diversified management of transportation operators, and often do not have uniqueness when selecting transportation operators. They separate their transportation needs to many carriers, but there are usually only 1-3 carriers with long-term friendly cooperation, as shown in table 1-1. For transport demand enterprises, the more the transport demand is divided, the less risk they will bear, but the higher the transport management costs will be.

Table 1-1 number of transport partners

Quantity	1	2~3	4~10
Proportion	5%	42%	53%

Data source: the fifth survey of China warehousing association (industry)

On the basis of the original two-dimensional matrix, increase the quantity standard of transportation enterprises that customers rely on. That is, the number of

commonly used carriers, and then divide customers into four categories of A, B, C and D, as shown in figure 1-2 below.

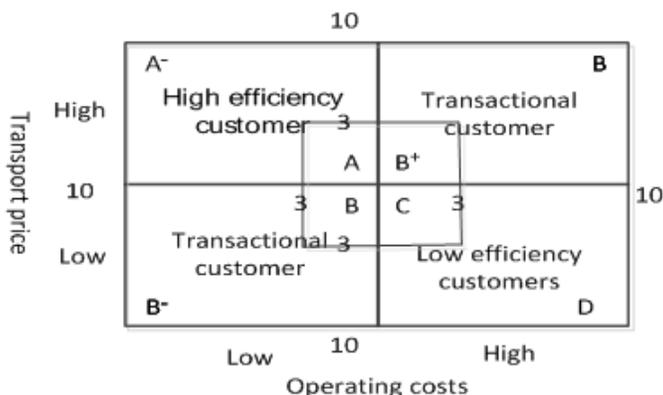


Figure 1-2 Customer classification matrix

High-efficiency customer refers to the customer from which the transportation operator can obtain a large profit, only considering the transportation cost and

transportation income. According to the principle of 20% customers and 80% profit creation, such customers are the main source of operating profit for transport operators.

Therefore, transportation operators should take an active attitude towards such customers and try to obtain more goods from them. In the high-efficiency customer group, customers with only one to three carriers are divided into class A. As the core customers of carriers, such groups are not only the main source of profits for carriers, but also the

long-term strategic partners for transport operators to maintain their conventional businesses. Similarly, the classification of customers can be divided into A, A-, B+, B, B-, C and D categories from the highest to the lowest. The corresponding customer adjustment coefficient ω is shown in the following table.

Table 1-2 the customer types and its adjustment coefficient

customer type	ω	Characters
A	0.999	Large-scale enterprises with Long-term stable cooperation, high reputation of strategic partners, bring long-term profits to the company.
A ⁻	0.998	Large-scale enterprises with Long-term cooperation , bring higher profits to the company, but the cooperation has a long periodic interval
B ⁺	0.996	Large-scale enterprises with Long-term cooperation , good reputation, adequate supply, strong ability to pay
B	0.995	Periodic cooperation, development potential, good reputation, medium cargo volume
B ⁻	0.993	Occasional cooperates, development potential is general, supply quantity is less , general profit
C	0.992	Enterprise scale is big, the quotation is low, the quantity of goods is big but the profit is low
D	0.990	Special transportation needs, high customer requirements, high risk, low profit

IV. CASE STUDY

4.1 DATA COLLECTION

Paper takes Busan of South Korea, Nagasaki of Japan, Manila of the Philippines and Danang of Vietnam as the starting port, and the transit station is the main coastal port of China. For the cargoes from Japan and South Korea, it is also considered to be transited into China in Vladivostok. For Laos, Vietnam and north Korea, which border China on land can also transit into China by road.

China and north Korea already have three transit railways, the Shendan line, the long map line and the Meiji line. The border stations connected with Vietnam railway

stations are Pingxiang station and Hekou station. Laotian goods can be transported through Kunming to central Asia and Europe, or by land to Vietnam and then by water to China.

The demand areas are mainly central Asian countries and European countries. According to the general line network transport sections except China are basically the same, and the countries that pass through are Mongolia, Kazakhstan, Russia, Ukraine, Uzbekistan, Turkmenistan, Turkmenistan, Iran, Turkey, Bulgaria, Romania, Hungary, Czech, Poland, Germany, etc.

Table 1-3the nodes of paths

Main port stations						
1	2	3	4	5	6	7
Busan	Nagasaki	Manila	Danang,	Dalian	Tianjin	Qingdao
8	9	10	11	12	13	14
Lianyungang	Shanghai	Qinhuangdao	Guangzhou	Hong Kong	Xiamen	Vladivostok
15	16					
Ningbo	Zhanjiang					
Main road stations						
17	18	19	20	21	22	23
Dandong	Tumen	Pingxiang	Hekou	Shenyang	Harbin	Mudanjiang
24	25	26	27	28	29	30

Changchun	Chengde	Peking	Jinan	Nanjing	Xuzhou	Hangzhou
31	32	33	34	35	36	37
Wuhan	Hefei	Zhengzhou	Xi an	Baoji	Lanzhou	Jining
38	39	40	41	42	43	44
Manchuria	Jinghe	Erlianhaote	Alashan pass	huoerguomu	Nanchang	Changsha
45	46	47	48	49	50	51
Chongqing	Chengdu	Suifenhe	Kunming	Nanning	Xinyizhou	Laos
52	53	54	55	56	57	58
Ulan Bator	Akdoka	Astana	Dostuk	Ulan uud	Moscow	Ukraine
59	60	61	62	63	64	65
Delaney	Istanbul	Sofia	Belarus	Czech	Warsaw	Berlin

4.2 NETWORK MAPPING OF DIFFERENT DEMAND FLOWS

The main export ports in China include Alashan pass, Erlianhaote, Manchuria and Suifenhe. There are three main lines of transportation routes, two of them are, the northern and southern routes of the new Eurasian continental bridge. They arrive in Moscow, Russia via the Mongolian and Siberian railway, and then go to Europe,

leaving from Alashan pass. The other line goes from Manchuria and Suifenhe to Europe along the Siberian land bridge. Because of the long distance between the origin and destination of transit goods transportation, this paper mainly considers combined transportation or railway transportation. Select transit nodes of railway, highway and waterway routes and draw the transport network diagram, as shown in figure 1-3.

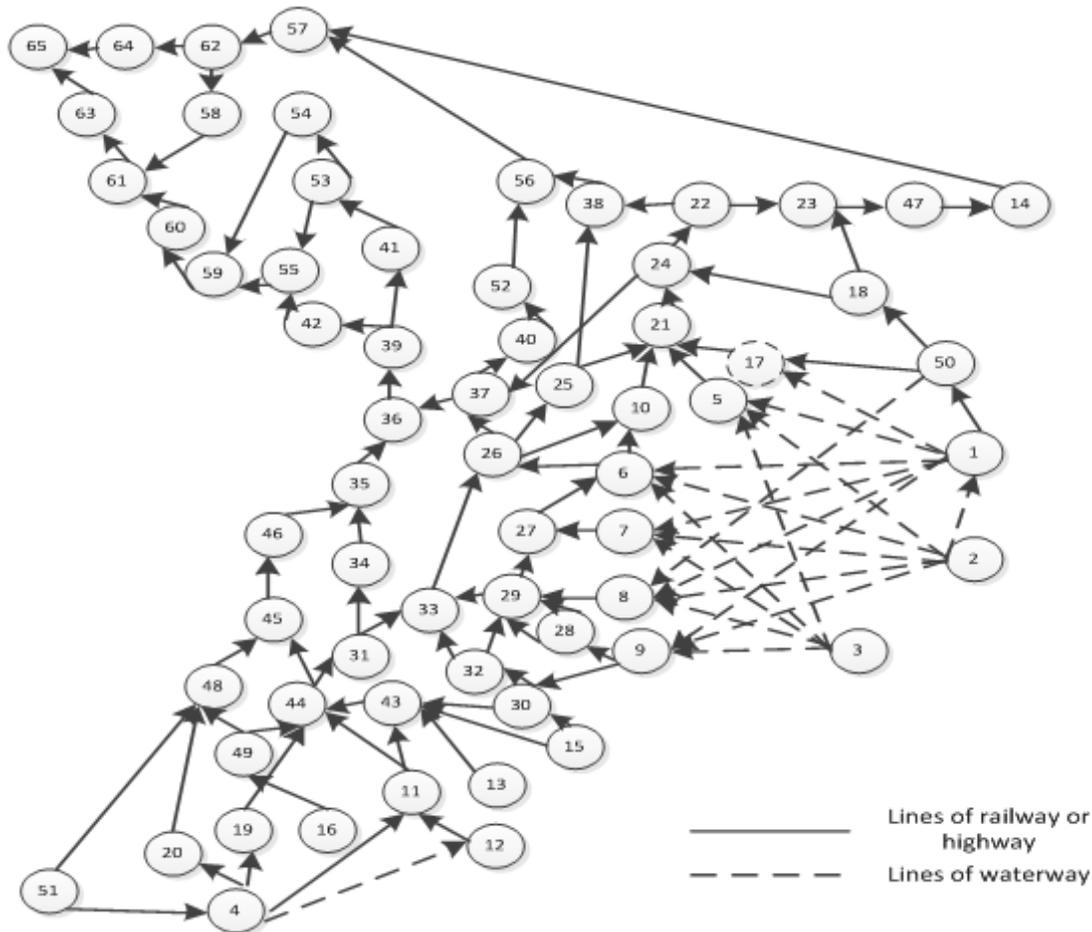


Figure 1-3 Node network diagram

4.3 HYPOTHESIS

In this paper, container is selected as the object of study, and the volume is assumed. The destination city and the type of cargo transport are unified. Based on the main types of goods exported from each country, it is assumed that an existing batch of goods from each country need to be transported to Berlin, Germany, with a total weight of 250 tons, loaded in standard 20-foot containers. Since the total freight volume is large and the transport distance is long, the main consideration is railway transport, road

transport or sea transport. The corresponding transport speed is 60km/h, 30km/h and 80km/h respectively. Suppose that when the transportation plan is drawn up, the customer requires the goods to arrive at the destination within 10-15 days.

(1) Determination of transportation cost

⊕ Railway container transport

The freight shall be calculated as: Container freight rate = (Base price 1 + base price 2 x kilometers) x discount rate

Table 1-4 standard freight rate of container railway transport

category	size	base price 1		base price 2	
		unit	Standard	unit	Standard
container	20 feet	CNY/container	440 .000	CNY/container*kilometer	3.185
	40 feet	CNY/container	532 .000	CNY/container*kilometer	3.357

Data source: notice of China Railway Corporation on adjustment of freight rate of railway containers

Table 1-5 discount rates for transit rail freight in China

path	20 GP	40 GP	First class carload	Second class carload
harbor to Erlianhaote	0.6	0.5	0.5	0.7
Erlianhaote to harbor	0.6	0.5	0.5	0.7
To Alashankou pass	0.5	0.4	0.4	0.7
Other paths	0.4	0.4	0.45	0.7

Data source: China Railway Corporation announced

The collection of other fees is shown in table 1-6.

Table 1-6 China railway electrification additional rate and construction fund rate

	construction fund rate (CNY/container*kilometers)	electrification additional rate (CNY/container*kilometers)
20 GP	0.528	0.16
40 GP	1.122	0.34

Data source: China Railway Corporation announced

Information of conversion and reloaded: Kazakhstan, Mongolia, Russia, Ukraine and Belarus use 1520mm wide rail , while other countries have a gauge of

1435mm. Therefore, the cargo should be converted or reloaded at the border station when going to the neighboring countries.

Table 1-7 Charges for handling operations of railway container cargo

Comprehensive conversion cost (CNY/container)	Truckage (CNY/container)	
	Within 50 meters	50~100meters
20 GP	150	45
40 GP	225	67.5

Source: China Railway Freight website

Other countries, if the country along the way belongs to international cargo association, Charge according "unified freight rate". If not, through literature review, the transit rate is 3.15 CNY/container (\$0.50 / container), and the cross docking fee is 200 CNY/container.

⊕ Road transport

The calculation method of container freight is as follows: container freight = (container maintenance charge + container freight charges x chargeable kilometer) x number of chargeable containeres. For long-distance freight routes, the international container freight price of

highway shall be calculated according to Chinese national unified basic freight price, as shown in table 1-8. The basic freight rate and container maintenance shall be calculated.

The starting charging kilometers is 5km, and for those less than 1 km, it shall be calculated as 1km.

Table 1-8 Road Freight rates

	freight charge (CNY/container*kilometer)	maintenance charge (CNY)	Transfer & storage charge (CNY/container*day)
20 GP	6	30	2~3
40 GP	9	46	4~6

Data source: Ministry of Transport announced

In addition to the transport charge, if the customer fails to pick up the goods in the specified time, the goods shall be stored in the cargo yard. The free stockpiling time is 3 days, and the storage charge from the fourth day to the picking up day, according to the unified price, shall be calculated at 30 CNY/hour.

3 water transport

Marine container freight = freight * volume + surcharge

The container freight from Chinese ports to other ports, as shown in table 1-9, and the shipping cost from Dalian, Qingdao, Lianyungang and Shanghai to Japan, South Korea and the Philippines is calculated by Excel.

Table 1-9 container rates from Chinese ports to other ports

| Freight charge (USD/TEU) |
|---------------------------|---------------------------|---------------------------|---------------------------|
| 1~5 | 133 | 2~10 | 150 |
| 1~6 | 175 | 2~11 | 290 |
| 1~7 | 110 | 2~12 | 260 |
| 1~8 | 120 | 2~13 | 200 |
| 1~9 | 115 | 3~5 | 390 |
| 2~5 | 145 | 3~6 | 430 |
| 2~6 | 175 | 3~8 | 350 |
| 2~7 | 130 | 3~9 | 280 |
| 2~8 | 135 | 4~9 | 320 |
| 2~9 | 100 | 4~12 | 120 |

Data source: <http://www.jctrans.com/>

Reloading cost have nothing to do with kilometer, without considering the time consumption of reloading caused by exchanging equipment and natural elements. It

assumed that the cost for changing outfits at each station is same. The conversion costs and time assumption of different transport modes are shown in table 1-10.

Table 1-10 conversion costs and time assumption of different transport modes

transport modes	railway (CNY/container , h/container)	highway (CNY/container , h/container)	shipping (CNY/container , h/container)
railway	-	1000/2	1000/2
highway	1000/2	-	2000/1
shipping	1000/2	2000/1	-

Data source: Literature review

(2) Distance between nodes

In the transport section of other countries, except for the transportation between the entry station and the terminal station of the destination country, it is basically

railway transportation. The railway and highway distance between the nodes, and the distance between some main ports in China are shown following chart.

Table 1-11 distance between major nodes (unit: km)

interval	distance	interval	distance	interval	distance	interval	distance
1~5	1011	3~5	2884	6~10	303	9~7	748
1~6	1274	3~6	3147	6~11	2785	9~8	719
1~7	917	3~8	2628	7~5	517	9~10	1274
1~8	952	3~9	2069	7~8	187	10~5	315
1~9	893	4~9	2402	7~9	748	10~6	303
2~5	1069	4~12	943	7~10	699	10~7	699
2~6	1332	5~6	485	7~11	2237	10~8	823
2~7	974	5~7	517	8~5	628	10~9	1274
2~8	998	5~8	628	8~7	187	10~11	2691
2~9	830	5~9	1030	8~9	719	11~5	2504
2~10	1263	5~10	315	8~10	823	11~6	2785
2~11	2154	5~11	2504	8~11	2200	11~7	2237
2~12	1080	6~5	485	9~5	1030	11~8	2200
2~13	1511	6~9	1287	9~6	1287	11~10	2691

Data source: China maritime services network

4.4 RESULT

(1) Transport paths

LINGO software is used to calculate cost and time of the transport between each section, as follows

① The transportation route of goods from Korea



Total transportation cost: 322728.3 CNY.
Total transport time: about 13 days, within the agreed time.

② The transportation route of goods from Japan



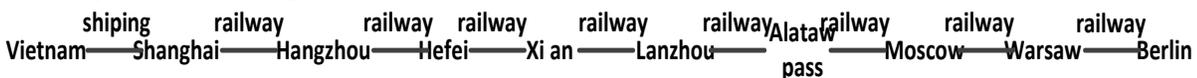
Total transportation cost: 335883 CNY.
Total transport time: about 14 days, within the agreed time.

③ The transportation route of goods from Philippines



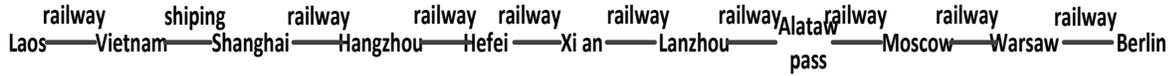
Total transportation cost: 317694.5 CNY.
Total transport time: about 13 days, within the agreed time.

④ The transportation route of goods from Vietnam



Total transportation cost: 326572.6 CNY.
Total transport time: about 13 days, within the agreed time.

⑤ The transportation route of goods from Laos



Total transportation cost: 342322.6 CNY.
 Total transport time: about 15 days, within the agreed time.
 6 The transportation route of goods from North Korea



Total transportation cost: 297178.4 CNY.
 Total transport time: about 9 days, one day ahead and no storage charge.

4.5 CALCULATION OF EARNINGS

According to the pricing model described above, re-price a company's container transport from North Korea to Germany in March.

(1) Benchmark rate

The transit distance is between 7,500 and 8500

and the freight rate of 20-foot containers is about 35492.8 yuan/container (5460.6 Swiss francs/container, or 3.31 yuan/container km), according to the uniform price. Setting the regulation coefficient of cargo property according to the container type and cargo type.

Table 1-12 cargo property adjustment coefficient

20'			40'	
Empty container	Heavy container	Refrigerated Container	Empty container	Heavy container
0.5	1	1.2	1	1.5

The container is 20 feet in the case, so the cargo nature adjustment coefficient 2 is set to 1. The adjustment coefficient of supply and demand is set to 0.99 to ensure stable fluctuation of price. What is more, according to China Container Transport Market Analysis report, it is found that the container market freight rate dropped in March, set to 0.99.

The average price of each freight company in March was 35750 CNY/container, set as the alternative price Q, for reference. Due to the competitiveness of other freight company is not strong, so set the price regulation coefficient μ_{max} to 1, the lower limit adjustment coefficient μ_{min} to 0.95.

In conclusion, the base price P0 can be calculated, is 34786.5 yuan/container.

(2) Determine the actual freight

Firstly assumed that the operator can provide sufficient capacity and set the adjustment coefficient ϵ according to the volume and distance. The freight volume provided by the customer in this case is more than 300,000 (tons *kilometers), so the ϵ is set to 0.995.

The actual freight is 34266.4 yuan per container, and the total income is 342664 yuan.

From the results of the model, compared with the actual price of 3.15 yuan/container*kilometer, the profit obtained by the proposed pricing method in the paper has increased by 4,921 yuan, which is better than the cost-based pricing. If the base freight is 35492.8 yuan/container, set as actual freight, income is relatively small. However it

can achieve long-term cooperation and maintain good relationships with class B customer. About 80% of customers belong to class B customers, with the increase of the customer base, the method will lead to more advantages than the original pricing method.

V. CONCLUSION AND PROSPECT

5.1 CONCLUSION

In this paper, the transportation channels of different transportation modes are sorted and the overall node network is drawn by using Visio mapping software. Based on the idea of revenue management, this paper proposes to re-establish the transit transport pricing model with the goal of maximizing revenue, taking into account the change of market supply and demand, market competitiveness and other factors. Referring to the differentiated pricing method, the customer is classified and the actual freight price is finally determined, according to the type of goods and the actual transport demand.

Based on the idea of graph theory and the most short circuit problem, the path selection model is established by taking the cost minimization as the target and the transport time relation as the constraint condition. For the circular route, the freight cost of starting point to reach the key node in two different directions is the same, the position of key point is determined, and the appropriate transportation path is determined according to the position relation between destination and key node.

Taking Japan, Korea, Vietnam, Laos and other neighboring countries as the starting place and Germany as the terminal station, the optimal transportation routes were calculated correspondingly

An case is also solved, proving the transit transport pricing model can bring more profit to the operator.

The research in this paper responds to the trend of trade internationalization and the "One Belt And One Road" strategy, improving the efficiency of transit freight transport, and providing certain reference for operators to formulate transport strategies and get more profit.

5.2 DEFICIENCY AND PROSPECTION

This paper study on the pricing and route scheme of transit transportation, which can also be made from the following aspects: The profit of transportation demanded by multiple customers at the same time. Considering the influence of traffic flow, risk factor and other factors on transportation. The route selection model would be perfected, if further studied the transportation route optimization of foreign sections.

REFERENCES

- [1] Michail Litvinenko & Ramūnas Palšaitis. (2006). The evaluation of transit transport probable effects on the development of country's economy. *Transport*, 21(2), 135-140.
- [2] Liu W, He M, & Sun Y, et al. (2009). Analysis of characteristics and influence factors of demands on transit transport. *Eighth International Conference of Chinese Logistics and Transportation Professionals*, 676-683.
- [3] Nuzzolo A, Crisalli U, & Comi A. (2009). A demand model for international freight transport by road. *European Transport Research Review*, 1(1), 23-33.
- [4] Ramūnas Palšaitis, Darius Bazaras, & Gintautas Labanauskas. (2004). The comparative analysis of lithuanian and latvian transit transport. *Transport*, 19(1), 9-14.
- [5] Bulis A & Škapars R. (2013). Development of international freight transit in latvia. *Procedia -Social and Behavioral Sciences*, 99(6), 57-64.
- [6] Almetova Z, Shepelev V, & Shepelev S. (2016). Cargo transit terminal locations according to the existing transport network configuration. *Procedia Engineering*, 150, 1396-1402.
- [7] U. Brännlund, P. O. & Lindberg, A. NÖU, et al. (1998). Railway timetabling using lagrangian relaxation. *Transportation Science*, 32(4), 358-369.
- [8] Anghinolfi D, Paolucci M, & Sacone S, et al. (2011). Integer programming and ant colony optimization for planning intermodal freight transportation operations. *Automation Science and Engineering. IEEE*, 214-219.
- [9] Q. Meng, (2015). Itinerary provision and pricing in container liner shipping revenue management. *Transportation Research Part E: Logistics and Transportation Review*, 77, 135-146.
- [10] Xie Y, Liang X, Ma L, et al. (2017). Empty container management and coordination in intermodal transport. *European Journal of Operational Research*, 257(1), 223-232.
- [11] Martín E, Salvador J, & Saurí S. (2014). Storage pricing strategies for import container terminals under stochastic conditions. *Transportation Research Part E: Logistics and Transportation Review*, 68, 118-137.
- [12] Crevier B, Cordeau J O, & Savard G. (2012). Integrated operations planning and revenue management for rail freight transportation. *Transportation Research Part B: Methodological*, 46(1), 100-119.
- [13] G. Wilmsmeier, J. Monios, & B. Lambert. (2011). The directional development of intermodal freight corridors in relation to inland terminals. *Journal of Transport Geography*, 19, 1379-1386.
- [14] Šakalys R, & Batarlienė N. (2017). Research on intermodal terminal interaction in international transport corridors. *Procedia Engineering*, 187, 281-288.
- [15] Sui M, Shen F, & Wei H, et al. (2010). Logistics route planning with geographic data considering multiple factors. *International Conference of Logistics Engineering and Management*, 2346-2352.
- [16] Ireland P, Case R, & Fallis J, et al. (2004). The Canadian pacific railway transforms operations by using models to develop its operating plans. *Interfaces*, 34(1), 5-14.