

# *Research on Optimization and Integration of Railway Logistics Resources in China*

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**ABSTRACT**—The optimal allocation of railway logistics resources is the current key issue confronted by China's railway industry. Under this background, this paper researches this issue along the route of motivation → mechanism → model → evaluation. Based on the research of internal development needs of railway logistics resources and motivation of external social needs, this paper analyzes the effect of dynamic factors generated by different resources on the logistics system, provides a direction for the optimization and integration of resources, establishes a multi-objective nonlinear programming model based on customer utility, and uses Lagrange multiplier form to explain the coupling relationship between corresponding services for customer needs and types of logistics resources. Combined with the relevant data of railway logistics in China Traffic Yearbook in 2000 to 2009 processed by DEA model, the coordination validity coefficient-Cs, development validity coefficient-Ds and comprehensiveness validity coefficient-Ss are used to represent the optimization effect of railway logistics resources in timing sequence. The research results show that China's railway logistics resource system is at the stage of increasing returns to scale. There is a need to take measures to strengthen resource integration and increase investment scale, so as to ensure the sustainable development of railway logistics system.

**Keywords**—dynamic factors; integration of resources; multiplier effect; multi-objective programming; validity coefficient

## I. INTRODUCTION

The rational allocation, optimization and reconstruction of railway logistics resources have a far-reaching strategic significance for the railway development. The Eleventh Five-Year Plan clearly points out that, "there is a need to make the resource conservation as the basic national policy, develop recycling economy, protect ecological environment and accelerate the construction of resource-saving", "promote the fundamental transformation of economic growth mode as a focus point, and promote the transformation of economic growth driven by increasing resource investment into mainly relying on the resource use efficiency". Based on the above requirements of national strategic development, the optimal utilization of railway logistics resources has become a key issue confronted by the railway industry.

The railway logistics system is a subsystem of the major logistics system [1]. For the optimization and integration of resources, it is necessary to follow the rules of logistics system

operation. Predecessors have conducted detailed researches of the planning layout of railway terminal [2], calculation of transportation capacity [3] and transportation organization method [4] and so on. In recent years, the relevant research literatures also are gradually increasing. For example, Lei Zhonglin [5] (2015) constructed a comprehensive evaluation index system for the railway terminal planning scheme and established a set of quantitative evaluation and calculation methods through combination with subjective weights and entropy weights and fuzzy evaluation methods; Lu Hongbing [6] (2016) put forward a new calculation method of railway network freight transportation capacity after comprehensive consideration of train marshalling plan and K short circuit, with the research object of bulk stable freight; Liu Yingwei [7] (2015) analyzed the adaptability of transportation capacity of Shengang Station through the station bottleneck of Shengang Station, arrival-departure track, interval and dispatching locomotive capacity, and finally put forward a reasonable arrangement. The above researches are indirectly involved in the railway logistics resources, but not directly discussing the issue of resources and the issue of optimal allocation of resources. This paper conducts researches from four aspects: motivation, mechanism, technology and evaluation of the optimization of railway logistics resources, in order to provide guidance for the optimal allocation of railway logistics resources.

## II. OPTIMIZATION OF RAILWAY LOGISTICS RESOURCES

Railway logistics system is one of numerous logistics systems. Its components and operating guidelines depend on overall planning and organic coordination, which should be goal-oriented and driven by integration and optimization of resources, aiming at promoting the healthy operation and sustainable development of the system [8]. There are many influencing factors of the railway logistics system operation, which are roughly divided into two kinds of influencing factors, namely, assistance factors and resistance factors. The coupling result of two factors is the final driving force of the development of railway logistics. The source of constituting influencing factors lies in the rational allocation of logistics resources.

This paper analyzes and explores the motivation of resource optimization and the mechanism of resource optimization based on the assistance or resistance factors

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generated by the railway logistics resources. Maintaining the integrity of the Specifications.

A. Motivation analysis

Numerous complex railway logistics resources are subject to policy, economy, culture and technology, and also driven by policy, economy, culture and technology. To optimize resources, it is necessary to comprehensively consider above four factors. Among them: the economic field involves in more content, the most prominent is market demand, and a large market demand can generate assistance, and vice versa; the political field mainly involves in the domestic logistics policy and worldwide economy uniformity. In order to develop the domestic economy, most of political factors are impetus; the technical field involves in the means and tools of resource optimization. The ultimate purpose of resource optimization is to continuously enhance the core competitiveness of railway logistics and achieve the sustainable development of the railway. Based on the historical development process of railway logistics and the current status of railway logistics, this paper summarizes the force factors affecting the survival and development as shown in Table 1.

TABLE I. LIST OF DYNAMIC FACTORS OF SUSTAINABLE DEVELOPMENT LEVEL OF RAILWAY LOGISTICS

No. of dynamic factors	Description	Symbol
1	Motive force of logistics market demand	F1
2	Driving force of railway development, namely, internal driving	F2
3	Impetus of worldwide economy uniformity and domestic logistics policy	F3
4	Competitive pressure of railway logistics	F4
5	Constraint force of resources	F5
6	Gravity increased by scale and system to the development of railway logistics	F6

The sustainable development level of railway logistics is the result of the combined action of above six dynamic factors, which can be described by the engineering mechanics model as shown in Equation (1):

$$Z = f(F_1, F_2, F_3, F_4, F_5, F_6, t) = f\{F_i, t\}, i = 1, 2, \dots, 6 \quad (1)$$

In Equation (1), Z represents the sustainable development level of railway logistics; t represents the development time of railway logistics. The situation of combined action of above six forces is shown in Figure 1:

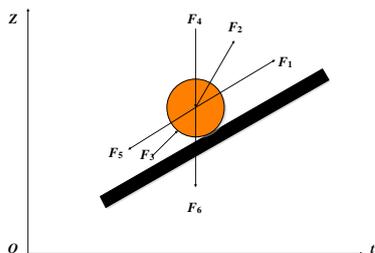


Fig. 1. Schematic diagram of the role of various dynamic factors of railway logistics

According to the marginal analysis theory of economics:

$$\frac{\partial Z}{\partial F_i} > 0, i = 1, 2, 3 \quad \frac{\partial Z}{\partial F_i} < 0, i = 4, 5, 6 \quad (2)$$

According to Figure 1 and Equation (2), F1~F3 represent momentum; F4~F6 represent resistance. The second-order partial derivatives of the power package are further solved:

$$\frac{\partial^2 Z}{\partial F_i \partial F_j} > 0, i \neq j, i, j = 1, 2, 3 \quad (3)$$

According to Equation (3), F1~F3 are not isolated, with partial substitution effect, and both have a multiplier effect.

According to the theory of resource-based view, the system is a collection of resources, and various factors of the system are caused by the utility of resources, or the coupling representation of resource efficiency. For example, F1 is caused by centralized driving of the customer resources, then:

$$F_i = \varphi(x_{ij}), j = 1, 2, \dots, n \quad (4)$$

In Equation (4),  $\varphi$  is a correspondence, a relationship between the effects of j-th resource on i-th dynamic factor;  $x_{ij}$  is a quantity of resources, j-th quantity of resources under i-th dynamic factor. According to Equation (1) and (4), at t moment, the action function of j-th resource on i-th dynamic factor for the railway logistics development level is shown in Equation (5):

$$Z = f\{F_i, t\} = f\{\varphi(x_{ij}), t\}, i = 1, 2, \dots, 6; j = 1, 2, \dots, n \quad (5)$$

Equation (5) represents that the railway logistics development level under the timing sequence with the time as a reference system is a quantitative formula related to the timing sequence, and also has a strong correlation with resources. Resource efficiency presents certain fluctuations in time. To maintain a relative balance state of railway logistics system stress in different time zones, it is necessary to make a general survey of multiple variables, and there is a high complexity, constituting a difficulty in the comprehensive consideration of various factors.

B. Mechanism of action

For impetus  $F_i(i=1,2,3)$ , to integrate j-th resource, that is, to enhance the efficiency of  $x_{ij}(j=1,2,\dots,n)$ , to enhance the efficiency of resources, thus strengthening impetus  $F_i$ , then:

$$\frac{\partial Z}{\partial F_i} > 0, \frac{\partial F_i}{\partial x_{ij}} > 0 \Rightarrow \frac{\partial Z}{\partial x_{ij}} = \frac{\partial Z}{\partial F_i} \cdot \frac{\partial F_i}{\partial x_{ij}} > 0, j = 1, 2, \dots, n \quad (6)$$

For resistance  $F_k(k=4,5,6)$ , to integrate j-th resource, that is, to enhance the efficiency of  $x_{kj}(j=1,2,\dots,n)$ , to enhance the efficiency of resources, thus reducing resistance  $F_k$ , then:

$$\frac{\partial Z}{\partial F_k} < 0, \frac{\partial F_k}{\partial x_{ki}} < 0 \Rightarrow \frac{\partial Z}{\partial x_{ki}} = \frac{\partial Z}{\partial F_k} \cdot \frac{\partial F_k}{\partial x_{ki}} > 0, j = 1, 2, \dots, n \quad (7)$$

According to Equation (6) and (7), after integration of

logistics resources, it is very beneficial to enhance the core competitiveness of logistics system or promote the development of logistics. Similarly, the situation after coupling of several motivation factors, that is, the multiplier effect can be analyzed. Considering driving  $F_i(i=1,2,\dots,6)$  two kinds of resources  $(h,j)$ , there is correspondence as shown in Equation (8):

$$F_i = \varphi(x_{ih}, x_{ij}), h, j = 1, 2, \dots, n \ \& \ h \neq j \quad (8)$$

Through summary and analysis, the railway logistics system is subject to the force generated by various resources, that is, the macro-direction presented by the system, that is, the resultant external force of the system. When the comprehensive resources are increased, the absolute value of the resultant external force will increase, then:

$$\frac{\partial^{(n)}Z}{\partial x_{i1} \partial x_{i2} \dots \partial x_{in}} = \frac{\partial Z}{\partial F_i} \left[ \sum_{j=1}^n \frac{\partial F_i}{\partial x_{ij}} \right] > 0, i = 1, 2, \dots, 6; j = 1, 2, \dots, n \quad (9)$$

The dynamic factors generated by resources under different backgrounds are coupled under the effect of multiplier effect, and involve in the enhanced relationship between integrated resources. The result of integration is the enhancement of functions, rather than the addition of original functions, that is, the integration is effective.

The above visual representation analyzed can be illustrated as shown in Figure 2.

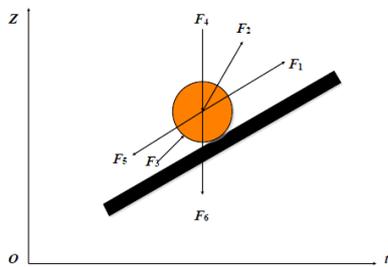


Fig. 2. Schematic diagram of mechanism of action of integration of railway logistics resources

Finally, combining time  $t$ , within  $\Delta t$  time, no matter how the state of system start, through a profound analysis of the effect of dynamic factors generated by each kind of resource, by using scientific optimization technology, the coupling and optimal allocation of various dynamic factors enable the system to operate efficiently and orderly, and enhance the overall efficiency of system on the basis of reducing costs.

Through reallocation of the content and structure of application resources, the system development is promoted to a new peak, thus the inherent laws of integration of railway logistics resources:

$$\Delta \frac{\partial Z}{\partial x_{ij}} = \Delta \frac{\partial f}{\partial F_i} \cdot \frac{\partial F_i}{\partial x_{ij}} > 0, i = 1, 2, \dots, 6; j = 1, 2, \dots, n \quad (10)$$

### III. MULTI-OBJECTIVE MODEL OF LOGISTICS RESOURCE OPTIMIZATION AND ITS SOLUTION

Logistics system is comprised by organic combination of various resources. The primary task of its optimization is to select optimization objectives. The selection of optimization objectives should be based on the evaluation indicators of the logistics system operation conditions [9, 10]. The merits and demerits of logistics system operation conditions are reflected by its effect, efficiency and social value. On this basis, the effect and efficiency should be the objective of logistics resource optimization. Secondly, it is necessary to seek for the optimal objective under certain rules, while these rules are the technical constraints of the objective. Only under the premise of technical constraints can ensure the scientific, fair, reasonable and sustainable development of logistics.

To sum up, the goal orientation of logistics should be restricted by social rules and economic rules, and their balance is the optimal state. The relationship between effect, efficiency, society and economy is shown in Figure 3:

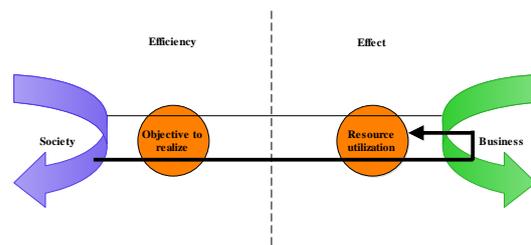


Fig. 3. Attributes of modern logistics objective system (efficiency and effect)

#### A. Modeling

Considering a logistics system,  $M$  logistics resources own  $n$  kinds of resources, and the market has  $N$  logistics service providers provide  $m$  customers with  $S$  logistics services through the integration of logistics resources. Based on the analysis of attributes of modern logistics objective system, the efficiency depends on the degree of satisfaction of the logistics demanders to the products, which is called as the utility level of the customer here; assuming that the output level of logistics services is increasing, if its investment level after the optimal allocation of resources presents a decreasing trend, due to failure to determine the exact quantitative relationship of this trend, this paper introduces an implicit function to describe the relationship between them. The function is positive and quasi-convex in nature. In addition, assuming that the resources can be optimized according to the rules of constraints, the logistics market can still present a balanced state to a certain extent, that is, it will not cause market fluctuations.

When each customer consumes all the resources of the railway logistics system and original resources provided, the service providers should use existing logistics resources to provide demanded services for the customer, in order to obtain the highest customer satisfaction, namely, the maximum utility. The multi-objective programming model based on the maximum utility is shown in Equation (11).

In Equation (11),  $x_{qj}^0$  is the fixed possession quantity of  $j$ -

th resource owned by  $q$ -th resource owner;  $x_{qj}^*$  is the quantity of  $j$ -th resource provided by  $q$ -th resource owner to the service provider;  $y_{hk}$  is  $k$ -th logistics service quantity provided by  $h$ -th service provider;  $y_{ik}^*$  is  $k$ -th logistics service quantity consumed by  $i$ -th customer;  $U_i = U_i(y_{i1}^*, \dots, y_{is}^*, x_{i1}^0 - x_{i1}^*, \dots, x_{in}^0 - x_{in}^*)$ ,  $U_i$  is the utility function of the customer;  $x_{ij}^0 - x_{ij}^*$  is  $j$ -th logistics resource quantity consumed by the customer; the implicit function of production is  $F_h(y_{h1}, \dots, y_{hs}, x_{h1}, \dots, x_{hm}) = 0$ .

$$\begin{aligned} & \max \quad \{U_i\} \quad (i=1,2,\dots,m) \\ & \text{s.t.} \quad \begin{cases} F_h(y_{h1}, \dots, y_{hs}, x_{h1}, \dots, x_{hm}) = 0 \quad (h=1,2,\dots,N) \\ \sum_{q=1}^M x_{qj}^* = \sum_{h=1}^N x_{hj} \quad (j=1,2,\dots,n) \\ \sum_{i=1}^m y_{ik}^* = \sum_{h=1}^N y_{hk} \quad (k=1,2,\dots,s) \\ \sum_{q=1}^M (x_{qj}^0 - x_{qj}^*) = \sum_{h=1}^N (x_{hj}^0 - x_{hj}^*) \quad (j=1,2,\dots,n) \\ x_{hj} \geq 0, x_{qj}^* \geq 0, x_{ij}^* \geq 0, y_{ik} \geq 0, y_{hk} \geq 0 \end{cases} \end{aligned} \quad (11)$$

### B. Model solving

According to the effective solution, the solving of multi-objective is transformed into a single-objective. Given the utility level of all other customers  $U_i^0$ , considering the utility maximization of customer 1, Lagrange function is constructed:

$$\begin{aligned} Z = & U_1(y_{11}^*, \dots, x_{1n}^0 - x_{1n}^*) + \sum_{i=2}^m \lambda_i [U_i(y_{i1}^*, \dots, x_{in}^0 - x_{in}^*) - U_i^0] \\ & + \sum_{h=1}^N \theta_h F_h(y_{h1}, \dots, x_{hm}) + \sum_{j=1}^n \delta_j \left( \sum_{q=1}^M x_{qj}^* - \sum_{q=1}^M x_{hj} \right) \\ & + \sum_{k=1}^s \sigma_k \left( \sum_{h=1}^N y_{hk} - \sum_{q=1}^m y_{qk}^* \right) + \sum_{j=1}^n \rho_j \left( \sum_{q=1}^M (x_{qj}^0 - x_{qj}^*) - \sum_{q=1}^M (x_{ij}^0 - x_{ij}^*) \right) \end{aligned} \quad (12)$$

In Equation (12),  $\lambda_i, \theta_h, \delta_j, \sigma_k, \rho_j$  are Lagrange multipliers. Assuming that the first-order partial derivative of  $Z$  is 0, obtaining Equation (13):

$$\begin{cases} \frac{\partial Z}{\partial y_{ik}^*} = \lambda_i \frac{\partial U_i}{\partial y_{ik}^*} - \sigma_k = 0 \\ \frac{\partial Z}{\partial y_{hk}} = \theta_h \frac{\partial F_h}{\partial y_{hk}} + \sigma_k = 0 \\ \frac{\partial Z}{\partial x_{ij}^*} = -\lambda_i \frac{\partial U_i}{\partial (x_{ij}^0 - x_{ij}^*)} + \sigma_k = 0 \\ \frac{\partial Z}{\partial x_{hj}} = \theta_h \frac{\partial F_h}{\partial x_{hj}} - \delta_j = 0 \\ i = 2, 3, \dots, m; h = 1, 2, \dots, N; k = 1, 2, \dots, s; j = 1, 2, \dots, n. \end{cases} \quad (13)$$

The solving result of Equation (13) is shown in Equation (14):

$$\begin{aligned} \frac{\sigma_a}{\sigma_b} &= \frac{\partial U_1 / \partial y_{1a}^*}{\partial U_1 / \partial y_{1b}^*} = \dots = \frac{\partial U_m / \partial y_{ma}^*}{\partial U_m / \partial y_{mb}^*} = (RCS_{a,b})_i \\ &= \frac{\partial F_1 / \partial y_{1a}}{\partial F_1 / \partial y_{1b}} = \dots = \frac{\partial F_N / \partial y_{Na}}{\partial F_N / \partial y_{Nb}} = (RPT_{a,b})_h; \\ &(a, b = 1, \dots, s; i = 1, \dots, m; h = 1, \dots, N) \\ \frac{\sigma_c}{\sigma_d} &= \frac{\partial U_1 / \partial (x_{1c}^0 - x_{1c}^*)}{\partial U_1 / \partial (x_{1d}^0 - x_{1d}^*)} = \dots = \frac{\partial U_m / \partial (x_{mc}^0 - x_{mc}^*)}{\partial U_m / \partial (x_{md}^0 - x_{md}^*)} = (RCS_{c,d})_q \\ &= \frac{\partial F_1 / \partial x_{1c}}{\partial F_1 / \partial x_{1d}} = \dots = \frac{\partial F_N / \partial x_{Nd}}{\partial F_N / \partial x_{Nd}} = (RTS_{c,d})_h; \\ &(c, d = 1, \dots, n; h = 1, \dots, N; q = 1, \dots, M) \end{aligned} \quad (14)$$

Equation (14) is the solving result of optimization model. The result is coupling optimization of multi-objectives, such as consumption efficiency objective, efficiency objective of service portfolio, efficiency objective of resource integration and so on. In addition, Lagrange multiplier in Equation (14) is an efficiency price of the corresponding service for customer demand and railway logistics resources, which is a necessary condition of optimal Pareto.

(1) High efficiency in consumption: the replacement rate of the logistics service  $a$  and logistics service  $b$  enjoyed by each customer is equivalent, and there is an equivalence relation between the value form of logistics service  $a$  and logistics service  $b$ ;

(2) High efficiency in service portfolio: the conversion rate of the logistics service  $a$  and logistics service  $b$  provided by each logistics service provider is equivalent, and there is an equivalence relation between the value form of logistics service  $a$  and logistics service  $b$ ;

(3) High efficiency of resource integration: the technical replacement rate of the resource  $c$  requiring optimal allocation and resource  $d$  requiring reconstruction is equivalent for the logistics service providers in the integration process, and the ratio of the value form of two resources has an equivalence relation. If the logistics resource suppliers directly use the logistics services, there is no any change in the service replacement rate compared to an indirect way, and there is an equivalence relation between the value forms of these resources.

(4) Necessary linkage between integration decision and consumption decision: the replacement rate of any pair of services is equal to the conversion rate of one pair provided by all service providers, and they are equivalent in the ratio of service value forms.

## IV. VALIDITY EVALUATION OF LOGISTICS RESOURCE OPTIMIZATION

### A. Index selection and data acquisition

This paper selects 9 years from 2000 to 2009 as the decision-making unit. Design input index: railway rectification funds (RMB 100 million) -  $x_1$ ; number of in-service staff in railway transport (10,000) -  $x_2$ ; operation cycle of freight train (Day) -  $x_3$ ; design output index: operating kilometers of railways (10,000 km) -  $y_1$ ; ratio of the kilometers of complex line and electrified railway and total kilometers (%) -  $y_2$ ; total transport volume of freight trains (100 million tons) -  $y_3$ ; freight volume of freight trains in the freight cycle

(10 billion ton kilometers) -  $y_4$ ; daily freight volume of freight trains (ten thousand ton kilometers) -  $y_5$ . The above collected index data shown in Table 2 are from *China Traffic Yearbook*.

TABLE II. DATA SHEET OF VALIDITY EVALUATION OF RAILWAY LOGISTICS SYSTEM RESOURCE INTEGRATION (YEAR 2000-2009)

Year	Input index			Output index				
	x1	x2	x3	y1	y2	y3	y4	y5
2000	119.70	149.3	5.39	6.87	52.80	17.86	137.71	99.4
2001	141.60	145.3	5.08	7.01	58.18	19.32	146.94	99.9
2002	163.70	148.8	5.07	7.19	58.51	20.50	156.58	102.2
2003	165.64	148.1	5.05	7.30	59.46	22.42	172.47	105.8
2004	191.51	148.6	4.94	7.44	59.42	24.90	192.89	108.7
2005	218.34	148.7	4.92	7.54	60.63	26.93	207.26	110.6
2006	222.56	147.8	4.87	7.71	65.94	28.82	219.54	114.3
2007	220.79	144.9	4.76	7.80	67.32	31.42	237.97	120.4
2008	226.58	144.7	4.73	7.97	70.79	33.04	251.06	123.6
2009	226.81	145.1	4.68	8.60	80.23	33.20	252.39	128.6

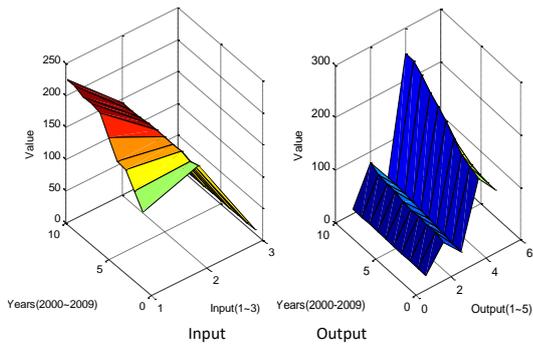


Fig. 4. Three-dimensional rendering trend of validity evaluation data

**B. Data processing and result analysis**

When  $\delta = 0$ , program (15) is *C2R* model; when  $\delta = 1$ , program (15) is *C2GS2* model. If the objective function value of the program model (15) is 1, then DEA is valid [11-13].

$$\begin{aligned}
 & \min h \\
 & \left\{ \begin{aligned}
 & \sum_{j=1}^n x_j \lambda_j + S^- = hx_0 \\
 & \sum_{j=1}^n y_j \lambda_j + S^+ = y_0 \\
 & \delta \sum_{j=1}^n \lambda_j = \delta \\
 & \lambda_j \geq 0; S^- \geq 0; S^+ \geq 0; \delta = 0 \text{ or } \delta = 1; j = 1, 2, \dots, n
 \end{aligned} \right. \quad (15)
 \end{aligned}$$

The integrated development validity is reciprocal of  $\sum_{j=1}^n \lambda_j^0$ . When the validity is 1, the integrated development is valid. When the validity is smaller than 1, the evaluation unit is at the stage of increasing returns to scale. When the validity is greater than 1, the evaluation unit is at the stage of decreasing returns to scale.

The calculation equation of the integration validity of the railway logistics system SS is:

$$S_s = C_s \times D_s \quad (16)$$

In Equation (16), CS is the coordination validity of the railway logistics system integration; DS is the development validity of the railway logistics system integration.

In the process of data processing, C2R(DS) type of the model (15) is first selected to calculate the validity coefficient of each year. These coefficients can be used to reflect the coordination validity and development validity of the railway logistics in the year. For  $\delta=1$  in DEA model, C2GS2 ( $D_\epsilon$ ) type of the model (15) is used to calculate the validity coefficient, and represent the coordination validity in a new form. The coupling validity of the logistics resource integration and optimization can be obtained through Equation (16). The calculation results of the validity coefficient are shown in Table 3:

TABLE III. COMPREHENSIVE VALIDITY OF RAILWAY LOGISTICS SYSTEM RESOURCE INTEGRATION AND OPTIMIZATION (YEAR 2000-2009)

Year	Validity coefficient			Year	Validity coefficient		
	Cs	Ds	Ss		Cs	Ds	Ss
2000	1.0000	1.0000	1.0000	2005	0.9737	1.1127	1.0834
2001	1.0000	1.0000	1.0000	2006	0.9794	1.0990	1.0764
2002	0.9824	1.0544	1.0358	2007	0.9989	1.0456	1.0444
2003	0.9848	1.0435	1.0276	2008	1.0000	1.0048	1.0048
2004	0.9825	1.0761	1.0573	2009	1.0000	1.0000	1.0000

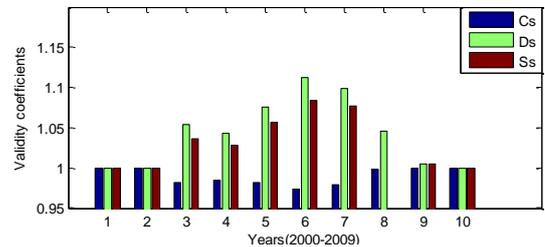


Fig. 5. Comprehensive validity of railway logistics resource integration and optimization based on timing sequence

According to the validity coefficient results of the railway logistics resources integration and optimization from 2000 to 2009, China's railway logistics resource allocation is generally better, which presents a optimal allocation validity in 2000, 2001 and 2009. When the comprehensive validity coefficient is greater than 1, it is necessary to take measures to strengthen integration, and it presents to be greater than 1 other than in 2000, 2001 and 2009, indicating that there is a need to continuously strengthen integration of China's railway logistics resources, in order to gain more output[14-15].

**V. CONCLUSION**

This paper researches the motivation, mechanism, model and evaluation of the railway logistics resource optimization, and obtains the following conclusions:

1) There are two motivations of the railway logistics resource optimization, one is internal motivation, that is, the development and efficient operation of railway system, and the other is external motivation, that is, the actual demand of customers and social value.

2) The mechanism of railway logistics resource optimization is to thoroughly understand the driving force and

resistance of resource contents to the logistics system operation, and integrate the synthetic effect of driving force and resistance by using the way of optimal allocation of resource structure, so as to achieve the efficient operation of the system and value embodiment.

3) The technical realization of the railway logistics resource optimization must rely on the multi-objective nonlinear programming mathematical model. The model optimization objective is the utility function of the customer. The technical constraints are the quantity of logistics resources, resource content, customer quantity, customer demand and socioeconomic status and so on.

4) The evaluation model of the operation condition of railway logistics system adopts DEA model. The coordination validity coefficient of the railway logistics, development validity coefficient and comprehensive validity coefficient in DEA model are used to represent the effect of logistics system operation in timing sequence.

The evaluation results of the validity coefficient based on the timing sequence show that, the overall optimal allocation of resources has a good condition. China's railway logistics resource system is at the stage of increasing returns to scale. To maintain sustainable and effective growth, it is necessary to strength integration of resources, and increase manpower and material resources for integration, thus obtaining higher values.

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