

# Research on Vehicle and Goods Matching Evaluation System based on Virtual Logistics Platform

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**Abstract.** This paper uses AHP, multi-objective matching and theoretical analysis to study the matching of vehicle and goods based on virtual logistics platform. This paper mainly analyzes the factors affecting the matching of vehicle and goods, and analyzes them from the perspective of vehicle and goods suppliers. Using the questionnaire method and the mean method, the weight value is obtained. Based on this, a vehicle-to-goods matching model based on virtual logistics platform is established.

**Keywords:** Virtual Logistics Platform; Vehicle and Goods Matching; Analytic Hierarchy Process; Multi-objective Matching.

## 1. Introduction

In recent years, China's logistics costs are still high. As an important mode of transportation, road transportation also occupies a large proportion. The study found that one of the main reasons for the high logistics costs is the idle and empty driving of the vehicle. An important reason for this happening is the poor communication of information. Therefore, we carry out informationization and build a vehicle and cargo matching platform to improve this situation. However, most of the current cargo matching platforms are in the initial stage of development, mainly to exchange data, to achieve information query and release, and can not find the potential demand of both parties. And the platform only provides information on the source of the vehicle and the source of goods. The real information inquiry and the decision to match the goods are determined by the owner and the owner of cargo. Based on this, we thoroughly study the factors affecting the matching of vehicle and goods, improve the matching efficiency of vehicle and goods, and reduce logistics costs.

## 2. Analysis of the Influencing Factors of Vehicle and Cargo Matching

### 2.1 Problems with the Cargo Matching Platform

In recent years, due to the development of the freight market and the importance attached to the freight market, the matching of goods has become one of the hot topics in the logistics industry in the past two years. However, with the development of the vehicle-to-goods matching platform, many problems have arisen, such as low development level, imperfect functions, and no intelligent and mature vehicle-matching platform. It is difficult for the owners and shippers to establish a trust relationship. Matching resources are very limited and marketing and retention are difficult. Based on this, the research on the cargo matching model of our virtual logistics platform is very necessary.

### 2.2 Car Goods Matching Factors

In order to build a vehicle-to-goods matching platform that satisfies both the owners and shippers, it is necessary to conduct a screening survey on factors that affect the owners and shippers of the vehicle. Through the investigation of relevant literature and related vehicle-matching platforms, it is determined that there are three main factors affecting the choice of the owners and shippers: time, economy and safety. The following is a detailed introduction to each factor.

(1) Time factors: The time factor mainly refers to the degree of compliance between the actual time and the time required by the order in the process of matching the goods. Specifically, it includes the timeliness of stocking, the timeliness of signing, the timeliness of order processing, the timeliness

of dispatching vehicles, the timeliness of loading, the timeliness of signing, and the timeliness of matching goods and goods.

(2) Economic factors: Economic factors mainly mean creating value, reducing costs and improving services. These include transportation prices, transportation routes, vehicle condition requirements, logistics cost factors, cargo characteristics and in-transit safety costs.

(3) Security factors: The safety of cargo matching is mainly the credibility of the service, reliability, safety of goods and vehicles, and so on. Specific factors include the level of qualifications, the level of credibility, the credibility and security of information, and the safety of vehicles and goods.

### 2.3 Analysis of the Weight of Influencing Factors

The weighting value of the factors affecting the matching of goods and goods is determined by using the analytic hierarchy process.

Analytic Hierarchy Process (AHP) is a decision analysis method that combines qualitative and quantitative solutions to solve complex problems of multiple objectives. Its basic principle is to evaluate the scheme according to the target, sub-objective (criteria), constraints, department, etc. with hierarchical structure, determine the judgment matrix by means of pairwise comparison, and then take the component of the largest eigenvector of the judgment matrix as the corresponding .The coefficients are finally combined to give the weight of each scheme.

Car goods index system:

**Table 1. Total ranking table of index weights (car source side)**

Target Layer	Criteria Layer	Weight	Sub-criteria Layer	Single Sort Value	Total Sort Value
Level A on vehicle and goods matching (car source side)	Temporal factor C1	0.105	Timeliness of stocking D11	0.701	0.074
			Source party signing timeliness D12	0.097	0.010
			Source party order processing timeliness D13	0.202	0.021
	Economic factor C2	0.637	Shipping price D21	0.606	0.386
			Transport route D22	0.092	0.059
			Cargo requirements D23	0.210	0.134
			Logistics cost factor D24	0.092	0.059
	Safety factor C3	0.258	Source of Qualification Level D31	0.414	0.107
			Source of credit level D32	0.414	0.107
			Credibility and security of source information D33	0.063	0.016
			Vehicle safety D34	0.109	0.028

**Table 2. Total ranking table of indicator weights (shipper)**

Target Layer	Criteria Layer	Weight	Sub-criteria Layer	Single Sort Value	Total Sort Value
Level A on vehicle and goods matching (shipper)	Temporal factor C1	0.2	Send timeliness D11	0.606	0.121
			Loading timeliness D12	0.210	0.042
			Car owner signing timeliness D13	0.092	0.018
			Owner's goods match the order and timeliness D14	0.092	0.018
	Economic factor C2	0.6	Shipping price D21	0.606	0.364
			Transport route D22	0.092	0.055
			Car condition requires D23	0.210	0.126
			Safety cost in transit D24	0.092	0.055
	Safety factor C3	0.2	Owner's qualification level D31	0.414	0.083
			The owner's credit level D32	0.414	0.083
			The credibility and security of the owner information D33	0.063	0.013
			Cargo safety D34	0.109	0.022

Therefore, for the above analysis of the results, we have drawn the following conclusions:  
For the owner of the car,

$$\text{Temporal factors: economic factors: safety factors} = 0.105: 0.637: 0.258 \quad (1)$$

For the owner of goods,

$$\text{Temporal factors: economic factors: safety factors} = 0.2: 0.6: 0.2 \quad (2)$$

Therefore, in order to successfully achieve the matching of goods, we use the average method to process, and get the following results:

$$\text{Temporal factors: economic factors: safety factor} = (0.105 + 0.2) / 2: (0.637 + 0.6) / 2: (0.258 + 0.2) / 2 \quad (3)$$

Which is:

$$\text{Temporal factors: economic factors: safety factors} = 0.153: 0.619: 0.228 \quad (4)$$

From the above list of the weights of the indicators of the source of the vehicle and the source of goods, we can see that for the source of the vehicle, in the time factor, the ratio of timeliness of stocking is the largest, 0.074; in the economic factor, the ratio of transportation price and cargo characteristics requirements is the largest, being 0.386 and 0.134 respectively. Among the safety factors, the ratio of the qualification level and the credit level of the source party is relatively large, both being 0.107. For the source of goods, among the time factors, the ratio of the timeliness of dispatching vehicles is relatively large, 0.121; among the economic factors, the ratio of transportation price and vehicle condition requirements is larger, 0.364 and 0.126 respectively; Among the safety factors, the ratio of the qualification level and the credit level of the vehicle source side is large, both being 0.083. Therefore, based on this, in the subsequent part of this paper, we analyze these factors when analyzing the vehicle-cargo matching model based on the virtual logistics platform.

### 3. Car Cargo Matching Model

#### 3.1 Model Hypothesis

(1) The background of the model establishment is that each vehicle only undertakes one transportation task, and each time the distribution application is independent;

(2) In the calculation of the objective function, the problem of the owner's working time, shipping fines and abnormal conditions of the road is not considered;

(3) When the source of the vehicle and the source of goods submit the demand application, the factors that are not filled in or incompletely filled are set to 0;

(4) For the source of the vehicle or the source of goods, after the screening of the restricted conditions, if there is no qualified cargo or vehicle information, then in addition to the vehicle type, cargo material type, load, length and volume, Appropriately reduce the value of the time to arrive at the application point, transportation price, qualification level, and credit level to obtain qualified goods or vehicle information.

#### 3.2 Model Establishment

##### 3.2.1 Restrictions

(1) Model (type of cargo material)

For the source of goods,

$$A_1 = \begin{cases} 1 & \text{Shipper demand type} = \text{vehicle owner type} \\ 0 & \text{Shipper demand type} \neq \text{vehicle owner type} \end{cases} \quad (5)$$

For the source of the vehicle,

$$A_1 = \begin{cases} 1 & \text{Vehicle can carry cargo material type} = \text{Cargo material type of the owner} \\ 0 & \text{Vehicle can carry cargo material type} \neq \text{Cargo material type of the owner} \end{cases} \quad (6)$$

(2) Load

$$A_2 = \begin{cases} 1 & \text{The weight of the cargo and the rated load of the vehicle are between 0 and 1} \\ 0 & \text{The weight of the cargo and the rated load of the vehicle are greater than 1} \end{cases} \quad (7)$$

(3) Car captain

$$A_3 = \begin{cases} 1 & \text{The ratio of the vehicle length required by the owner to the vehicle length is between 0 and 1} \\ 0 & \text{The ratio of the vehicle length required by the owner to the vehicle length is greater than 1} \end{cases} \quad (8)$$

(4) Volume

$$A_4 = \begin{cases} 1 & \text{The ratio of the volume of the cargo to the volume of the vehicle is between 0 and 1} \\ 0 & \text{The ratio of the volume of the cargo to the volume of the vehicle is greater than 1} \end{cases} \quad (9)$$

(5) Time to leave the starting point of the source of supply

$$A_5 = \begin{cases} 1 & \text{The ratio of the time from the application point to the departure of the source of supply and the specified time is between 0 and 1} \\ 0 & \text{The ratio of the time from the application point to the departure of the source of supply and the specified time is greater than 1} \end{cases} \quad (10)$$

(6) Shipping price

For the source of goods,

$$A_6 = \begin{cases} 1 & \text{The ratio between the price given by the owner and the price of the corresponding standard is between 0 and 1} \\ 0 & \text{The ratio between the price given by the owner and the price of the corresponding standard is greater than 1} \end{cases} \quad (11)$$

For the source of the vehicle,

$$A_6 = \begin{cases} 1 & \text{The ratio between the price given by the owner and the corresponding standard price is greater than 1} \\ 0 & \text{The ratio between the price given by the shipper and the corresponding standard price is between 0 and 1} \end{cases} \quad (12)$$

(7) Qualification level

$$A_7 = \begin{cases} 1 & \text{The ratio of the qualification level of the owner and the owner to the specified qualification level is greater than 1} \\ 0 & \text{The ratio of the qualification level of the owner and the owner to the specified qualification level is between 0 and 1} \end{cases} \quad (13)$$

(8) Reputation level

$$A_8 = \begin{cases} 1 & \text{The ratio of the credit level of the owner and the owner to the specified credit level is greater than 1} \\ 0 & \text{The ratio of the credit level of the owner and the owner to the specified credit level is between 0 and 1} \end{cases} \quad (14)$$

### 3.2.2 Objective Function

(1) Time compliance.

$$B_1 = \frac{T'}{T} = \frac{l_1 + t_1}{T} \quad (15)$$

The meaning of the parameters in the formula is as follows:

$T'$ - the time the vehicle leaves from the point of application to the completion of the shipment;

$T$ --specified time;

$l_1$ - Estimated total distance (km) from the surrounding request point to the starting point of the source of supply;

$V$ - the average speed of the vehicle;

$t_1$ - the time the vehicle waits at the source of supply;

When the value of  $B_1$  is closer to 1, it represents the more consistent with the specified time; the closer to 0, the greater the difference from the specified time.

(2) Cost compliance

$$B_2 = \frac{C_1}{F_1} \quad (16)$$

$$C_1 = c_1 + a_1 * (l_1 + 1) * H' \quad (17)$$

$$F_1 = f_1 * H' * 1 \quad (18)$$

The meaning of the parameters in the formula is as follows:

$C_1$ - represents the fixed cost of completing one mission;

$F_1$ --income;

$c_1$  - the fixed cost of completing one mission for the vehicle;

$a_1$ —The average cost per ton of freight (yuan/km) when the vehicle completes the distribution task;

$l_1$ - Estimated total distance from the starting point of the source of supply to the destination (km);

$f_1$ - the freight cost of the vehicle to complete the delivery task (yuan / ton \* km);

$H'$ - the quality of the goods in the source (tons);

(3) Safety compliance

$$B_3 = \frac{S'}{S} \quad (19)$$

$S'$  refers to the average of the qualification level and credit level of the owner (or shipper);

$S$  refers to the average value of the qualification level and credit level that meet the minimum requirements.

(4) Objective function

$$Z = x_1 * B_1 + x_2 * \frac{1}{B_2} + x_3 * B_3 \quad (20)$$

According to the questionnaire survey method and the analytic hierarchy process in the previous chapter, the ratio of the weight of the three factors of time, economy and safety is obtained for the source of the vehicle and the source of goods. So combined with the research situation, we draw the following conclusions:

$$x_1 : x_2 : x_3 = 0.153 : 0.619 : 0.228 \quad (21)$$

So,

$$Z=0.153*\frac{l_1+t_1}{T}+0.619*\frac{f_1*H'*l}{c_1+a_1*(l_1+1)*H}+0.228*\frac{S'}{S} \quad (22)$$

Substitute the information of the vehicle owner and the shipper who meet the restrictions into the above formula. After that, the value (matching degree) of the objective function is calculated and sorted. Finally, the shipper or the vehicle owner is recommended to the corresponding vehicle owner or shipper based on the calculated value.

#### 4. Summary

Based on the virtual logistics platform, this paper mainly studies the platform-based vehicle-cargo matching problem and has achieved certain results. Firstly, the factors affecting the matching of the shippers and owners are analyzed firstly, and the importance scale and weight value of relevant data are obtained by using the AHP analytic hierarchy process. Through the analysis of the weights, the factors of the source and the source are compared. Based on this, a multi-target vehicle-to-goods matching model is constructed to realize the matching of the goods.

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