Research of Logistics Transport Costs Computing in Automobile Industry

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Abstract: Transportation is one of the most important functions in logistics system. Transport cost is a financial format of transportation module in logistics system. Aiming at the problems of complex logic and mass data about the trade vehicle transport costs computing in big automobile enterprise, some resolutions are provided. In the process of computing, the change of price master is recorded in the database table in order to compress the computing time and make the computing logic simple. Moreover, the cost computing is carried out in database layer using the pagination thinking in order to reduce the requirement to hardware configuration. Finally, the time complexity is optimized to O(n).

Key words: Logistics Transportation, Cost Computing, Transport Payment, Transport Request

1. Introduction

Logistics refers to the purposive entity flow process from the supplying area to the receiving area, in the course of society reproduction of substance entity [1]. The main method of substance moving in logistics is transportation. Transportation is the most core element in logistics system [1].

Some researches indicate that transport costs account for nearly 50 percent of the whole logistics costs, to some products, even exceed the production costs. Therefore, the potential of saving is very big. The approach of transport is multiple. The railway, road, waterway, aviation, pipeline, and etc. hold the main proportion [2].

In recent years, the automobile logistics costs ascend as others business logistics at all times. However, the investment of logistics system is not in proportion to the profit. Therefore, the automobile manufacturers expect to control the investment to the logistics, at the same time to improve the sales service so as to go for high profits. The effective approach is to contract its own logistics business with the logistics enterprise. Thus the manufacturers need to manage the contractor and not to increase additional investment. So the agility of task is strengthened. The phenomena of automobile logistics contraction will become more and more general, especially to those manufacture enterprises, their own logistics resources lack but the experience of logistics management is rich. In the long term, the three types of logistics cost, namely the management, storage and transportation, will be peeled off finally [3].

On the background of logistics informatization, the logistics transport management of some international automobile enterprise is regarded as the research object in this paper, which selects the contract way. Aiming at the characteristic of the association transport way of road and waterway, considering the mass data and the complex computing logic, a design thinking and realization method are provided. In the following, we call this international automobile enterprise with T in short.

2. The Management Pattern of Logistics Transportation

As an international automobile enterprise, the business of T is distributed all over the world. It adopts two types of transport approach: road and waterway.

Fig.1 gives the basic pattern of transport management of T. The sales company informs the logistics company to transport goods according to the order. The logistics company confirms the transport path and the transport approach (road or waterway), according to the destination and the arriving date, and specifies the transport company to transfer the goods.

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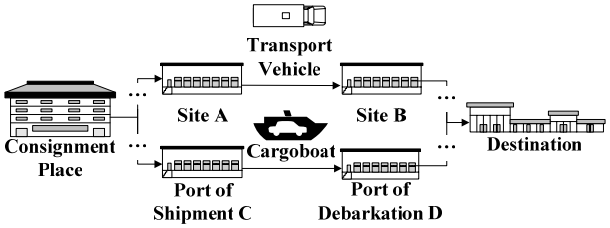

Fig.1 Basic Pattern of Logistics Transportation in Automobile Manufacturer

The site is a scattered place in geography. The consignment place and the destination are both sites. Comparing with the transfer site, they have decisive sense in business. Every trade vehicle is transported from one consignment place to a destination. In general, destination is the storage place of automobile retailer.

The transport task is carried out by a clear transport path. In Fig.1, the transport path corresponds to a path from the consignment place to the destination, which is composed of several transport lines served as directed edges in Fig.1 respectively. The transport line records the transport information from one site to another site in the process of trade vehicle transport, including departing time (from previous site), departing site, arriving date (to next site) and arriving site. In the circumstance of waterway transport, the corresponding information may be shipment time, the port of shipment, debarkation time and the port of debarkation. Except for these, the transport line also records the indication book number. According to the differentiation of road and waterway, the transport indication book may be the road transport indication, including the information of road transport company, transport vehicle code, driver, and etc. It also may be the cargoboat transport indication, including the information of cargoboat transport company and the cargoboat code.

In the transport process, the yard busywork is an indispensable part. It happens in all sites except for the destination. In this task, the logistics management of T mainly adopts the real-time confirming method to solve the problem of changeful costs in the yard busywork. So the method of real-time inputting costs is used in the process of design and realization.

Recently, the logistics management of T is more and more stabile, so the course of logistics informatization is quickened. Therefore, we developed XTL system. XTL system is a network system of logistics transportation. It adopts the intranet technology and has the general merits of logistics informatization building, such as the resource sharing, the wide distributing, the real-time data updating, the transparent pipeline circulating, and etc [4]. Therefore, it greatly shortens the transport time and greatly reduces the transport costs.

3. The Computing Rules of Logistics Transport Costs

The transport cost computing is one of the most core contents in the automobile logistics transportation. It provides with the financial details for the sales company, the logistics company and the transport company.

The logistics transport costs include transport payment costs and transport request costs. When a section of transport is finished, the logistics company will pay the trade vehicle transport costs for the transport company. To the logistics company, this cost is named as payment cost. When the logistics company transfers the trade vehicle to the dealer and the dealer checked and accepted, the sales company will pay the trade vehicle transport costs for the logistics company. To the logistics company, this cost is named as request costs.

The transport costs are different from the yard costs. It is confirmed before the actual transport. The logistics company would consult with the transport company and the sales company before the transport task starts. To the sales company, it only considers the consignment point, destination and transport time. To the transport company, it only considers the costs and benefits of the transport task.

Table 1 shows the difference of the transport payment costs and the transport request costs.

Table 1 Comparison of Transport Payment Costs and Transport Request Costs

Costs / Difference	Transport Payment Costs	Transport Request Costs
Trade Object	Transport Company	Sales Company
Date of Cost Happening	Arriving Date	Accepted Date
Considering Time of Costs Computing	Departing Time	Consignment Time
Places of Cost Happening	All Sites except Consignment Place	Destination
Lines of Cost	A Line	The Whole Path

The aim of transport costs computing of T is to real-timely compute the transport costs according to the upper business logic based on the actual status in every phase of trade vehicle transport. The logistics transport costs computing sub-system in XTL system is just designed and realized in order to finish this task.

4. The System Framework of Logistics Transport Costs Computing

The logistics transport costs computing sub-system includes not only computing, but also the master maintenance of transport price and the browsing function of transport costs. Besides, the extended tasks also come down to the account balancing, as Fig.2 shows. In the way of the software framework design and realization, the transport costs computing sub-system adopts the *duwamish* framework of .net, which realizes every model by four-layer structure.

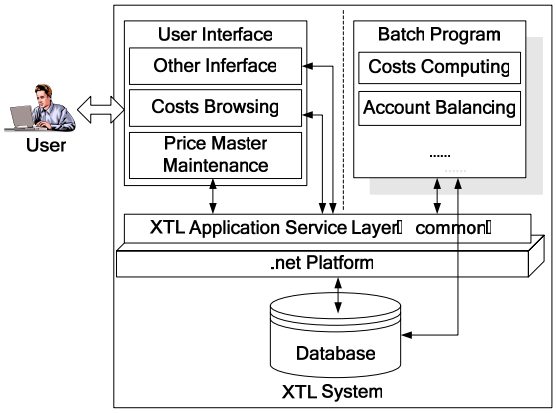

Fig.2 Framework of Logistics Transport Costs Computing Sub-System in XTL System

In design, the master maintenance model and the costs browsing model support on-line operations. The authorized user can carry out the operations on any terminal of the XTL network system. The transport costs computing model has not user interface. It adopts the mode of timing batch processing. On one hand, under the worst circumstance, the daily accumulation would make the top computing quantity of the trade vehicle transport costs very big. On the other hand, the factors affecting the costs computing are very complex, which only make the single trade vehicle and the single transport line as the computing unit. The two reasons make the computing time become the chief problem in the realization. Therefore, the method of batch processing is adopted, that is, the transport costs computing model is designed and realized by the way of the database storage processes which is regarded as the main and the application layer logic which is regarded as the assistant.

In detail, the master maintenance is divided into the transport payment price maintenance and the transport request price maintenance. The logistics company maintains the request price master according to the agreement with the sales company and maintains the payment price master according to the agreement with the transport company. In general, the master inputting is mainly centralized in some phase, and once confirmed, it is modified seldom. The batch programs are started on the dawn everyday. They compute the trade vehicle transport costs which are satisfied with the condition of request and payment before today. The batch programs of transport costs account balancing are started after the computing batch programs, and if today is not an account balancing day, they do not any operations; otherwise, they will create some account report forms. Moreover, the request costs and the payment costs of trade vehicle are not permitted to be modified after account balancing. The transport costs browsing function includes road payment costs browsing, waterway payment costs browsing and request costs browsing, which is used to view all kinds of computing results of transport costs. It is a frequent used model which can help the operators of the logistics company to query and display the useful data among the numerous transport costs data.

5. The Design of Logistics Transport Costs Computing

In actual business of enterprise, the daily transport costs computing may educe some non-basic logic processing because of detailed and complex conditions. In common, the transport costs computing can be summarized to three statuses. For the example of request, the first is the status that the trade vehicle is transported according to the plan, which normally computes the transport request costs of the trade vehicle every day. The second is the status that the properties of trade vehicle are changed, which need to re-compute the transport request costs. The third is the status that the transport request price master is changed, which need to re-compute the transport request costs of the affected trade vehicles. Because the transport cost computing is finished by batch programs, to the second and the third status, the re-computing is not real-time. Thus the problem is how to record the modified trade vehicles and masters, and how to enhance the performance efficiency of the batch programs as possible.

Fig.3 provides a basic design method to solve these problems. It shows the main relations of persistence objects in the process of transport costs computing. The information of trade vehicle and transport line is the core resource, which is shared in every phase of transport. For the example of request, in the status of common costs computing, the transport request cost is confirmed by the transport request price master matched with the trade vehicle, and is recorded in the database table. When the properties of trade vehicle are changed, the computed sign is set to *FALSE*, which denotes that its transport request cost is not to be computed in current status, sequentially notifies the batch programs to re-compute its transport

request cost. When the transport request price master is changed, it will be recorded in the request master modification table. At the time of batch programs computing, query the data in the request cost table which use the master recorded in the modification table, and re-compute them. The design thinking of payment is as the same as request and is not narrated again

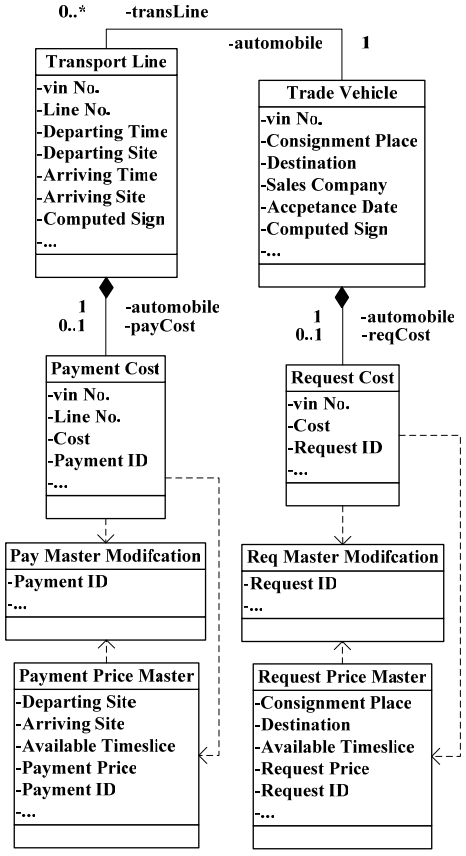

Fig.3 Class Diagram of Persistence Objects

The two function tables of payment master modification and request master modification answer for recording those masters that affect transport costs computing in the process of master maintenance.

- If delete master *M*, add *M* into modification table.
- If update master *M*, add *M* into modification table. If the effective timeslice of *M* is updated, according to the effect of timeslice, other masters may be added into modification table.
- If create master *M*, according to the effect of timeslice, other masters may be added into modification table.

The effective timeslice expresses the time area when the master price has effect on computing. When business information of a trade vehicle is matched with several master records, the master record whose timeslice starting point is most close to the time of costs computing of the trade vehicle is picked out. Accordingly, the timeslice starting point of the masters which have the same primary key cannot be same one another. Fig.4 (a) shows the status that the timeslice may be overlapped.

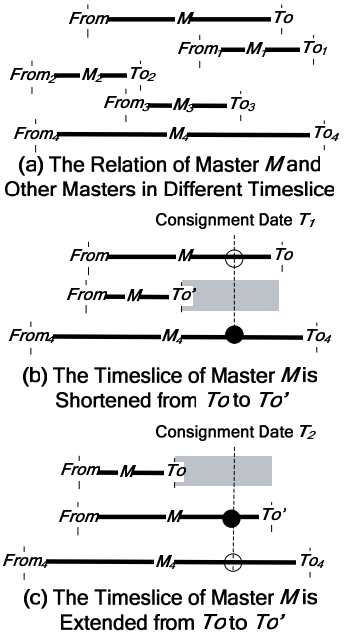

Fig.4 Analysis Diagram of the Master Timeslice Changing

When the effective timeslice of master *M* is changed, the cost computing of many data may be affected. In Fig.4 (b), at first, the business information of T_1 is matched with the master *M* and M_4. Because T_1 is more close to the starting time of *M*, the price of *M* is served as the transport cost. When the ending time of *M* is ahead from *To* to *To'*, the cost of T_1 is modified to price of M_4. It is showed that the transport costs derived from master *M* need to be re-computed in the above condition. In Fig.4 (c), at first, the business information of T_2 is only matched with the master M_4, so the price of M_4 is served as the transport cost. When the ending time of *M* is extended from *To* to *To'*, *M* also becomes the master which T_2 is matched with, furthermore, its staring time is more close to T_2 than M_4's, so the cost of T_2 is modified to price of *M*. It is showed that if the timeslice of master includes the old timeslice of *M*, the transport costs using this master need to be re-computed in the above condition.

The conditions of Fig.4 (b) and Fig.4 (c) can be described as the following rules. *M* denotes the master whose effective timeslice is modified. *From* denotes the starting time of *M*'s effective timeslice. To_{old} denotes the primary ending time of *M's* effective timeslice and To_{new} denotes the current ending time of *M's* effective timeslice.

- If $To_{new}<To_{old}$, only record *M* into the modification table.
- If $To_{new}>To_{old}$, look for the master whose starting time is smaller than *From* and ending time is greater than To_{old}, then record it into the modification table.

When creating a new master, the effect to costs is similar to Fig.4 (c).

6. The Realization of Logistics Transport Costs Computing

In the process of design, whether common computing, or re-computing because of some modification, it must make trade vehicle and transport line as the computing start point. Therefore, in the arithmetic, the above three statuses are not distinguished. In addition, the result of computing or re-computing does not always provide the corresponding costs for the trade vehicle or transport line, because there are problems about data itself or there is not any price master matched with it. Therefore, the error report file must be provided for the user.

The batch programs are divided into three steps:

i. Query the records in the transport cost table which are matched with the masters recorded in the modification table. Set the computed sign of the corresponding trade vehicles or transport lines with *FALSE*, that is, change their status to *NOT COMPUTED*, and then clear the modification table.

ii. Query the cost records in the transport cost table corresponding to the trade vehicles or transport lines whose status are set with *NOT COMPUTED*, and then delete them.

iii. Query the records in trade vehicle table and transport line table that satisfy the computing conditions, then compute their costs and set their status to *COMPUTED*. Finally add the computed results into the corresponding transport cost table.

In order to maintain the integrality of the data, the transaction mechanism is adopted. Because of the characteristics of mass data, in the process of realizing the arithmetic, we do not directly get the whole data once, but get them by the way of pagination whose size can be dynamically configured by XML configuration file. The principle of pagination is showed as Fig.5 (a). For the best performance in actual application, according to the software/hardware configuration of the database server, the data quantity of one page is adjustable so that the computing efficiency of single record can reach the tiptop. The advantage of pagination processing is that the computing performance does not greatly descend along with the expandability of data. Accordingly, the restriction to the quantity of the computing data is avoided. Thereby, the time complexity of computing is dropped to O(n), that is, the computing time is linear. So the stability and efficiency of computing is guaranteed, as showed in Fig.5 (b).

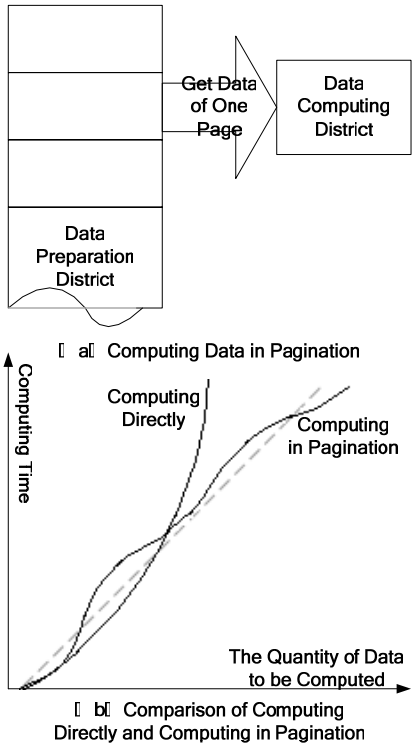

Fig.5 Computing Data in Pagination and Comparison

7. Conclusions

The logistics, served as the source of "the third profit", has become the research hotspot by many enterprises, experts and researchers recently [1]. At present, the research to logistics transportation in many literatures is often centralized on the design and realization of the transport path. However, considering the actual conditions of enterprise informatization building, the optimizing process of transport path is slow because of many objective factors. The informatization building of transport costs computing can be realized in advance [5-6]. In the process of transport costs computing, mass data is the commonness of most goods transport and logic complexity is the characteristic of trade vehicle transport. Therefore, in the process of informatization, decomposing the computing logic is prerequisite and quick and stable computing is the core.

The design thinking and solving scheme described in this paper have been recognized by T, which not only predigests the operations, but also improves the stability of computing and reduces the requirement to

software/hardware. Therefore, the whole logistics transport actions of T is popularized, including over 300 transport destinations and thousands of trade vehicles every year.

However, the computing speed based on the realization perhaps can be further optimized, and with all kinds of actual applications, the logic processing ability will be checked. Be sure that the logic processing can be made to the best disjunctive point in the process of practice application and theoretic research.

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