Solving the problem of trucking optimization by automating the management process

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Abstract. This article discusses the solution to the optimization problem associated with trucking by automating the management process, namely the creation of software. The authors consider the main problem, because of which there is a need to automate processes. The introduction of software into the organization will help to maximize freight profit and fully automate the components that make up the process of transportation. Characteristics of the software and the depiction of interface are presented.

1. Introduction

According to statistics, more than half of all goods in the Russian Federation territory are transported by road [1, 2]. Trucking is indispensable in the functioning of the transport system of the country. With the constant growth of cargo flow associated with the development of the economy and the integration of domestic highways into a single transcontinental network, the road transport industry is developing steadily [3]. The production and technical base is growing and modernizing, management methods are being improved, modern computer and telecommunication technologies are being introduced to transport workers and logisticians. The main and rather big problem is the lack of proper management of cargo flows - the reason for the large number of unjustified empty runs, which leads to an increase in the cost of services and travel time [4]. This factor leads to the loss of customers.

The problem of optimal delivery of goods from one point to another is handled by logistics. The subject of logistics is the organization of a rational process of promoting goods and services from suppliers of raw materials to consumers, the functioning of the circulation of products, goods, services, inventory management and food supply, creating the infrastructure of distribution [5 - 8].

To maximize profit from freight, it is necessary to automate the process of transportation of goods, including an extract of the waybill, calculation of the optimal way based on the history of transportation, taking into account the time of day (at what time of day the truck moves), the cargo (measured in tons) as well as the situation on the roads. These are the optimization tasks: creating a projected system in the automatic mode, which offers a user the most suitable options for trucking; implementation of the calculation of financial delivery indicators.

2. The organization of trucking

In the current conditions of competition in the trucking market, the company is unable to raise trucking rates, because in Krasnoyarsk carriers mainly transport cargo at uniform rate. Therefore, to

ensure profitability, it is necessary to transport goods with minimal time and cost. The whole process of trucking calculation is made depending on the following factors: the brand of the car, its load capacity, time, distance and place of delivery.

There are two main approaches to the organization of the transport process: traditional and logistic with the participation of the multimodal transport operator (Figure 1).

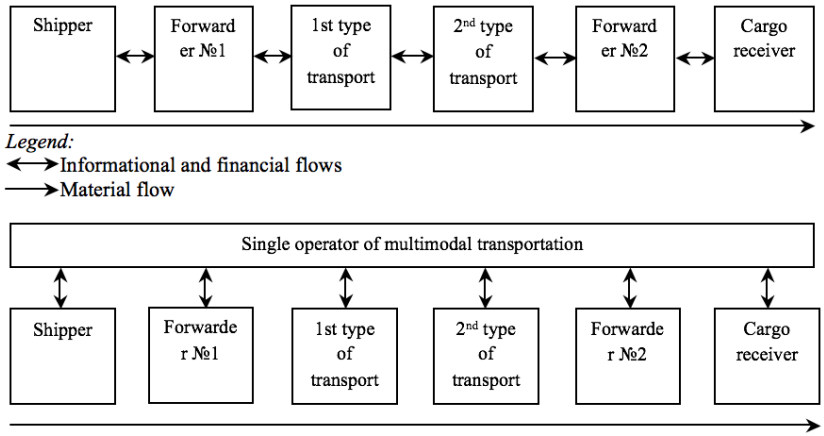

Figure 1. Scheme of the transportation organization.

Transport logistics is a system for organizing delivery, namely for moving any material objects, substances, etc. from one point to another along the optimal route. These are more detailed features of this logistics: personnel who are engaged in the implementation of these tasks (loaders, drivers); vehicle classification (by volume m^3); pricing policy (for labour, for fuel, provision of transport services).

The transport and logistics system is understood as a set of consumers and service providers, as well as management systems used for providing the services, vehicles, means of communication, facilities and other properties. Another definition says that the transport and logistics system is a set of objects and subjects of the transport and logistics infrastructure along with material, financial and information flows between them, performing the functions of transportation, storage, distribution of goods, as well as information and legal support of product flows. An appropriate infrastructure is required for well-functioning transport and logistics system. The processes of movement of goods, warehousing and storage and the information flows accompanying them require certain technical means. These means make up the logistics infrastructure and their interrelations create a logistic system.

The infrastructure should provide a clear and uninterrupted performance of all logistic functions. The transport logistics infrastructure includes (figure 2):

- Transport routes of all types of transport, including pipeline, as well as transport hubs, namely, sea, river and air ports, container terminals, railway transhipment and sorting stations, terminals of combined transport.
- Buildings and structures that allow warehousing and storing together with their technical equipment, allowing for handling cargo and implementing basic functions, such as supplement and packaging, as well as floor covering, loading and unloading fronts, ramps.
- Elements of logistics hub infrastructure such as distribution centres logistics service centres, transport and storage facilities.
- Devices and means of processing and transmitting information together with the appropriate software.

Logistics costs for transport primarily consist of different costs of transporting goods on different types of transport, which are determined by the tariff or freight rate. The tariff is the price for the cargo

transportation, set by the carrier for a certain period of time. Freight is the price for transportation, established by agreement between the cargo owner and the carrier for each particular transportation by sea.

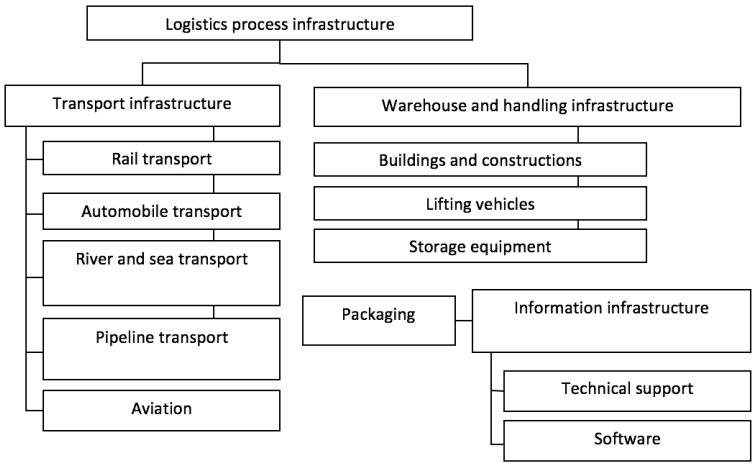

Figure 2. Transport logistics infrastructure.

The process of shipping can be called a logistics system. Transport participates in a variety of technological processes, fulfilling the tasks of a logistics system. Also transport exists as a fairly independent transport field of logistics, requiring multidimensional consistency between participants of the transport process.

The result of using the transport logistics system is a high probability that the "six rules of logistics" are fulfilled: the right cargo, in the right place, at the right time, in the right amount, of the required quality, with minimal costs.

Joint planning of commercial activities of participants in the logistics system means the development and application of unified plans for schedules.

Due to the above, the software system is designed to optimize the calculation of the path between company offices, warehouses, temporary parking lots and destinations.

3. Software design

The program system has such functions as providing the user with the ability to add, delete and change directories, lists of suppliers and consumers, the ability to search for cities, routes and the ability to display information in the form of reports (waybill). The program also stores the entire history of transportation. The data being added and changed are under control.

Due to the low cost of implementation in the enterprise, the system can be used in small and medium-sized businesses, where the volume of trucking is not so large. At the enterprises of this type it is necessary to calculate the path of the truck in the most optimal way.

The software algorithm goes as follows: all paths leading from the initial vertex to the final one are observed until a minimum is found. When choosing a vertex, among other things it takes into account the entire path traveled to it (component g(x) is the cost of the path from the initial vertex, and not from the previous one, as in the greedy algorithm). At the beginning of the work, the nodes adjacent to the initial nodes are observed; the one that has the minimum value of f(x) is chosen, after which this node is expanded. At each stage, the algorithm operates with a set of paths from the starting point to all not yet opened (leaf) vertices of the graph (by "a set of particular solutions"), which is placed in a queue with priority. The priority of the path is determined by the value $f(x) = g(x) + h(x)$. The algorithm continues its work until the value of f (x) of the target vertex is smaller than any value in the queue (or until the entire tree has been scanned). From the multiple solutions, the solution with the lowest cost is selected. The algorithm is presented in Figure 3.

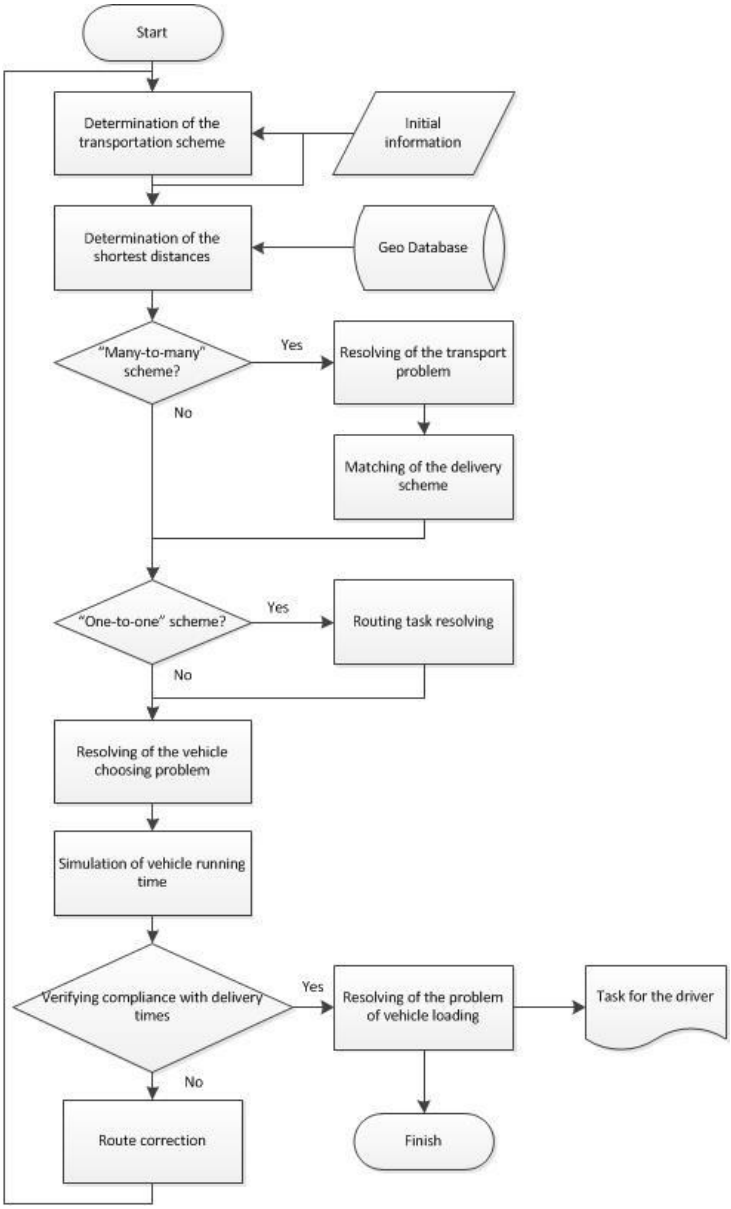

Figure 3. Transport logistics infrastructure.

The program includes the following blocks: directories, waybill and route map. The route map is the main window of the program. Directories and waybills occur by pressing the corresponding buttons.

4. Program system experimental study

The main window of the program has the interactive map where the main menu is located (Figure 4). The system provides simple and fast integration with the accounting system, automation of work on the distribution of orders between cars, automated calculation of orders delivery routes, visualization of addresses and delivery routes on an electronic map, the formation of an optimal order of bypassing the delivery points with the possibility of changing it. The system forms a database of warehouses shipping orders, a database of vehicles with the characteristics of each car, a database of consignees with addresses attached to the map, a database of customer orders with the characteristics of orders. The system calculates the planned consumption of gasoline, mileage and operating time of each vehicle, the cost in rubles for fuel for each route, the fuel component of the unit cost of delivery of goods in rubles / kg, coefficients of vehicles and flights, the need for cars to ensure delivery.

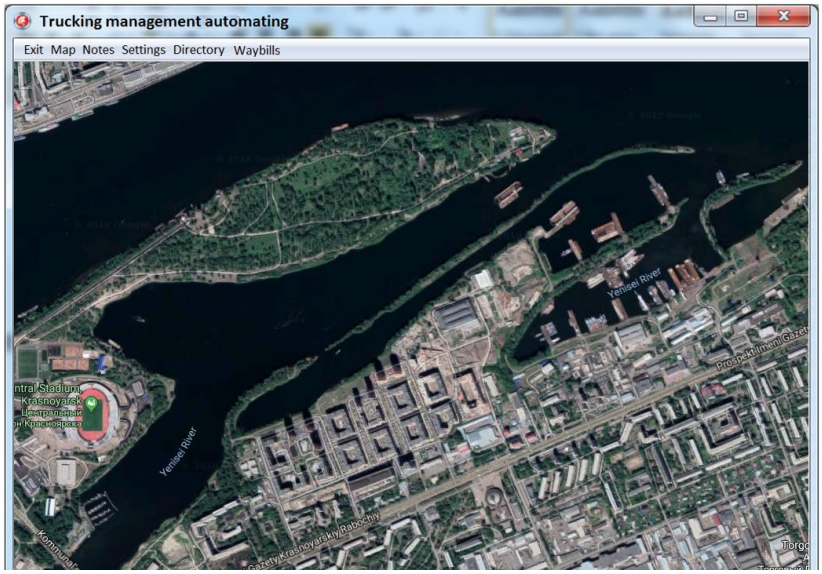

Figure 4. Application main window.

The system takes into account the working time of each vehicle, the time the vehicle was supplied for loading, the time of delivery points operation, time intervals for delivery of orders, capacity limitations for each vehicle in locations, kg and m3, restrictions on the number of delivery points for each vehicle, mileage limits for each route, etc. Logistics of transportation is not only cars, but also warehouses and shipping addresses. In the delivery address window, there is an opportunity to keep a directory with a complete list of customers and their corresponding addresses. In this case, it is possible to implement the binding address to the map. It is also possible to implement the correctness of the automatic finding of the address. The purpose of transport logistics includes optimization of transportation and delivery. Therefore, it is possible to implement the binding of the delivery address to the warehouse. The warehouse will be tied to the map.

System provides a possibility to make a list of orders (Figure 5), depending on which the manager can automatically generate an optimized route map and waybill for a truck driver.

Figure 5. Orders window.

We will conduct an experimental study of the effectiveness of the developed automated system in solving the practical problem of forming a waybill.

The formulation of the problem is as follows: it is required to deliver the goods in Krasnoyarsk city (Russia) from the warehouse to several consumers with minimal gasoline costs and minimal time. These are the addresses where the goods are required to be delivered: 60 Let Oktyabrya st. 105A; Belinskogo st. 3; Bograda st. 15; Dzhambul'skaya st. 12D; Krasnoyarskiy Rabochiy prospect 64; Krasnoyarskiy Rabochiy prospect 163; Partizana Zheleznyaka st. 21A; Pavlova st. 28/1; Respubliki st. 28B.Warehouse address is Prospekt Metallurgov, 1E.

As a result, we get the following order of bypassing the route points: Partizana Zheleznyaka st. 21A; Krasnoyarskiy Rabochiy prospect 64; Pavlova st. 28/1; 60 Let Oktyabrya st. 105A;

Krasnoyarskiy Rabochiy prospect 163; Bograda st. 15; Respubliki st. 28B; Belinskogo st. 3; Dzhambul'skaya st. 12D.

In Figure 6, the route is graphically represented in the map.

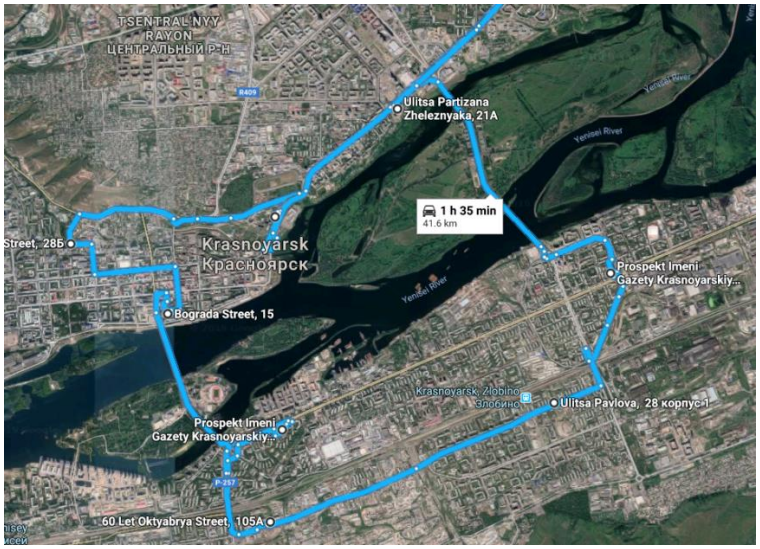

Figure 6. The route corresponding to the formed waybill.

5. Conclusion

Automation of logistic processes at the enterprise allows increasing the efficiency of its activities significantly, reducing operating costs, increasing customers' loyalty and increasing profits.

The automated system proposed in the article is integrated into the activity of the enterprise through advanced information exchange tools with modern ERP systems. The developed program allows one not only to keep records of requests for delivery, but also to automatically plan the route of delivery using optimization algorithms. As a result of the experimental study, the effectiveness of the proposed system, the implementation of which will significantly reduce the influence of the human factor, is shown.

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