INFORMATION SYSTEMS FOR ROAD TRANSPORTATION

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ABSTRACT
The article considers the selection of management systems of transportation activities. A review of IT-solutions for the transport and logistics business, existing in the Russian market, is given and an approach is offered justifying the assessment of functional and non-functional characteristics of the system being implemented. It is based on modern methods, which help to select software, which is suitable for targets.

Keywords: road transportation, control, information system, analytical hierarchy method, choice of software.

Background. *The overwhelming part of the development of domestic business software accounted for banking and accounting, inventory accounting, ERP and CRM systems. At the same time, specialized programs for controlling transport or logistics company, car fleet, which are typically combined under a title Transportation Management System (hereinafter-TMS) or a narrower specification – Fleet Management System (hereinafter-FMS), were absent at the market of our country.*

This is largely explained with the fact that road management processes are considerably less formalized than banking and accounting operations, and require in-depth knowledge about the structure of vehicles, their operation, regulatory and legal framework. In addition, in the transport sector there is no strict regulation of business processes, and each car fleet can have its form of internal documents and reports that are created based on own needs, organizational structure, nature and methods of doing business, and so forth.

Objective. *The objective of the authors is to study different aspects of information systems, applicable to road transportation.*

Methods. *The authors use general scientific methods, simulation, pairwise comparison, analytic hierarchy process.*

Results.

Forced rotation of approaches

This situation makes it urgent to develop internally consistent classification scheme of management systems of transport activities. So, as one of the variants of the classification scheme it is proposed to use conditional differentiation of business processes in planning and management [1]. In this scheme, planning tasks are associated with forecasting demand for materials, organization of production and distribution. Execution tasks include direct operating activities: consideration of applications for transportation, maintenance of transport process, inventory control. This approach is gradually implemented in information systems of enterprise management of general purpose over the past thirty years.

In connection with special tasks, which, for example, include optimization of number and types of vehicles in the fleet of the enterprise, scheduling entering of vehicles on the line, to determine optimal schedules of maintenance of rolling stock, taking into account intensity, operating conditions, etc., obviously, the architecture of Fleet Management System should include both operational accounting modules and planning modules. There are also levels of operational, tactic and strategic management.

It is necessary to reflect the functionality of the system, for example, the management of domestic transportation or international. It is also possible to allocate different performance technologies for urban transport, commuter and long-distance; and on the used mode of transport uni- and multimodal transportation [2].

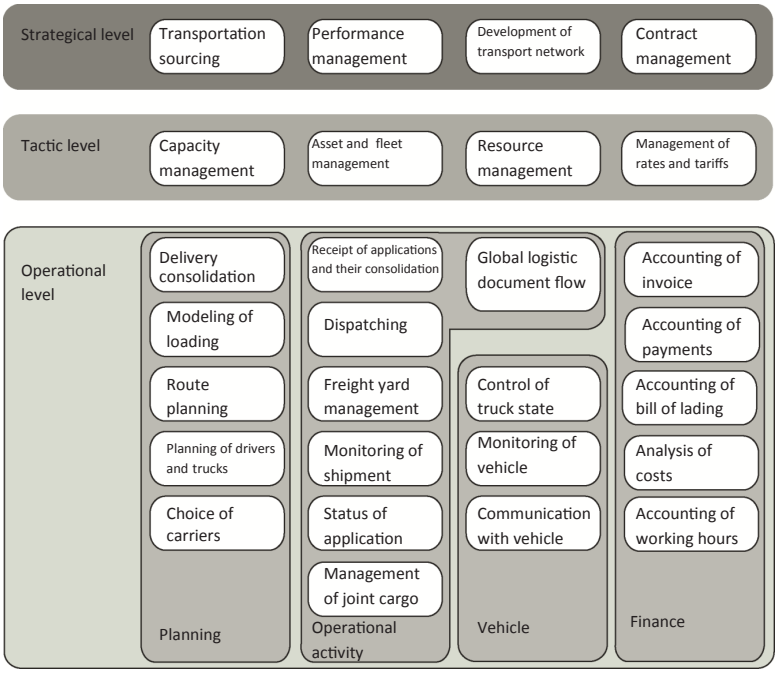
The essential feature of the classification is a legal form of the carrier's activities. It matters whether the transportation is carried out by specialized transport, logistics or freight forwarding company, or it is performed by the transport division of the company, the owner of transported goods. With external identity of the transport process, which in both cases includes making up of cargo, loading, moving, unloading, there are significant differences. Transport company aims to profit from transportation, and for the company-cargo owner an important aspect will be reduction of delivery costs.

Specialized commercial carrier, in contrast to the company providing transportation with vehicles belonging to it, requires effective management of transport services marketing, the calculation of transportation charges for different schemes of tariff formation, tracking financial flows, control of income and profitability of transport activities. Since transport service in many cases is limited to providing vehicles to a cargo owner in its application, in such situations, route optimization and monitoring their implementation takes a back seat. On the contrary, the customer seeks to provide transportation of goods belonging to him with a minimum number of vehicles, which is achieved by optimizing taken planned decisions. It is these circumstances that determine the architecture of the system, a set of its constituent function blocks.

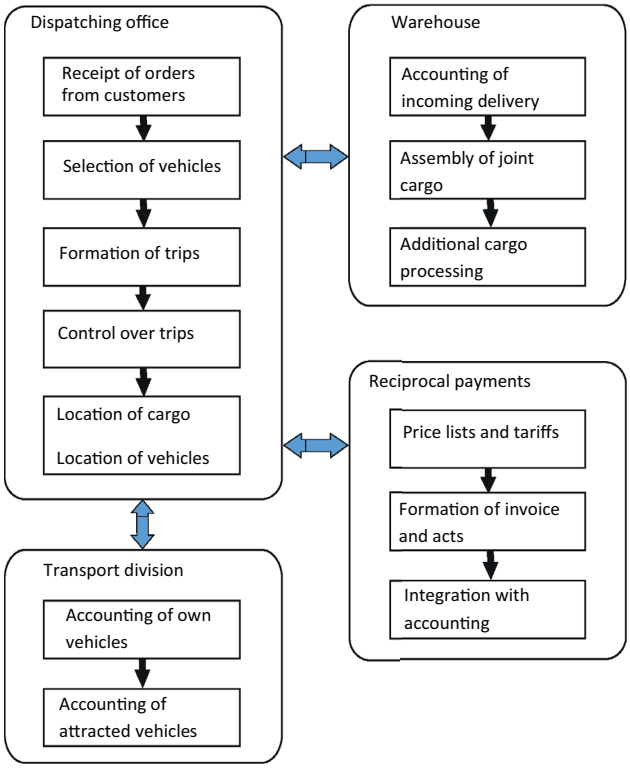
It should be noted that the concept of «Transportation Management System» in Russia contains a slightly different meaning than in other countries. Thus, according to the definition of Gartner [3], TMS is designed to plan and control the movement of goods, carried out by both road, sea, rail and air transport. Moreover, the range of tasks that must be implemented in the functional TMS [4] is very broad:

- *strategic and tactic planning;*
- *optimization of the network of shippers;*
- *management of contracts and reciprocal payments of the whole chain of contractors;*
- *routing and scheduling;*
- *3D-modeling of loading;*
- *various analytical capabilities, data marts, KPI;*
- *scaling and comprehensive integration, which provides synchronization of all business processes of cargo transportation.*

As examples of this kind of IT-solutions can serve information systems IBM Sterling Transportation Management System, SAP Transportation Management, Oracle Transportation Management, which in its architecture is almost comparable to the classic ERP-applications. For example, a functional model of the consulting company Capgemini Consulting (Pic. 1) shows components of universal TMS, which basically allow to automate business processes of virtually any logistics company [5]. Among them there are:



Pic. 1. Function modules of Transportation Management System.

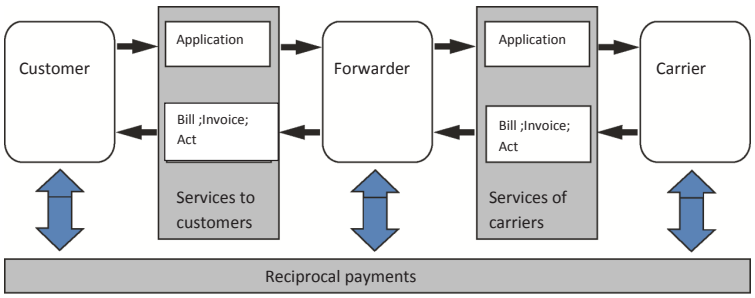


Pic. 2. Information exchange between units of 1C-Rarus: Transport logistics and freight forwarding.

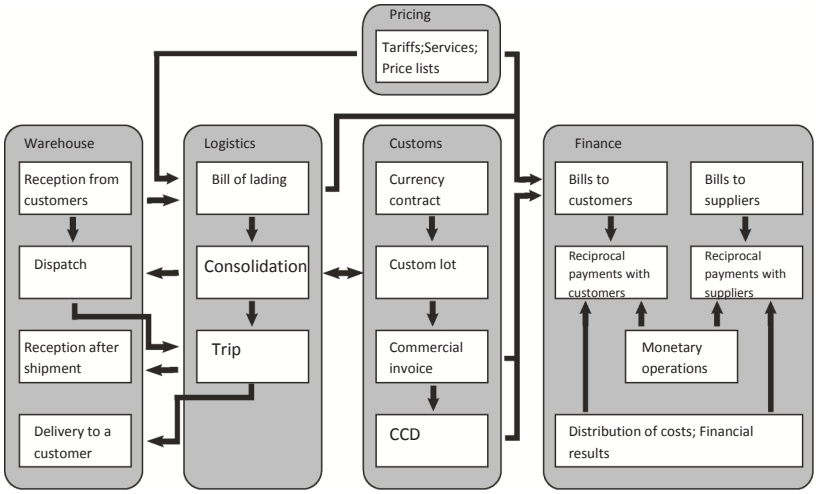
• Module Transportation Sourcing allows among a list of transport companies and logistics service providers to select and analyze companies that can provide the most appropriate according to various criteria (freight possibilities, certificates, transport network geography, tariffs, reputation) options of freight transportation;

• Module Performance Management helps to analyze the ratio of costs of implementing transport activities and customer's satisfaction;

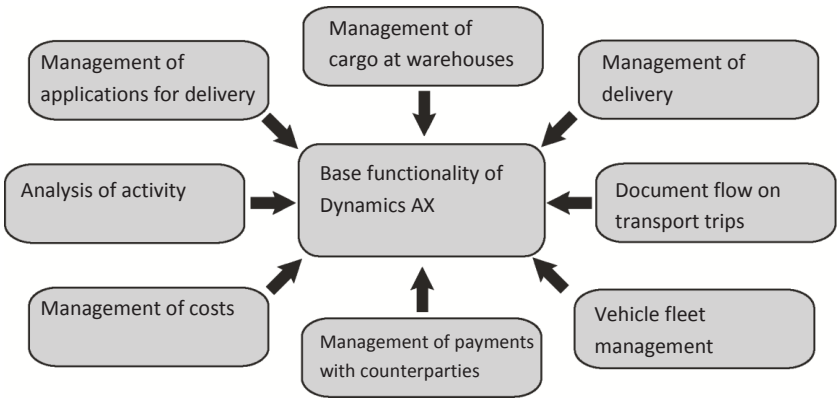
• Module Capacity management addresses issues of compliance with current and future business needs in capacity and productivity;



Pic. 3. Business process for processing of applications for transportation in the information system «Trans-manager».



Pic. 4. Architecture of Mercury TMS.



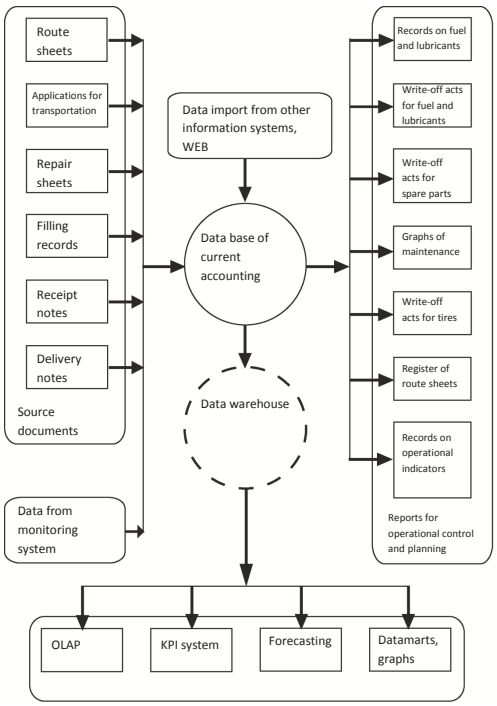
Pic. 5. The composition of solution IT-Box Freight Transportation, Logistics, Warehouse.

• Module Asset and fleet management contains the business logic, which provides an analysis of the value of ownership of the vehicle all along their life cycle.

Flexibility of IT-architecture

The starting point for the design of TMS architecture in a particular organization is to identify its position in the classification scheme to avoid enumeration of a huge amount of logistics and business processes on the basis of their demands to choose options that are necessary to implement the automation of business [6].

Obviously, the number and complexity of business processes, the number of business roles depend on the business profile, its organizational structure, the scope of the company, a niche in the market of transport services, the type of transportation and other factors. Accordingly, in determining the contour of



Pic. 6. Architecture of the information system «Carpool».

information system it is necessary to provide a complete picture of all the problems related to management operations of transportation process, which currently existing and will be possible in future.

A special feature of the Russian market of software for business is an exceptional position of company 1C among domestic developers, which share in the segment of ERP-systems is about 30%, giving place only to SAP [7]. And in the segment of economic business software for small and medium-sized businesses the company takes from 80 to 90%. A feature of the architecture of information system IC is that it is a platform or development environment that can be adapted to the client's business processes.

On the one hand, it opens up opportunities for flexible system configuration, including a deep modification of interface and business logic, as well as integration with an accounting core [8]. On the other hand, such an approach requires a qualified programmer, having high competence in the field of software engineering and logistics and road transport.

On the market there are several solutions, implemented on the platform 1C – for example, 1C-Rarus: Transport Logistics and freight forwarding. Management of vehicles; BIT: Forwarding; BIT: transport logistics management; 1C: TMS Logistics.

The software product, as can be seen on the example of 1C-Rarus: Transport logistics and freight forwarding consists of several interconnected units (Pic. 2) and solves various specialized tasks – management of customer orders, control of cargo and containers, vehicle management, routing, reciprocal payments.

The system is available for commercial carriers and forwarders for the transportation by any means of transport and using their own and / or hired vehicles. [9] From this it follows that from the scope of this software company excludes companies, performing own cargo delivery by vehicles they own. Management of vehicles is done with integration with the software package, focused on road transport management.

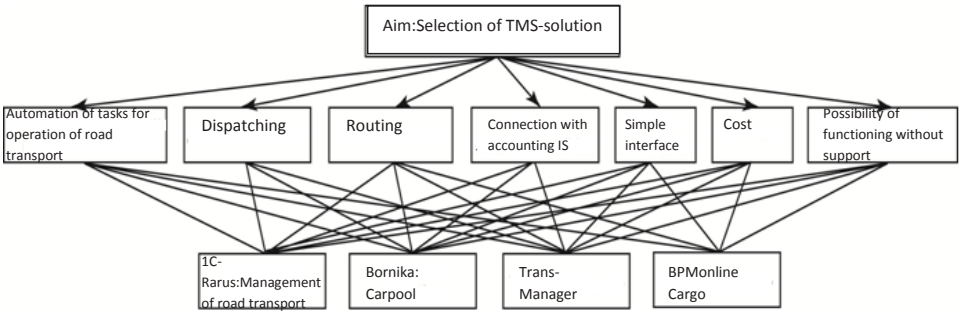
There are separate software products developed not on a platform 1C, designed for controlling the activities of freight forwarding, fleet, road transport. One of the most popular systems in shipping companies is considered a program «Trans-manager». Its architecture is based on business processes of processing requests for transportation. In the course of the provision of transport services application status changes, this is done at the stage design- execution-payment, while all operations are completely controlled by the manager (Pic. 3).

The system has various directories: suppliers, services and tariffs, types of vehicles, urban routes, etc., which enable to fully describe various parameters of the application for the transportation of goods. To the application are attached all necessary documents accompanying the implementation of transport services – above all contracts, invoices for payment, invoices, acts of work performed [10].

Features of industry specifics

Some manufacturers of programs refuse universality in favor of specialization. For example, the company «CargoSoft» offers the information system for the Mercury TMS for logistics companies [11] involved in international multimodal freight transportation. Accordingly functionality of the software complex is formed, which includes traffic management, tracking, cargo consolidation and warehousing cargo handling, customs operations, etc. (Pic. 4). Transportation scheme may contain several routes; each of them is made up of the sections.

An example of an integrated solution is the product IT-Box Freight transportation, Logistics, Warehouse [12] that is based on enterprise management system Microsoft Dynamics AX (Pic. 5). The system architecture determines benefits for companies with their own production or trading platform, and its logic involves the formation of the application from the supplier in the implementation



Pic. 7. Layering of TMS-selection problem.

Pic. 8. The matrix of pairwise comparisons TMS selection criteria in DSS «Super Decisions».

of the delivery or the customer when he purchases a particular product.

It should be noted that among organizations involved in transportation, can be identified car fleets with mixed fleets, which include in addition to trucks also buses, special vehicles. As a rule, they are construction companies, industrial plants, airports, forming applications for transportation in accordance with their process. In many cases, the input data for applications are graphs of driver's shifts, which are often multivariate. And drivers can be assigned to several vehicles.

The system «Carpool» of a company «Bornika» is designed with focus on road transport companies with mixed fleet of vehicles [13]. This application has a classic client-server architecture, which functionality covers not only transportation management, including accounting of route sheets, route jobs and other tasks related to the operation of vehicles (repair, maintenance planning, calculation of the cost of transportation and so forth.). Special analytic extension allows decision makers to count KPI of transportation process, to build OLAP-cubes, to plan the activities of the enterprise (Pic. 6).

In the transport sector factors of uncertainties and risks are very often present. In this regard, in management decisions it is quite difficult to make a choice from a set of alternatives based on incomplete information. Obviously, in the presence of loyal customers with a known amount of applications for transportation, it is easier to plan than in a situation of accidental receipt of requests for transportation. In addition, a serious problem remains the minimization of empty runs to the home base of the vehicle, or additional loading en the route. The solution of the problem of the search for opportune cargo, including adapted transportation rescheduling in real time is effectively done with multi-agent systems (MAS).

Distributed multi-agent architecture helps integrate information about the location and status of each truck (traffic, accident, anticipation), take into account the road conditions on the routes, as well as various properties of orders (tonnage, volume, distance of transportation, earning capacity and so on.) [14]. Such a system Smart Truck has been developed and is being implemented SPC «Reasonable solution». Implementation is carried out both by the classical scheme by purchasing a license by transport company and the scheme SaaS.

Programs for multicriteria tasks

An analysis of TMS-systems on the Russian market, showed that the existing solutions automate in general operational accounting of applications for transportation, enable to create route jobs, including with the use of map services, to carry out the distribution of orders for vehicles, to calculate the cost of transportation. TMS-systems have a variety of architecture, designed for small transport companies and large logistics enterprises.

Pic. 9. Matrix of pairwise comparisons of functional and nonfunctional properties of TMS.

It should be noted that when choosing an automation system for the transport process it is necessary to be guided by a set of features and cost of ownership, which is the cost of the system itself, possible subscription fee, the cost of the work on setting up customer's business processes. A detailed description of organization's business processes, analysis of business requirements, objectives and constraints affecting the functioning of the information system will enable the most radical approach to the selection of TMS [15].

However, in general, from the analysis of sources, it can be stated that the problem of the selection and evaluation of the «packaged» software for the automation of administrative activity is a non-trivial task with a variety of criteria which must be taken into account. The term «packaged» software (commercial off-the-shelf, COTS) means that the program is ready to be bought, and not developed for the requirements and functions of the customer. However, the difficulty lays in the fact that it is necessary to take into account non-functional criteria, which include, for example, the manufacturer's reputation in the market, renewal policy, popularity and reliability, utility of the product to solve business problems [16].

Today, for the selection and evaluation of the software that belong to the class of multicriteria tasks, a variety of methods and approaches is applied, among which are the method of weighted sum of criteria (Weighted sum method (WSM)), method of hierarchy analysis (Analytical Hierarchy Process (AHP)), ELECTRE method, etc. [17]. Let's consider the example of the choice of TMS-solution using the analytic hierarchy process.

So let TMS implementation takes place in a company engaged in the carriage of non-metallic materials, operating 30 trucks, carrying capacity of 20 tons. The production base is located far from major population centers, so there is no possibility to use a constant technical support of IT-specialists. TMS-decision must have the simplest interface and primarily focus on the problems associated with the operation of motor vehicles (accounting of route sheets, repairs, spare parts, maintenance planning and so on. To a lesser extent opportunities for dispatching, distribution of trips, cargo are required. Tasks for monitoring and integration with the accounting system are in demand. The price of the system must be low. On the basis of these input data a hierarchical structure of the task of TMS selection is built (Pic. 7).

After building the analytical network that is a model of this situation, it is necessary to interview decision-makers or other interested employees of the company in order to determine priorities, influencing the choice of TMS. The degree of their importance is defined by pairwise comparisons. Suppose that, in the opinion of the director of the enterprise, ranking the necessary signs TMS is distributed in a way shown in Pic. 8.

In turn, the results of the analysis of TMS-decisions, present on the Russian market, a pairwise comparison was also carried out, reflecting the views of decision-makers to functional and other properties of pre-selected information systems. For assessment the following scale was used. If properties A and B are set, we estimate in such a way [18]:

- *in the case where A and B are equally important, enter 1;*
- *in the case where A is slightly more important than B, enter 3;*
- *in the case where A is much more important than B, enter 5;*
- *in the case where A is clearly more important than B, enter 7;*
- *in the case where A in its significance is absolutely superior to B, enter 9.*

Pic. 9 shows some of the matrix of pairwise comparisons of functional and non-functional properties of different TMS-decisions. As a result of analysis of the hierarchical structure priorities for the organization are distributed as shown in Pic. 10a. In turn, the following the analysis of priorities DSS «Super Decisions» makes assessment of the most preferred embodiment of TMS-solution (Pic. 10b).

In the considered example input conditions and prioritization were formed at random, using the results of a survey of managers of transport companies. The main factors that became determinant, were cost, simple interface and solution of tasks on operation of road transport. And obviously, this approach can be used in real practice when deciding on the implementation of software.

Conclusion. *The above approach offers science-based principles for selection and evaluation of options for managing transport activities. Its application in the practical sphere will allow to take strategic right decisions on the deployment of IT-infrastructure at the logistics enterprises to improve business results of the transportation process.*

a)

Icon	Name	Normalized by Cluster	Limiting
No Icon	TMS selection	0.00000	0.000000
No Icon	Automation of tasks on RT operation	0.23794	0.118970
No Icon	Dispatching	0.04231	0.021154
No Icon	Routing	0.05459	0.027297
No Icon	Connection with accounting IS	0.04727	0.023636
No Icon	Simple interface	0.19208	0.096038
No Icon	Cost	0.25360	0.126801
No Icon	Possibility of work without support	0.17221	0.086104
No Icon	1C-Rarus:RT management	0.19476	0.097378
No Icon	Bornika:Carpool	0.36760	0.183800
No Icon	Trans-Manager	0.33152	0.165761
No Icon	BPMOnline Cargo	0.10612	0.053061

b)

Name	Graphic	Ideals	Normals	Raw
1C-Rarus:RT management		0.529808	0.194757	0.097379
BPMOnline Cargo		0.288690	0.106122	0.053061
Bornika:Carpool		1.000000	0.367599	0.183800
Trans-Manager		0.901855	0.331521	0.165761

Pic. 10. The result of the analysis of hierarchical network: a – the result of priorities' analysis; b – the results of preferred embodiment of TMS-solution estimation.

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