Intelligent system for centralized freight traffic planning

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Abstract. In order to develop intelligent transport systems an intelligent system for centralized freight traffic planning is suggested. Function principles of this system are suggested, the methodological base has been developed for orders distribution and rail way vehicles assignment for freight claim, algorithms for centralized freight planning in the software are developed.

1. Introduction

Exporters and receivers number increase caused by commercial relations development lately determine high demand for freight services. Nowadays transport operator choice is done by the consumer who seeks the transport company and makes a decision basing on the small number of alternatives.

To find a transport operator in the Internet numerous forums, sites, tender platforms are used, but their data bases on the railway transport and operators are extremely small (tender platforms, sites) or absent at all (forums). Many tender platforms operate as auctions; that dumps the prices for orders. There is no centralized planning of motor trucking in Russia nowadays.

Contract relations between a consumer of transport services and a transport operator are formed in the conditions of: information lack about the market and its offers; absence of the scientific approach to contract formation between the participants of the transport market; absence of the intelligent system for centralized freight traffic planning. It results in formation of the chaotic transport flows.

According to [1] federal highways have exhausted their carrying capacity nowadays. 13 thousand km of roads are used with the exceeding transport load especially near big cities that makes nearly 29 % of the network expand. Local road network is underdeveloped, that is why the significant part of local transportation is done by federal highways. Automobilization of the country does not result in the increase of road network building and reconstruction, and highway repair even decreased lately. Though, general purpose highway length increased by 15 % over the last 10 years, stock of cars increased nearly by 75 %. Territorial and technological accessibility of transport services determines possibilities for the development of local economies and social sphere [1].

Intelligent system for centralized freight traffic planning is suggested in order to enhance transport infrastructure usage, rational exploitation of auto transport industry resources, and reduction of automobilization negative consequences [2], freight safety improvement [3], and computerization of freight transportation system.
2. Methods
With modern tendencies in mind intelligent system for centralized freight traffic planning functioning should be in the form of the electronic trading facility. Contrary to modern ways of transportation sales, it is necessary to ground scientifically freight consumers’ orders among transport operators’ resources.

Figure 1 shows function principles of the intelligent system for centralized freight traffic planning. The program automatically chooses optimal characteristics of the transport vehicles their number, the transport operator, and the delivery scheme.

At the stage of determining the transport service performer it is necessary to solve the issue of the best vehicle characteristics for transportation, and their number. For this:

1. A methodology for orders distribution and rail way vehicles assignment for freight claim [4, 5] has been developed.
2. Algorithms [4, 5] have been developed for the centralized freight planning by the program. The software “Freight planning system in the inter-city transportation” [6] has been created.

Automobiles choice includes auto detecting of the railway vehicles place, its distance from destinations. There are two approaches in the railway vehicles choice algorithm: route choice to the load carrying capacity and vehicles choice to the highway, providing the shortest distance. When constructing the route it is necessary to take into account possible ways of the train passing, axle loads, roads drying in spring, repair works, fee at the route parts according to “Plato” system.

3. Results
In the program together with the best freight vehicles characteristics, their number it is necessary to take into account the characteristics of the transportation company, which is a transport operator. When the index system is formed, mostly those parameters are taken into account, which influence the result of transportation. For example, the staff qualification is not taken into account, as this parameter is in the rating of the companies. Tariffs flexibility and packet services are not taken into account which is conditioned by the electronic trading facility. After investigation of the wide range of parameters, given in the literature and scientific resources, the most important complex parameters have been denoted which can be estimated [7]:

– tariff, determined by the transport operator;
– packet service – a complex parameter, taking into account expeditionary services complex, information service;
– rating – the complex parameter, including rating parameters: “reputation”, “working experience in the market”, “freight protection”, “transportation safety”, “delivery dates observance”;
– transport operator financial stability, including facilities.
Besides, the program allows choosing the best delivery scheme. For this the system of parameters is investigated, which should be taken into account by the intelligent system for centralized freight traffic planning, and parameters system is formed for automated choice of the best delivery scheme (Table 1).
Table 1. Parameters for the best delivery scheme automatic choice by the program intelligent system for centralized freight traffic planning

| Parameters, important for the transport operator | parameters, the most important for the freight services consumer |
|-------------------------------------------------|---------------------------------------------------------------|
|  | Delivery scheme parameters, concerning transportation service, loading, unloading and reloading works |
|  | Delivery time |
|  | Delivery-time compliance (complex parameter, determined with the account of delivery dates and urgency number[8]) |
|  | Fright motion tracking / complete information about freight condition and location |
|  | Route sector number |
|  | Safety (with the account of environment conditions) |
|  | Freight preservation |
|  | Damage probability |
|  | Probable damage rate (complex parameter, accounting transportation without damage and loss [8]) |
|  | “Transportation” stage parameters |
|  | Transportation time |
|  | target freight date compliance |
|  | Delay probability |
|  | shipping costs for the transport operator |
|  | shipping costs for the consumer (the total of the shipping costs for the transport operator and the desired profit of the transport operator) |
|  | Traffic–carrying capacity |
|  | Traffic intensity / Traffic jams |
|  | Roads quality (complex parameter) |
|  | Convenient access roads |
|  | parameters, concerning transportation service, loading, unloading and reloading works |
|  | Waiting time at the intermediate transfer hubs |
|  | Compliance with the calculated waiting time at the transfer hubs |
|  | Transport operator expenses caused by waiting at the hubs |
|  | Maintenance costs at hubs for the consumer |
|  | number of transport hubs |
|  | Carrying capacity of the transport hubs |
|  | Transport hubs crowding |
|  | System convenience at the transport hubs |

At mixed freights it is necessary to take into account time expenditures and expenses for freight handling and its temporal storage at hubs and reloading from one type of transport at the other.

Existing parameters for freight transportation estimation, introduced in the regulatory documentation and works F. Kotler, A. E. Goreva, A. O. Nichiporuk, A. V. Dmitriev and M. V. Afanasiev have been analyzed and estimated.

More often the freight transportation scheme is chosen by the least transportation costs of the transport operator (shipping costs) and delivery time, but in fact the consumers should take into account more parameters.

The wide range of the quality parameters is introduced in AUSS R 51005-96 “Transportation services. Freight transportation. Quality parameters name plate” [8]. But the parameters list in [8] can not be applied to the automated freight transportation planning, as some parameters depend on the transport operator and the some parameters depend on the route environment. Road conditions influence both freight timeliness and transportation without delay (environmental conditions), as well as actions (competency) of the transport operator, that is why they should be taken into account when choosing a transport operator and the freight route.
Besides, their importance should be taken into account. Importance of some parameters (timeliness parameters, freight safety, and delivery without delay) cannot be estimated at the planning stage, they can be estimated after the delivery, and consequently, statistic values of these parameters should be taken into account when estimating transport operator reliability.

Transport operator choice scheme as well as delivery scheme takes into account parameters’ importance data. The authors plan to determine importance coefficients in further investigations [9…11] for determining the best transport operator and the delivery scheme automatically. To determine the importance coefficient of individual and complex parameters it is planned to use the expert estimation method.

Figure 2 shows the algorithm of the best freight transportation scheme choice in the intelligent system for centralized freight traffic planning.

**Figure 2.** The algorithm of the best freight transportation scheme choice in the intelligent system for centralized freight traffic planning: $n$ – number of alternative delivery schemes; $A_{ij}$ – value of $i$-th parameter for $q$-th delivery scheme, $i=1…m$; $j=1…n$; $b$ – normalized parameter value; $\gamma$ – importance coefficient; $d$ – delivery scheme efficiency.
4. Conclusion.
The Intelligent system for centralized freight traffic planning allows:
- distribute the orders for freight transportation among transport operators’ resources automatically, this distribution will be fulfilled by the program algorithms, with the account of parameters important for the consumers, transport operators and society, with the account of hubs and vehicles location;
- to fulfill freight transportation requirements using resources of the transport operators efficiently;
- regulate and optimize vehicles flows;
- partially bring out irrationally exploited railway vehicles from the routes.

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