Conceptual framework for solving problems of commercial transportation of goods in the city logistics system

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Abstract. The aim of the study is to develop conceptual provisions and operational recommendations for the development of urban transport logistics on a public-private partnership basis. Theoretical studies were carried out using methods of analysis and synthesis of existing scientific developments in the field of territorial management of logistics centers, distribution sites, and terminals at the municipal level. At the end of the study the following results were obtained: - the necessity to change the format of transport and logistics services for urban economic relations is proven; - the efficiency to establish a city network of interceptive logistics sites for trucking on the principles of public-private partnership is justified, parameters for choosing locations for such logistics facilities are developed and their attributes are formulated; - recommendations on advanced transport management on the basis of the municipal digital center with the aim of increasing the efficiency of the urban transport system with environmental protection were proposed.

1. Introduction
The problems of high-quality and timely delivery of goods in the urban logistics system are conditioned by an increasing number of consumers, by changes in life formats, and by an increase in the number of cities themselves. The understanding of the size of a city has also changed: cities with a population of one million or more were long considered as large, but due to rapid automobilization regional cities with a population of 300 thousand people and more than three hundred vehicles per thousand inhabitants were also involved in the range of problems. Truck transport in the city is forced to "compete" with private and public transport for highways, increasing the level of environmental pollution and exacerbating traffic safety issues.

The subject of the study is the determination of economically feasible freight transport schemes in the urban area.

The study showed the complexity and heterogeneity of the theoretical framework in this area of scientific studies, the lack of uniform standards for the commercial cargo movement under conditions of local road congestion, the lack of regulations for toxic vehicle emissions within the city limits.

The listed reasons with reference to the subject of the study necessitated the development of a draft urban network of interceptive sites for commercial freight vehicles based on the principle of public-private partnership. The logistics tools of the project will radically change the concept of urban transportation of goods, passengers, and the concept of using private vehicles.
2. Methods and materials
The study was conducted using methods of analysis, synthesis, based on integration theories and concepts, scientific developments on the problems of the urban transit system, transport and logistics services, logistics centres management within the limits of a city. [1]

A transport system of a city is a vital service infrastructure and it directly affects the development of public production and living standards of the population. From a logistics point of view, this system includes such management objects as loading and unloading points, sections of constant and discrete movement, special parking lots for freight vehicles, and other system objects. The main task of logistics management is to minimize the resistance of freight traffic to the general urban traffic stream and its effective construction within a framework of urban logistics.

Numerous publications are devoted to the study of the essence and structure of the urban transit system. Generally speaking, scientists agree that this is a combination of various transport communications, that include engineering structures and equipment, transportation facilities with rolling stock, passenger and cargo transportation control systems.

Most authors pay attention to the division of urban space depending on the mobility factor:
- maximum use of private vehicles
- vital activities on the periphery
- life in the centre of a city with well-developed urban public transport
- constantly limited car traffic in a city centre and during rush hours. [2]

Freight transport in a city is an integral part of processes of production, distribution and consumption of goods. Therefore, vehicles are mainly used for movements between manufacturing enterprises, distribution centres, warehousing facilities, retail stores.

As part of the study, it is important to see into a matter of transport and logistics services and its elements. Using the analytical method of decomposition, we would like to give attention to the concept of logistics services, which usually means customer service and, accordingly, a set of processes and actions to form consumer utility for solving customer problems. Typically, logistics services are defined as "... activities that provide an opportunity to meet customer needs at the lowest total cost and guaranteed receipt of goods of the appropriate quantity and assortment in the right place, at the right time at the right price." Thus, price, quality and delivery time are directly related to cost optimization for all stakeholders in the logistics process.

Of special significance is the study of the essence of the transport services concept, which is presented in the Big Dictionary of Economics as “... the final performance result of transport enterprises in fulfilling a contract of carriage. It represents a set of means, forms and methods that ensure a sale of transport products (services) to a customer (seller or buyer) .... " In practice, transport services are used to refer to passenger and cargo transportation by various means of transport with the provision of related transport services.

Transport and logistics services remain understudied as an economic phenomenon. Most authors include not only warehousing, storage and delivery among such services, but also financial services, information and communication processes. However, the common view is the understanding of transport and logistics services as "... a range of services by planning and organization of the delivery of goods in sufficient quantity, quality, to the right place, right on time, at the best price." [3]

One has to agree with the opinion of some authors [4] that all transport and logistics services can be grouped as follows:
- services and facilities before sale of goods;
- logistics services for warehousing and formation of supplies of commodities, assortment, cargo units and capacities, organization of information flows during the process of sale of goods;
- logistics after-sales services for guarantee maintenance and customer retention.

In a logistics system, transport acts as a technical base for material flow carrying. Freight transport as part of urban logistics provides economic ties between manufacturing enterprises, distribution centres, wholesale and retail trade enterprises. Road carriage is easily combined with other means of transportation, as it is characterized by high speed of delivery and flexibility. In the Russian
Federation, ¾ of cargo is transported by road, and if expressed in terms of municipal units this figure is close to one hundred percent. However, on the territory of a city freight transport can impede passenger traffic and is also characterized by high servicing costs.

Thus, the availability of commercial trucking for an exporter and a receiver creates a competitive environment in the market of transport and logistics services, but at the same time this advantage is offset by a poor urban road infrastructure.

3. Research results

3.1. Logistic analysis of road freight transport

For the purposes of the study, a logistic approach was used to solve the problem of road freight transport within the urban area, that ensure the complexity of all elements and processes.

So, the highway acts as a logistic tool for servicing and providing road conditions for all participants of the logistics process. This is confirmed by the integrated evaluation parameters of logistics systems in different countries. For example, the Russian Federation ranks 97th in transport infrastructure development, 94th in timely delivery, 92nd in logistics quality and competitive pricing, 79th in transparency and control of customs procedures.

Generally, when choosing a type of transport for a delivery of goods, six parameters are the leading: shipping costs, delivery time, reliability, capacity, availability and safety. Highway transport ranks first in reliability, availability and safety. It is to be recalled that urban transport "require" compliance with such parameters as small lots and "just in time".

When overviewing the general situation, it may be noted that in 2018 in the Russian Federation, the volume of highway transportation increased by 2.6%, and freight turnover increased by 1.6% due to the development of retail trade, electronic commerce and the increase in the transportation of agricultural commodities.

The most viable factor of increasing car traffic was online trading, which in 2018 showed an increase of 1.6 times. Motor transport leads in groupage due to the high speed of transfer and delivery of goods and due to tariff design process, that is comfortable for customers.

In the motor transportation market, there are various enterprises that vary in structure, scale and type of services provided and are part of retail companies, large industrial and agricultural holdings; transport and logistics operators, including those specializing in groupage or full truck load transportation; integrated logistics services companies 3PL and 4PL. Major players in the Russian trucking market are the Business Lines group of companies, OOO Celta (owned by the largest retail discounter PAO Magnit) and OOO Agro-Auto (owned by the federal retail chain X5 Retail Group).

The density of paved roads in Russia is 47 meters per square kilometre, in China it is 320, in India it is 525, in Germany it is 1848 meters per square kilometre. At the same time, the share of transport costs in the structure of GDP in Russia is one of the highest in the world and amounts to 20%.

3.2. Analysis of the road conditions in the city of Rostov-on-Don

According to the official statistical data analysis, the following problems of the studied municipal territory were identified:

- the capacity of the existing road network does not correspond to the actual traffic density, that arise from the lack of relief roads of the main gateways to the city, insufficient number of detours for the exit of transit transport out of the city, the existence of single-level highway and railway crossing;
- regulatory requirements of operational characteristics are not complied with: traffic density should be 1-3 thousand cars per day, but currently this figure is up to 25 thousand cars per day at the approaches to the city. Since 2011, the share of roads that meet regulatory requirements in the Rostov Region has decreased by 13.9 percentage points;
- road facilities remain at a quite low level: additionally about 150 km of electric lighting lines, about 4 thousand road signs, approximately 15.5 km of guard rails are required;
3.3. Development of a city network design of interceptive sites for commercial freight vehicles on the principles of public-private partnership

We consider it expedient to suggest consolidation of heavy vehicles at the interceptive parking lots of logistics centres and delivery of received goods to stores with lighter commercial freight vehicles, as a conceptual approach to solving the problems of moving freight vehicles in the city logistics system. The delivery fleet will operate on the principles of sharing. The municipality must participate in an asset contribution with cars of the corresponding class.

Let us pay attention to the following fact. All large retail chains have their own distribution centres, that impedes the consolidation of goods for small wholesale, of local chains and retail trade, which major players consider as competitors and do not want to process their goods.

This confirms the effectiveness of our suggestion of using consolidating goods for small-network and non-network retail at network logistics sites and reducing the load on urban highways. Such freight consolidation will reduce the number of cars at the "final mile" in the city by 40-60%.

According to experts, the average load of a freight vehicle is approximately 25%, and one average truck travels up to eight outlets per working day. It is thus estimated that one supermarket receives up to 40 shipments per day from various suppliers. [6-10]

In the city of Rostov-on-Don federal highways intersect with thoroughfares. The trading environment of the city is represented by the objects of the federal and regional distributive networks, that have their own logistics centres.

According to experts, transport and logistics costs can reach up to a fifth of the price of goods, and the proposed logistics approach will help reduce this figure to 10%.

About a tenth of freight transit cars move through the gateways to the city, almost all remain in the city, including up to 30% in the city centre. From the thirty percent indicated above, 25% are heavy vehicles. More than a hundred logistics companies are located in the city, but only about 15 of them have parking lots for trucks.

In our opinion, it would be efficient to use these logistics sites as “interceptive” parking lots for trucks that enter the city from federal highways, thereby reducing the load on urban thoroughfare.

We suggest the introduction of uniform regulation of the city traffic of commercial vehicles and the use of interceptive parking lots. The capacities of ordinary city parking lots are not designed to service the increasing flows of freight vehicles, as confirmed by the results of the study on the problems of the parking congestion of objects of various functional purposes, conducted by the Federal Autonomous Institution “Federal Centre for Regulation, Standardization and Technical Conformity Assessment in Construction” (see table 1).

| Time   | Households | Business centres | Hotels | Industrial buildings | Shopping centres | Entertainment facilities after 19:00 |
|--------|------------|------------------|--------|----------------------|------------------|-----------------------------------|
| 07:00  | 100        | 0                | 100    | 0                    | 0                | 0                                  |
| 08:00  | 90         | 25               | 95     | 75                   | 0                | 0                                  |
| 09:00  | 50         | 75               | 85     | 90                   | 15               | 0                                  |
| 10:00  | 45         | 100              | 80     | 95                   | 40               | 0                                  |
| 11:00  | 45         | 100              | 78     | 100                  | 60               | 10                                 |
| 12:00  | 45         | 100              | 75     | 100                  | 75               | 20                                 |
| 13:00  | 45         | 90               | 92     | 95                   | 80               | 25                                 |
We suggest using the following principles for regulating the movement and parking of commercial freight vehicles in the city:

1) The intensity of truck traffic should decrease as it nears the city centre and tend to zero in central urban areas.

2) Transit traffic should not affect heavily populated areas of the city.

3) Urban public transport should be prioritized.

4) To integrate transport networks a system of interceptive parking lots should be developed.

5) Cargo transportation in the city should be optimized by developing logistics centres and systems.

Let us specify that a logistics centre should be understood as a number of companies in a certain territory that provide such logistics services as warehousing, cargo processing, distribution, as well as transport and auxiliary services.

Within the concept being developed we suggest considering not only the existing sites of current logistics centres as interceptive parking lots for trucks, but also newly created under the network principle facilities in the places that are most convenient for reformatting large loads. Network elements will serve nearby retail, construction and other socio-economic facilities that require regular delivering of goods.

Such a logistics facility will serve the entire supply chain, not individual customers.

Let us formulate the following signs of interceptive logistics sites:
- location on a separate territory;
- aggregation of several commercial enterprises for providing logistics services not lower than 3PL;
- availability for any commercial company;
- participation of the state in the design, construction and management;
- shared cost allocation between participants of network platforms for the development of services, information and communication technologies.

4. Discussion

Let us go to the experience of several European countries in the use of municipal distribution centres to optimize the movement of commercial goods within the city in order to improve delivery efficiency and reduce environmental risks. [6-10]

So, in Germany, city distribution centres fulfil a function of a city logistics service and provide coordination and optimization of vehicle loading, which is currently 70-80% and this is a very high indicator. Private enterprises willingly cooperate with these centres. Of special note is the use of small vehicles, that reduces transport costs by 20-30% and halves the number of cars on city roads. [11]

In the city of Kassel, 10 transport companies cooperate with one logistics operator with the transfer of the rights to it to deliver goods around the city. The city logistics centre provides cargo transhipment to light-duty vehicles for delivery to end users. In Bremen nine out of 12 transport companies collaborate with a logistics operator that manages the city distribution centre. Since the
beginning of the 1990s, the urban logistics service in Berlin has been coordinating shipping operations of ten transport companies in the city through two urban distribution centres. [11]

A similar experience is presented by Paris, where there are many small and pedestrian, very crowded traffic areas. A small city distribution centre is also used here, from the platform of which vehicles of particularly light capacity are loaded, in combination with a system of reversing areas and parking lots.

We believe that the participation of the state, municipality and business in the management of transport development of the city on the basis of public-private, state-municipal partnership is the most effective tool. [12]

Municipal authorities can extensively use land tax privileges for logistics centres that provide their sites for interceptive parking lots. To monitor compliance with the rules for the movement of freight vehicles in urban space, we offer, based on the experience of developed countries, to establish a service for parking inspectors equipped with mobile devices with appropriate software.

An important point is the establishment of a parking charge, depending on compliance with carbon dioxide emission standard. Thus, in London, the highest parking rate is set at a carbon dioxide emission level of 225 g / km, and with a rate of 100 or less grams per kilometre, parking charge is not paid. Such a system will stimulate the use of electric vehicles in the system of light-duty commercial vehicles. [13]

We confirm our suggestion with some examples from the experience of European countries. [12] In Austria, a state-owned transport and logistics infrastructure development program is being implemented that helps optimize supply chains and organize multimodal transportation.

In Hungary, logistics centres are owned by the state and private companies. With significant private investments, the state in the first year provides benefits, bears a part of the salaries expenses for employees.

In our opinion, the following parameters can be used as criteria for choosing location for an urban logistics site within the framework of public-private partnership [14,15]:
- number of manufactures, volume of shipped goods of own production, work and services performed
- retail turnover for a year
- foreign trade turnover of the municipality
- number of small and medium enterprises, including microenterprises, in the city
- turnover of small and medium enterprises, including microenterprises, million rubbles
- urban population
- urban population density
- development area of the city
- climate in the region
- density of paved public roads
- public railways on the urban territory
- distance from the logistics site to transport corridors
- location of the logistics site relative to the airport, seaport
- distance from interceptive sites to industrial parks and manufacturers
- quality characteristics of roads and associated communications
- volumes of commercial cargo transportation by mode of transport

In our opinion, the territory of the interceptive logistics site must be divided into functional zones:
- change of modes of transport and its unloading in the area of a multimodal or intermodal terminal;
- processing and warehousing of goods, consolidation or their disaggregation, cross-docking in the industrial and logistics zone;
- a zone of services for transport: repair shops, services;
- administrative zone: business offices for all participants;
- a zone of commercial services for employees and users.
When choosing a location of a network interceptive site, it is necessary to determine the need for the provision of transport and logistics services for potential customers (wholesale and retail trading companies) and assess the possibility of creating optimal conditions for their implementation.

According to the experience of Westminster County, London, we consider it appropriate to regulate the stay of commercial vehicles for unloading goods in the city as follows:

- from 8:30 a.m. to 11:00 a.m. trucks can be loaded or unloaded without time limits
- from 11:01 to 18:30 commercial vehicles may stop for loading and unloading for no more than 20 minutes.

We suggest resolving payment issues using a mobile application on iOS, Android and Windows Phone platforms with the functions of interacting with a car navigation system, working out a route to a parking lot; tracking of available lots and tariffs; sorting results and saving your favourite parking spots.

Monitoring compliance with all requirements, storing and analysing information should be carried out through a single municipal digital centre, which is created as part of a public-private partnership and with the help of modern software provides the following options:

- monitoring through detailed electronic maps of the best-route selection, installation of the route control points, control of restricted areas for entry, the time of parking and delivery of goods, the passage of the route;
- monitoring the state of transport and cargo, including the installation of sensors on the car, its location and speed, travelled distance, mass control, cabin temperature, fuel consumption;
- operative communication between the driver and the dispatcher, driver identification, door opening control, automatic transmission of coordinates, blocking of motor;
- reducing mileage and run time, improving the safety and reliability of transportation in urban logistics. [14]

Thus, the development of interceptive network logistics platforms for commercial cargo will be carried out on the principles and technologies of adapting urban logistics to increasing freight volumes.

This will allow to effectively regulate the number of transport vehicles in bottlenecks of urban highways, to increase vehicle fleet turnover by using light-duty vehicles, and to reduce the load, including environmental one, on street road networks.

5. Conclusion

Based on the results of the study the following measures are suggested to address the identified issues and problems:

- urbanization is characterized by the territorial expansion of cities, which is accompanied by an increase in the volume of commercial transportation of goods and leads to an overload of both new and existing urban highways in the context of an increase in housing density. The current situation requires a review of the established practice of managing the urban transport system based on a logistic network approach to organizing a system of interceptive platforms for freight vehicles on the principles of public-private partnership;
- the existing municipal system of urban transport development management does not provide innovative transformations, which requires system reform based on the creation of a digital control centre and using intelligent logistics tools, including those for air pollution control;
- the suggested conceptual approach to the creation of logistics platforms will help reduce urban freight turnover, consolidate cargo on lighter and more compact trucks, which will reorganize the system of limited movement of freight vehicles, create conditions for the development of a new logistics terminal and logistics infrastructure.
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