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## **CONDITION FOR APPLICATION OF LOGISTIC PRINCIPLES IN PRACTICE OF URBAN PUBLIC PASSENGER TRANSPORT IN THE CITY OF OMSK**

**Summary.** The task of increasing efficiency and quality of public transport has gotten special acuteness for large cities of Russia in connection with expansion of service by commercial carriers. There have no works done on the city of Omsk, where the transport system has its own characteristics. In this paper, characteristics of Omsk urban public transport are researched. The scheme that clearly demonstrates what factors have a negative impact on the development and functioning of the Omsk passenger transport system is developed. The measures that improve the efficiency of the passenger transportation system and provide an opportunity to advance the implementation of logistics principles are proposed. The activities took into account the experience of reforming the public transport system in other cities, the characteristics of the Omsk city system and a view to engagement of other scientists in this field of science.

### **1. INTRODUCTION**

The traditional concept of the organization of public passenger transport, the use of which is widespread in the cities of Russia, is more acceptable to the "seller's market" conditions of transport services. Currently in the market of transport services of passenger traffic, where supply exceeds demand, it is important to make the transition to the logistics concept, which considers, in the first place, the terms "buyer's market".

On the one hand, the work of public passenger transport is in line with the demand for its services; on the other hand, it formed the demand for transportation, depending on the capabilities of the city transport system [14, p. 92]. It should be noted that at the heart of transport logistics is a systematic approach that provides the satisfaction of demand in terms of effective use of resources of the transport system.

### **2. THE SYSTEM AND PROBLEM**

To date, none of the big cities of the Russian Federation have a fully integrated system of urban passenger transport. In most cities, passenger transport is not considered as a single unit by

a functional or a spatial point of view [19, 20, pp. 170-176]. Evaluation of how new development affects the traffic has been carried out very rarely. The declared aim of the urban passenger transport is to meet the needs of the city population in transportation, but in practice, it is more inclined towards providing revenues for carriers. As a result, there is poorly synchronized movement of all modes of transport, and there is practically no integration of transport modes. There is no single information support that would include modules for the passenger, the carrier, the customer of the services and the management system. Transport does not work as a single mechanism; it works in conditions of separate types which occurred in the competitive fight for revenue [21].

The use of logistics in passenger transport is poorly developed. There are no full theoretical works describing the influence of the dependencies of the transport service system, and there are not enough studies. The losses from the decline in the quality of services (in the transition to the "buyer's market") are manifested in the increase in waiting time, the time of communication and the increase in the cost of travel. They directly affect both the financial results of the carrier and the customer of services, and the social activity of the population [16].

Attempts to create a unified transport system of passenger traffic with the integration of road transport, metro, rail, river and air transport, with a unified information base that works online, have been taken in a number of Russian cities, including St. Petersburg and Moscow. However, we cannot say that the purpose of the work at the same time has been fully achieved. The most successful, according to the authors, is the experience of the city of Kazan [11]. The transport portal of Kazan presents all kinds of public transport and transportation schedules, with filtering by the routes, stops, destinations and carriers, and provides news about changing traffic patterns and information about tariffs. Since 2007, the bus system in Kazan has gradually reformed, and there has been an almost complete renewal of the bus fleet with the transition to low-floor medium and large-capacity buses with a uniform red color, which gave Kazan the definition - "the city of the red buses." By 2013, light rail and aeroexpress were launched, the international airport was updated, railway and bus station were constructed and a further update of the rolling stock of ground public transport and development of information security were done. However, as in other cities, consumers complain regarding the transport services such as driving style of buses, missing of stop, long downtime at the stops, the early termination of work of public transport, the lack of tickets for pupils and students and the difficulties arising from the return of cash debited from the card [11].

In Omsk, as well as in several other cities of Russia, the need to attract private logistics operators and use of commercial vehicles occurred in the mid of 90s. Since then, the conditions of functioning of public transport have been constantly changing. The main stages of reforming of Omsk public transport system are presented in Fig. 1.

In the city of Omsk, since 1999, the administration has been making continuous efforts to put under regulations and limit the uncontrolled growth of traffic of commercial vehicles and its impact on the operation of public transport. Since 2012, the administration has attempted to coordinate the work between the municipal and commercial vehicles by forming a common route network and creating the transport portal where it is possible to locate the vehicle and calculate the arrival time of the stop [4]. In connection with the adoption of the Federal Law 220 in 2015, it has decided to form a new unified route network for the coordination of passenger flows between municipal and commercial vehicles [1, pp. 386-390]; however, private carriers operating on the routes continue to oppose the administration if it does not coincide with their interests. By Federal Law № 220, all the routes were divided into two categories: the regulated tariff and the non-regulated tariff routes [12]. While the private rolling stock runs on both of these, the municipal transport serves only at the regulated tariff. The same route may serve by municipal carrier at the regulated tariff, by private carrier at the regulated tariff and by private carrier at the non-regulated tariff with the provision of travel by transport cards and electronic tickets or without him. At the same time, the coordination of municipal and commercial vehicles has been solved in full.

The municipal enterprises have continued to use vehicles in spite of their absolute wear of service life until now. Wear of trolleybus and tram depot of the city is more than 90%. Over the past two years, the number of routes served by municipal enterprises has decreased dramatically due to the reduction of the municipal units of rolling stock. Increasing the number of commercial routes has

increased the total number of scheduled routes in the city, which has led to unnecessary duplication of routes and reduction of passenger traffic at each of them, which, in turn, has led to reducing the effectiveness of the use of the rolling stock.

In general, the route network of the city is often adjusted based on experience and intuition of expert trucking companies - it does not take into account changes in the efficiency of the whole route system of urban passenger transport. The network route of commercial vehicles is usually formed spontaneously, without taking into account features of the municipal network. Often the intensity of traffic of public transport during peak hours exceeds the capacity of a number of central stopping points from the use of a large number of minibuses.

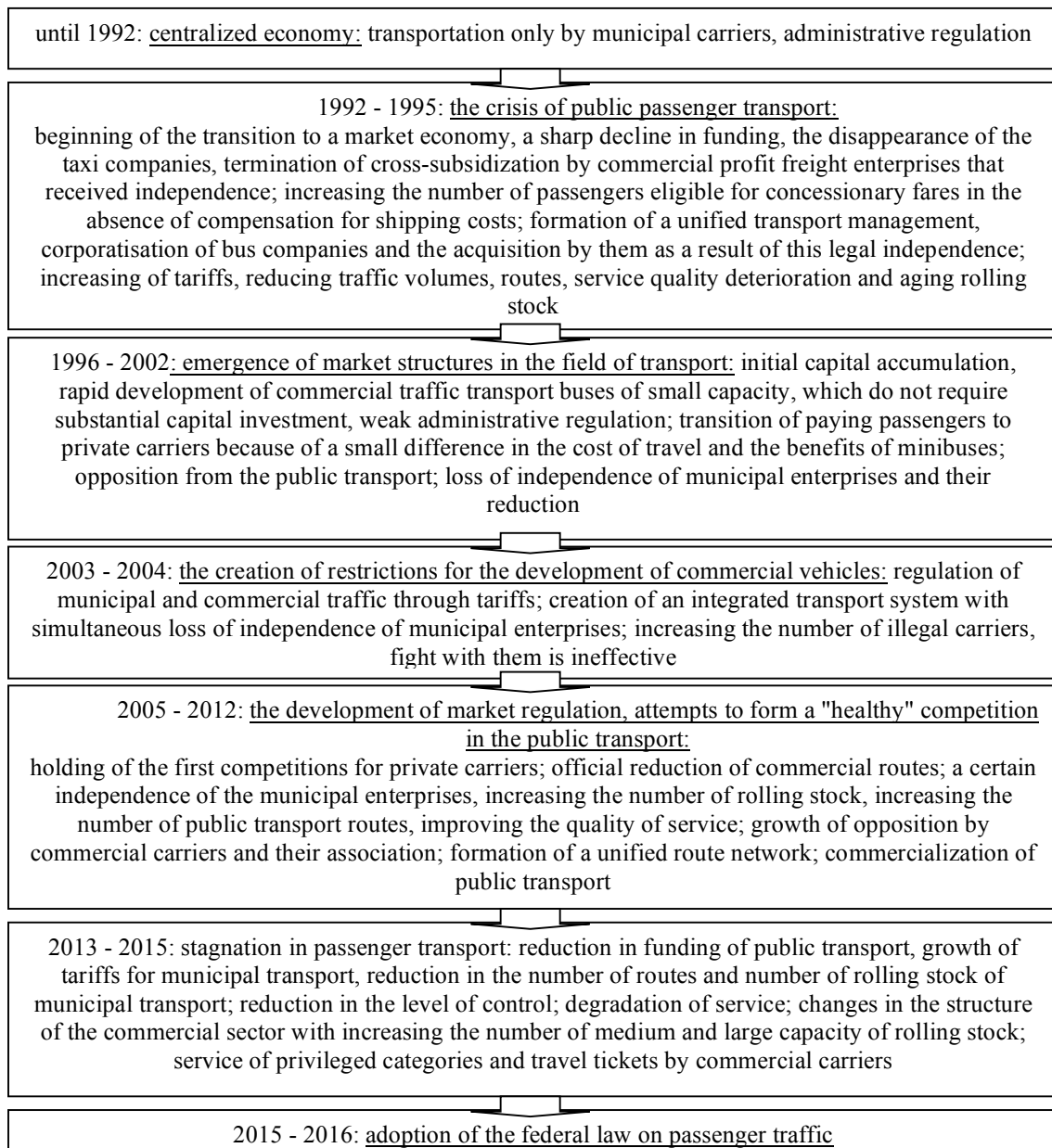


Fig. 1. Stages of reforming the public transport system in Omsk

In most major cities of Russia, and in Omsk in particular, the adaptability of the system of urban public transport takes place by the scenario presented in Fig. 2.

One of the peculiarities of the work of public passenger transport in Russia is the presence of rudimentary administrative municipal transport management system. Along with weak legal regulatory base in the industry, it is leading to distortions in the functioning of the conditions for municipal and commercial sector. With the lack of legal protection, which lags behind the development of market relations in the field of passenger transport, it is difficult to regulate the market. Problems of the coordination of municipal and commercial vehicles and the formation of a rational structure of the rolling stock are not solved [16]; there is a duplication of routes and split of passenger volume traffic between them.

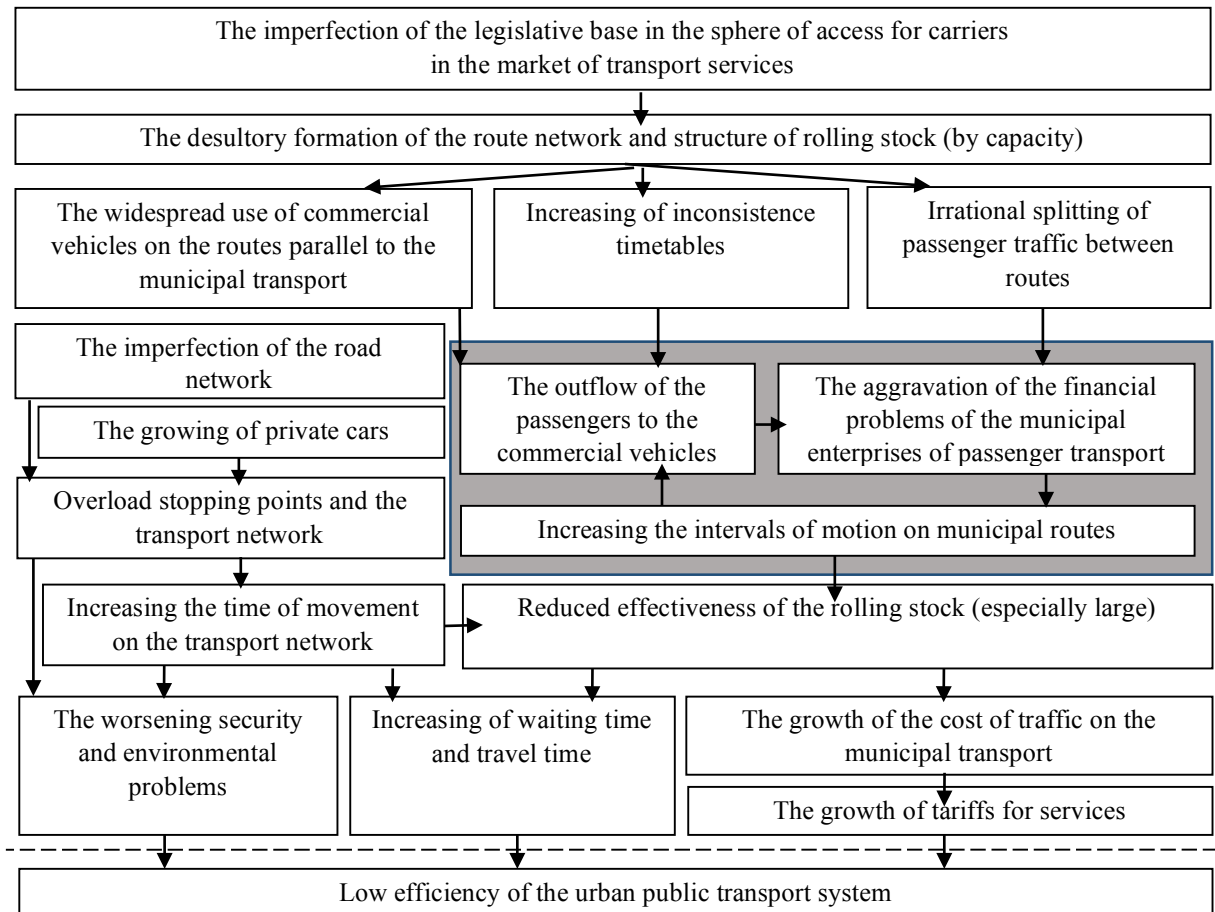


Fig. 2. The main problems of the reform of Omsk public transport

Municipal carriers, which as a rule are forced to use the rolling stock at all times during the work on the route in accordance with the schedule, incur significant losses due to the large unevenness of demand for passenger transport over time. Rolling stock of large capacity is forced to stop at all the stops to ensure compliance with established standards [13, p. 113-134]. In addition, the use of rolling stock of large capacity on routes with low passenger traffic increases the intervals of motion, which is the cause of reduction in the demand for transportation, and consequently, reduction of the income [18, pp. 80, 100]. Moreover, as there are higher levels of taxation for large-capacity buses, all this determines the loss of municipal transport in competition with commercial carriers, which use small capacity buses. Commercial buses are not connected with the schedule and can easily respond to changes in demand to achieve a greater density of passengers and improve the financial result.

The aggravation of the financial problems of municipal enterprises leads to a lack of funds for the purchase of new buses and spare parts, and, therefore, to a wear of rolling stock. In turn, it reduces the efficiency of transportation and the attractiveness for the public transport of passengers and increases transportation costs. By increasing the cost of travel in the municipal transport and a minor difference

to the cost of travel with a commercial transport, revenues of municipal enterprises are not increased. Passengers go to commercial carriers, which provide a higher level of quality - a shorter interval and a higher speed of commuting. Some of the carriers work illegally.

At the same time, there is a cycle (highlighted by color blocks in the figure), which is expressed in the fact that the problems of municipal public transport lead to reduction in service quality. Therefore, most passengers choose a personal or commercial vehicle to reduce the time, which in a way exacerbates the problems of municipal enterprises. In turn, it leads to a reduction in service quality. It is necessary to affect the elements of the system by control system, taking into account the principles of logistics. Otherwise, a further reduction in the traffic volume and the number of vehicles in line will continue.

Due to a lack of financing, municipal enterprises cannot serve passengers while preserving proper quality, and in such conditions, they are forced to give up routes of servicing to private carriers.

Thus, at present, commercial transport takes an increasing share of passenger traffic due to advantages in speed of delivery and a small difference in the cost of travel.

The existing system of municipal passenger transport in Omsk is characterized by insufficient efficiency, as for the passenger, it is manifested in increase in the intervals of traffic and waiting time and reduction in reliability and accessibility of services; for the carrier, in the absence of profitability on routes; and for the transport department, in the growth of subsidies and the reluctance of carriers to serve the social meaningful routes [1, pp. 399-405].

### **3. METHODOLOGICAL APPROACH**

#### **3.1. Literature review**

With regard to passenger transport, logistics is a set of administrative decisions, technical means and technologies that provide a given level of passenger service, with safe, reliable and continuous delivery "from door to door" at a certain time at a minimum cost [6, pp. 19-20, 32-38]. Logistic approach to the management of passenger transportation requires full consideration of factors and requirements for the transport process [5]. To do this, it is necessary to combine some parts of the transportation process in a single system, oriented in their work to ensure the quality of transport services to the public in achieving their goal [10, pp. 319-325]. Implementation of logistics principles in the practice of public urban passenger transport for optimization the transportation process makes it possible to eliminate the complex contradictions that arise on the one hand, between local authorities and passenger transport enterprises, and on the other hand between transport enterprises and society.

In an article [34], the authors said: 'basic logistic principles, which can be applied in the development and management of the route system of public passenger transport: quality control principle, total costs principle, system stability and adaptability principle In view of the trend of development and implementation of logistic principles in public passenger transportation organization, within the logistic principle of the system stability and adaptability using the given methodology in the formation or improvement of the route network provides the possibility of rapid re-routing, assigning temporary routes, prompt intervention in the transportation process in order to meet transportation needs of the population'.

The purpose of the urban public transport system - the timely satisfaction of demand for passenger transport and delivery of passengers to their destinations with the appropriate quality - is achievable by using the logistical approach to the functioning of the system [3, pp. 6, 33-35, 58]. The functioning of urban passenger transport system brings together different actors with different objectives [27, p. 64]. So transport companies are interested in obtaining the maximum possible profit, municipal governments are interested in minimizing the burden on the budget, and the passengers are interested in the availability of urban passenger transport services, primarily in value [2, pp. 138-139]. The interests of the passenger and carrier in the sphere of urban passenger transportation do not coincide. For carriers, efficiency is estimated by profitability, and it is important for them to receive revenue, including due to the replacement rate. From the point of view of the municipality, efficiency is

understood as the satisfaction of the transport needs of the population, with minimal costs to the city budget and compliance with security requirements. For a passenger, the efficiency of urban passenger traffic is determined by the reliability of the service, the comfort of the trip, the speed of the message, the minimum number of transfers and the availability of a fare. The system should be guided by a high level of quality of services, because it is the quality of service that improves the level of transport demand, which ultimately forms the carrier's profit [9].

An analysis of the developed approaches to the quality of the passenger transportation process is clearly presented in the work [1].

### 3.2. Assumptions

However, there is a positive trend to competition for use of a route, and not on the route. Carriers wishing to operate on the route, reducing travel costs and maintaining preferential categories of the population, improve the quality of service. Increasingly, there is a tendency to reduce the proportion of the volume of traffic by public transport, and increase capacity of rolling stock and number of routes by commercial vehicles.

In order to identify further ways to improve the efficiency of public transport (in the conditions of poor coordination and integration of the work of municipal and commercial transport in Omsk, a high wear of rolling stock and increasing competition from private carriers), it is advisable to analyze the practical experience of the implementation of logistics principles in passenger transport, i.e., the dynamics of public passenger transport in the city.

The creation of conditions for the application of logistics principles in the practice of urban passenger transport will increase its effectiveness, quality and accessibility.

### 3.3. Basic structure of methodology

Methods of research of the passenger transportation system by public transport are as follows - the theory of passenger road transport, logistics, theory of urban transport systems development, queuing theory, fuzzy sets theory, project management, business planning, structural and functional and system analysis, mathematical modeling and forecasting, expert methods assessments, full-scale surveys, statistical processing of empirical information, economic and mathematical methods, marketing of the transportation process to the planning and operational organization of transportation process.

The main directions of solving the problems of public transport in the cities are the creation of a competitive environment, the definition of the rational structure of the park and the effective organization of transportation.

Competitive environment helps to reduce budgetary expenses, i.e. there is an opportunity to receive more services for the same money; however, in the market conditions, local authorities are forced to make more informed decisions, as private operators will refuse to provide transportation services otherwise [30].

However, in the conditions of the market, there is always a real threat of monopolization, which hinders the possibility of achieving the basic goals of the development of public transport. In order to move to a regulated market, antimonopoly legislation should be improved in order to provide competitive advantages with setting a quota for the maintenance of routes by one operator in the proportion of 20 to 30% of the total number of routes on the route network. One of the important conditions, including in the opinion of carriers, is the presence of one "owner" on the route, which avoids competition for the passenger on the route and its negative manifestations in the form of a "race" for the passenger [25].

When holding a competition, it is possible to provide a group of routes with segmenting the market into a network of social routes where financial support is required, and self-supporting routes. Contractual relations with local authorities should provide for real obligations and responsibility of local governments to recover costs when performing socially significant transportation, transport during peak periods, on weekends, and on routes with a small passenger traffic (including through sanctions to unscrupulous carriers, fees for the use of infrastructure) [8]. One option is to separate the

regulatory and operational functions from the establishment of an independent management body. Municipal transport enterprises can be transformed into joint-stock companies to increase motivation for effective transportation services.

For commercial carriers to work, it is necessarily to monitor the performance of their obligations. The process of involving private operators in the urban passenger transport system is to compel them to fulfill all the legal obligations, regularly pay taxes, to refuse unfair competition on the routes, to ensure compliance with the requirements for traffic safety and environmental protection.

In the market for public passenger transport, it is necessary to develop conditions for the formation of a competitive environment with large capacity buses. Currently, minibuses are in demand because, compared to large capacity buses, they provide greater profits and lower investment risks. At the same time for passengers, it is extremely undesirable to reduce buses of small capacity, as route taxis in the city of Omsk carry the function of high-speed transport and significantly reduce the time of delivery due to small intervals of traffic and a higher speed of commuting. However, for operators using rolling stock of large capacity, certain advantages should be provided.

To achieve these benefits, one needs the following:

- identify routes that are advisable to service by large vehicles - with a passenger traffic of about 500 passengers per hour in one direction (the equivalent is to ensure the nominal load of the vehicle at a 10-minute traffic interval), with suitable parameters and condition of roads [1, p. 411-413];
- determine the routes that it is advisable to service with a rolling stock of small capacity, above all, it is routes with low passenger traffic or insufficient width of streets [33];
- reduce investment risks associated with the use of large capacity buses, increasing the duration of contracts [23];
- ensure unconditional fulfillment of obligations to compensate for the loss of profits associated with transportation by electronic transport cards, including benefits [32];
- prevent the use of minibuses on routes with a large passenger traffic (over 500 passengers per hour one way), where it is possible to make a significant profit;
- divide buses of large capacity and buses operating in the mode of route taxis in the cost for passengers, while compensating all costs associated with a reduced tariff for transportation by buses of large capacity [28];
- is not necessary to sharp increase in the tariff for buses of small capacity, as this may lead to an increase in movements in private cars [31];
- put in order the taxation system so that the rolling stock of large capacity has certain advantages in paying taxes: equalize taxation, or reduce differences in the taxation of the operation of small and large buses [29];
- exclude the departure of private entrepreneurs from paying taxes from real wages of personnel, the real number of rolling stock, real profits;
- develop of priorities for public transport in the organization of traffic in order to reduce the rate of growth of private cars and increase the speed of delivery and the expansion of the time limits of "peak hours" - their "smoothing" by adjusting the operating modes of enterprises and educational institutions [30];
- adjust the parameters of the urban public transport system, including measures to improve the organization of transportation [7].

To ensure the required level of quality, the rolling stock should be brought in compliance with the operating conditions on this route - the mobility needs, namely the capacity of the rolling stock should correspond to the amount of passenger traffic on the route [7, 15, p. 108-110].

Determination of the rational capacity of rolling stock along the routes can be determined by the formula indicated in [34, p. 210] using the data on the loading of the limiting distillation in the peak hours and the required interval of motion.

$$q_{rat} = \Pi_l^{ph} \cdot \frac{t_t}{A_n} = \Pi_l^{ph} \cdot I_r, \quad (1)$$

where  $\Pi_l^{ph}$  - the loading of the limiting distillation in the peak hours, passenger-in-h. [26];  $t_t$  - the turnover time on the route, h.;  $A_n$  - the number of rolling stock on the route,  $I_r$  - the interval on the route, h (taken equal to 0.1 h).

The choice of rolling stock suitable for the purpose, modification and capacity calculate three different brands of rolling stock based on the economic calculations by the efficiency.

Also for the efficient operation of the passenger transportation system, the density of the route transport network should be brought into conformity with the density of the population of the city districts, the specific weight of the road doubles of the main transport highways should increase [24, 26]. It is necessary to reduce the administrative barriers to regulation of market and ensure regularity of traffic through the introduction of electronic controls and controls, while reducing the time and number of traffic congestion [23].

#### 4. APPLICATION OF THE PROPOSED METHODOLOGY

##### 4.1. Inputs

The carriers of passengers in the city engaged in municipal and private enterprises: municipal enterprises comprise four bus companies and the "Electrical transport" [1, p. 385], whereas commercial enterprises are limited liability companies and individual entrepreneurs. The structure of units of Omsk public transport is present in Fig. 3.

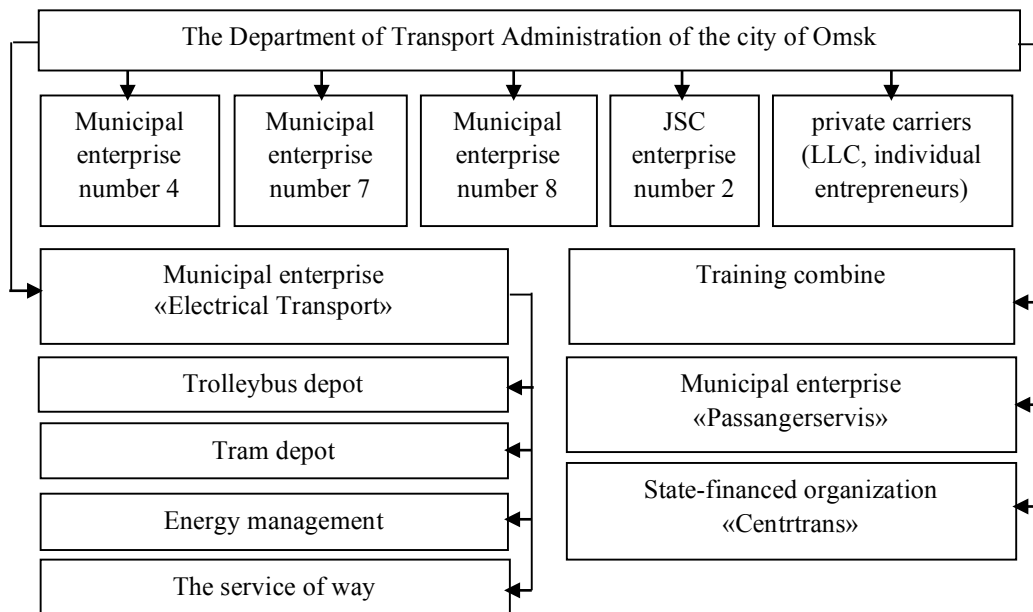


Fig. 3. The structure of public transport units of the city of Omsk in 2017

The distribution of traffic volumes as a result of daily passenger surveys for different periods of time are presented in Fig. 4 [17]. From 1970 to 1990, the volume of traffic of municipal transport, including traffic volumes of electric transport - trams and trolleybuses, increased significantly. During this period, the length of the contact through electric network was increased, and new routes were opened. In the period from 1990 to 1995, traffic volumes of electrical transport continued to grow, despite the start of reforming of economies and policies in relation to municipal transport. Electric transport was more resistant to these changes, at the same time the volume of traffic by buses declined



slightly. In 1999, with the appearance of commercial transportation, which on the one hand, came to the aid of municipal, on the other hand was a competition, the volume of traffic of municipal transport reduced even more. However, the main reason for the decline of traffic volume of municipal transport does not lie in the interception of passengers by private carriers [1, pp. 396-398], the reason is the rise in proportion of private vehicles along with the deterioration of the quality of public transport.

Trams began to carry four times less passengers than four years ago, whereas trolleybuses, half times less. By 2009, the volume of traffic of municipal transport was lesser than in 1970, and commercial buses began to carry virtually every day as much passengers as the municipalities. In 2015, the volume of public transport in general was lesser than in 1970, while private bus carriers transported twice more passengers than municipalities.

The increase in traffic volumes of commercial vehicles cannot compensate for the decline in the volume of public transport because of increasing in fares on public transport, reducing routes and increasing motorization [17].

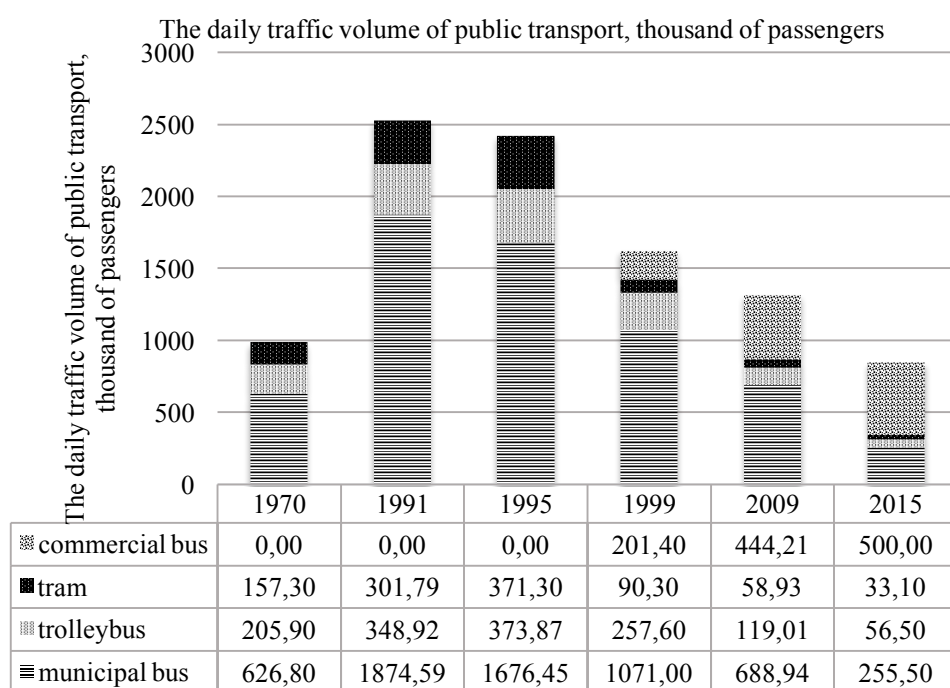


Fig. 4. The daily volume of traffic of Omsk public transport by year

Changes in traffic volumes to a larger extent depend on the amount of rolling stock on the routes. Fig. 5 displays change in the amount of rolling stock of public transport over the years [17].

From 1991 to 1995, the number of rolling stock on the line almost has not changed, which is associated with the provision of the loan of the European Bank for Reconstruction and Development for the purchase of buses in 1994-1995. In 1997, on the roads of the city, the first private buses appeared, and by 1999, the number of private buses was almost equal to the number of municipal buses. Based on the desire to increase the capacity of transport routes in the city center, there was a significant reduction in network of electric transport. By 2005, the number of private rolling stock had tripled, while the municipal rolling stock, including electric transport, continued to decline due to the deterioration and lack of new purchases. In 2009, there was an increase in the number of rolling stock of municipal enterprises at the expense of purchases of new vehicles, together with the administrative measures for stopping of increasing the number of private carriers on the roads. By 2016, the number of private buses remained virtually unchanged, and there is a tendency to reduce the number of transport units of private carriers by increasing their opportunities by increasing the capacity of rolling stock. Municipal rolling stock decreased again, as most of its service life has already exceeded [17].

In 1995, the volume of traffic per one trolleybus was more than in 1991. This is due to some reduction in the number of trolleybuses on the line and the increase of traffic volume by electrical transport. Other indicators (for bus and tram) declined slightly.

By 1999, there were reduction in traffic volumes by one transport unit in half on all types of municipal transport due to the reduction of traffic volumes in general and the competition from private vehicles. By 2005, a municipal transport unit carried four times less passengers than in 1995. It took place simultaneously with the reduction of traffic volume by municipal enterprises. However, one private bus also transported half less, but by increasing the number of private buses on the market. In 2016, the reduction of traffic volumes by one municipal unit continued. Commercial rolling stock carries more passengers by one unit, which is associated with the transition to large buses. The share of commercial vehicles in the total volume of traffic of public transport in Omsk, since 1999, has been steadily growing and now represents more than half of the total volume of traffic [17].

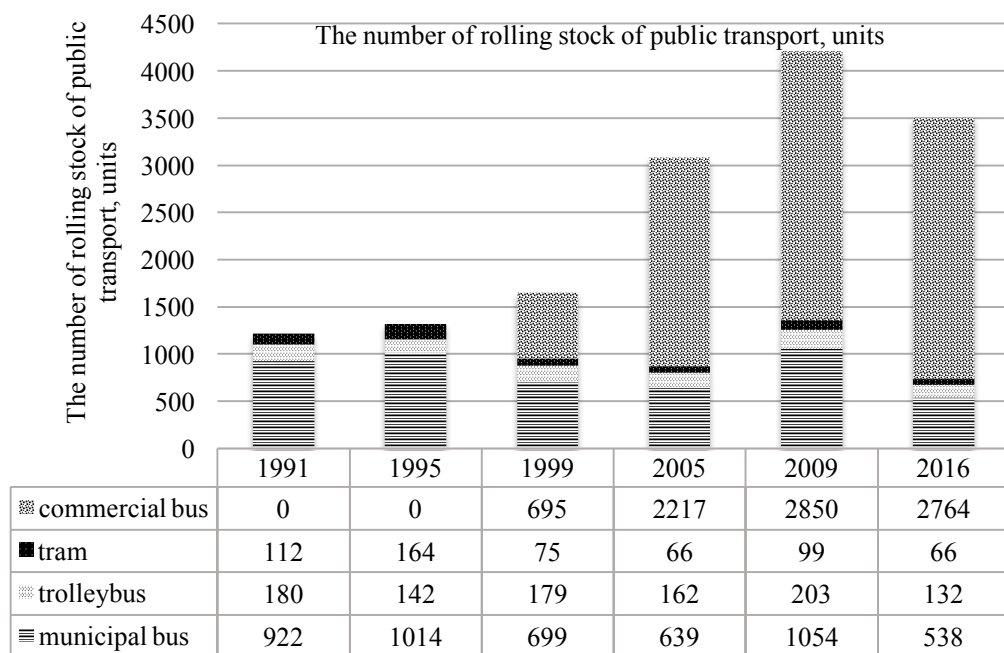


Fig. 5. The number of rolling stock of Omsk public transport on line by year

The involvement of commercial operators in the sector and the increasing the number of private cars had a considerable influence. From 1990 to now, the number of electric transport routes in the city fell by half, and the proportion of traffic volumes of electric transport in the total traffic volume has decreased from 0.25 to 0.08.

The distribution of rolling stock of Omsk public transport based on the number the Department of Transportation data is presented in Fig. 6.

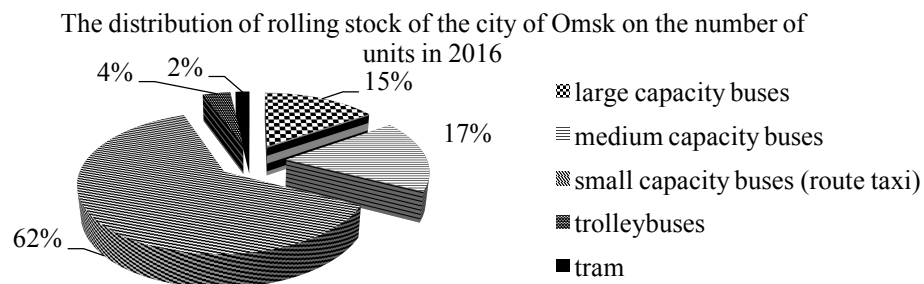


Fig. 6. The distribution of rolling stock of the city of Omsk on the number of units in 2016

The distribution of routes between modes of transport in the city based on the Department of Transportation data presented in Fig. 7.

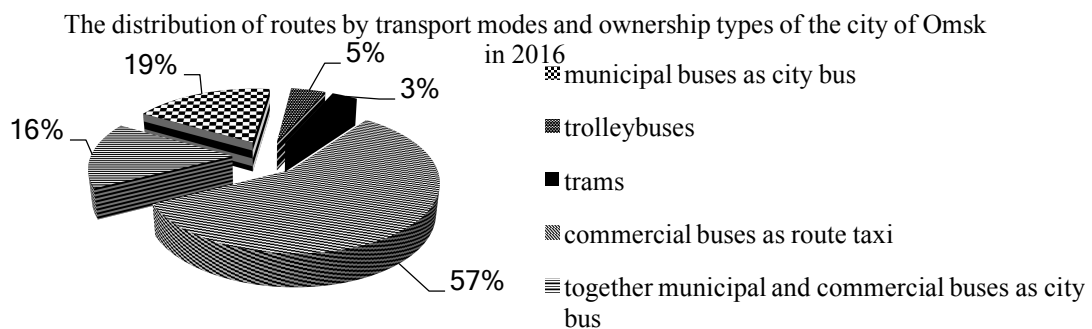


Fig. 7. The distribution of routes by transport modes and ownership types of the city of Omsk in 2016

According to the register of routes, commercial carriers serve 130 bus routes out of 162. At the same time, the issues of coordination of municipal and commercial transport are not fully resolved; in particular, work has not been carried out on a single schedule in the conditions of regulation by the centralized dispatching service of the city.

The share of the route network of commercial transport is 0.7 of the total length of the route network serviced by bus transport [17].

According to the results of the study [17], the average interval of the commercial buses is 7 minutes, which is primarily because of the small capacity of vehicles, as well as the saturation of this segment of the transport services market. The traffic interval of municipal transport is much higher and it is 21 minutes.

The average distance traveled by using bus transport became higher due to the expansion of the geography of trips; for route taxis, it is 7.24 km. Since commercial buses have a higher speed of commuting, and also provide the possibility of travel while sitting, the passenger uses this type of transport when traveling for long distances within the city limits. It can be assumed that at present, it tends to increase due to the tendency of building peripheral areas of the city [17].

The route coefficient is an indicator of the overlap of routes per one kilometer of the path. In 2009 there were already 8 routes for one kilometer of the route. But in the conditions of glut of the market and reduction of inefficient, duplicating routes by the transport department, it can be assumed that the route coefficient has already reached its maximum and in the future the number of routes will be reduced [17].

The load factor that determines the efficiency of rolling stock use on the municipal bus has significantly decreased from 0.38 to 0.18 and continues to decline, which is associated with a decrease in the occupancy of the passenger compartment due to a decrease in the volume of transport by public transport in general and the outflow of a significant proportion of passengers to commercial transport [17].

The dynamics of changes in incomes and expenditures of municipal enterprises [1, pp. 402-408] indicate a continuous increase in costs, while the level of income remains virtually unchanged. Consequently, we can speak of a fall in the efficiency of municipal public transport enterprises.

## 4.2. Results

Taking into account the provisions of the Transport Strategy of the Russian Federation, the authors developed phased measures to improve the efficiency of public passenger transport, which are as follows:

- 1) the development of the institutional base and economic conditions for the equally profitable functioning of various modes of transport and their micro-logistics systems in the market of passenger services;

- 2) improvement of the antimonopoly legislation with a view to providing competitive advantages with the establishment of a quota for the maintenance of routes by one operator in the amount of 20 - 30% of the total number of routes on the route network;
- 3) estimation of the volume and structure of demand for transport services in general and by modes of transport, information collection and processing, accounting for passenger traffic volumes;
- 4) development of infrastructure for public transport;
- 5) development of measures to increase the capacity of the road and road network and their evaluation [30, 31];
- 6) development of priorities for public transport in the organization of the movement;
- 7) transformation of municipal transport enterprises into joint-stock companies to increase motivation for efficient transport services;
- 8) development of a competitive environment with competition "for the route" contributes to a reduction in budget expenditures, i.e, it becomes possible to receive more services for the same money; while in the market conditions, local authorities are forced to make more informed decisions, as private operators will refuse to provide transport services otherwise;
- 9) the principle of "one owner" on the route, which avoids competition for the passenger on the route and its negative manifestations in the form of a "race" for the passenger;
- 10) the principle of dividing the market into a network of social routes where financial support is required and self-supporting routes;
- 11) the principle of separation of regulatory and operational functions with the establishment of an independent management body;
- 12) the principle of real obligations for cost recovery (when carrying out socially significant transport, traffic during peak periods, on weekends, on routes with a small passenger traffic, including fees for unfair carriers and fees for using the infrastructure);
- 13) introduction of unified travel documents - transport cards for all types of transport operating in the logistic system of transportation, ticket sales and control of travel payment;
- 14) development of variants of transport services for passengers - a rational scheme of routes with ensuring the shortest connections between the main passenger-forming points and their technical and economic assessment;
- 15) choice of the mode of transport and vehicles and the development of options for moving passengers along the links of the logistics chain on different modes of transport and their technical and economic assessment;
- 16) calculation of the required number of vehicles and their parameters for each link of the logistics system, taking into account the compliance of the capacity of the rolling stock with the amount of passenger traffic on the route;
- 17) development of an integrated traffic schedule by mode of transport;
- 18) creation of a quality control system for the services provided, an assessment of the quality of service, one of which is the tariff for services, minimizing the discrepancy between the expected and actual quality levels;
- 19) development and implementation of a regulatory system, including operational management, coordination of work on passenger services;
- 20) organization of financial settlements and documents on the logistic chains of passenger traffic;
- 21) creation of a unified information system to ensure the stable functioning of the logistics system, continuous monitoring of all links in the system and information services for passengers;
- 22) development of a list of related and additional services;
- 23) control over the fulfillment of obligations, including tax, on traffic safety and environmental protection;
- 24) development of conditions for working with large buses.

The results of calculating the rational capacity on the routes are presented in [1]. The structure of the fleet of rolling stock is shown in the Fig. 8. The correct choice of the class of capacity and the brand of rolling stock will make it possible to transfer urban public transport to self-repayment, reduce waiting time for the passenger and improve the ecological situation in the city.

Based on the results of calculations, the dependence of the rational capacity of the rolling stock on the load value of the limiting distillation in the peak hours has been confirmed:

if  $\Pi_l < 100$ , then  $q_{rat} < 20$ , if  $100 < \Pi_l < 250$ , then  $20 < q_{rat} < 35$ , if  $250 < \Pi_l < 500$ , then  $35 < q_{rat} < 60$ , if  $\Pi_l > 500$ , then  $60 < q_{rat} < 120$ .

The proposed structure of the rolling stock in the city of Omsk

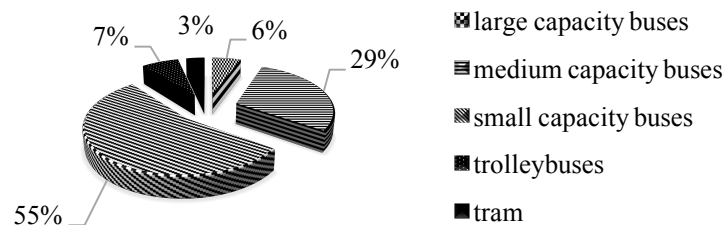


Fig. 8. The proposed structure of the rolling stock in the city of Omsk

Small buses occupy the most part in the estimated structure of the rolling stock, as the expansion of the city boundaries and the emergence of new microdistricts increase not only the population's need for travel but also the number of directions (ramifications) on which public transport operates. In this situation, it is impossible to reduce the number of routes, as this will certainly lead to an outflow of passengers from public transport and the use of their personal cars. However, with the increase in the number of directions (ramifications), passenger traffic on each route is reduced, which leads to the inadvisability of using large buses in these directions.

## 5. CONCLUSIONS

Characteristics of the public passenger transport of the city of Omsk are provided. Increasingly, there is a tendency to reduce the share and volumes of transportation by municipal transport and increase the transport capacity and the number of routes from commercial transport. There is a decrease in the traffic volume of public transport. The review of the main stages of development and functioning of the system of urban passenger transport in Omsk on the way to a logistics transport system is presented. At present, Omsk public transport is functioning in conditions of poor coordination and integration of the work of municipal and commercial transport in Omsk, a high wear of rolling stock and increasing competition from private carriers.

The scheme that clearly demonstrates what factors have a negative complex impact on the development and functioning of the Omsk passenger transport system are presented. The solutions offered by the authors are aimed at improving the efficiency and quality of service by urban passenger transport. The activities take into account the experience of reforming the public transport system in other cities, the characteristics of the Omsk city system and a view to engagement of other scientists in this field of science. The main directions of solving the problems of public transport in the cities are the creation of a competitive environment, the definition of the rational structure of the park and the effective organization of transportation. The correct choice of the class of capacity and the brand of rolling stock will make it possible to transfer urban public transport to self-repayment, reduce waiting time for the passenger and improve the ecological situation in the city. The capacity and the number of rolling stock, obtained from the results of calculations, can be used to develop the characteristics of the route as an object of competitive distribution.

These results of work provide an opportunity to proceed to the implementation of logistics principles in the practice of the urban public transport system and can be used by the Department of Transport in practice to make it possible to smoothen out the contradictions that emerges between public interests, interests of operators and the interests of the regional and municipal authorities.

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