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Features of Development of Route Networks of Public Urban Passenger Transport in Russian Monotowns: the Case of the City of Nizhnekamsk

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ABSTRACT

Currently, improvement of public transport of general use is among priority areas for development of urban transport systems. Convenient public transport routes, combined with modern rolling stock and a developed transport infrastructure, allow solving most transport problems and ensure high mobility of residents and guests of a city.

The objective of the research, main results of which are described in the paper, was to build an efficient urban public transport network in monotowns of Russia to ensure sustainability of functioning of public passenger transport intended for general use. The article presents an option for solving the problem of functioning of public transport in single-industry towns.

Very often, in such cities (with enterprises pronouncedly influencing urban planning), there are two mutually exclusive transport networks, namely, municipal one and contracted one (contracted by an enterprise and intended for shift rotation). As a result, contracted routes are not optimal, municipal carriers suffer losses, transport companies do not meet the schedule, switch to a less capacious type of vehicles, and consequently people are dissatisfied with the work of public transport in the city.

To solve these problems, it is proposed to combine the municipal and contracted networks into a single transport network of the city.

Keywords: public transport, monotown, single-industry town, shift rotation routes, industrial zone.

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The text of the article originally written in Russian is published in the first part of the issue.
Текст статьи на русском языке публикуется в первой части данного выпуска.

INTRODUCTION

Currently, in many countries of the world much attention is paid to the prospects for development of public transport in cities. The Russian Federation makes no exclusion.

In recent years, the structure of demand for passenger transportation has changed significantly. This is due to the processes of socio-economic development, which have caused the emergence of new objects and areas of attraction of passenger flows, including industrial, shopping, entertainment, tourist, sports, and business centres, as well as to changes in the behaviour of residents and guests of the cities, affecting the number and purpose of travelling.

In the Russian Federation, as probably in all the countries, the transport system should not only fulfil a social function, but also be profitable or cost effective. However, in all developed countries, public transport is unprofitable. The real incomes of public transport as compared to its costs constitute in Switzerland 72 %, in Great Britain 68 %, in Italy 30 %, in the Netherlands 22 % [1].

Among all cities in Russia, the so-called monotowns or single-industry towns with a city-forming enterprise can be distinguished into a separate group that merits special analysis.

This article according to the objective of the research presents an option for development of public transport in single-industry towns in Russia, describes the main problems of development of urban passenger transport in Russian monotowns using the example of the city of Nizhnekamsk, and also contains proposals for construction of a new efficient urban passenger transport network intended for public use and ensuring sustainable functioning of public passenger transport.

RESULTS

The creation of an efficient transport system of a city in the Russian Federation, as elsewhere in the world, is a complex systematic problem, which includes several tasks, among which one can single out: identification of routes of urban passenger transport (UPT) [2], substantiation of the type, kind and number of vehicles for each route, development of a timetable and of a financial model of the project, etc. [3].

Decisions on optimising route networks in various Russian cities are made differently, depending on the specifics of a particular city, on the condition and development of transport infrastructure, urban public transport, and other factors.

Monotowns should be analysed like a special case. The concept of monotown or of single-industry town (city) means a settlement that depends on a single enterprise or several large enterprises in terms of employment of the population. Such enterprises are also known as «city-forming» enterprises. Such an organisation of resettlement became widespread in the USSR and continues to this day. Monotowns ensure the optimal development of territories of various administrative levels. They function under the conditions of increased socio-economic risks: during the periods of economic upturn, single-industry towns ensure the growth and development of production, but during the crisis they are the first to become its «victims» [4].

Monotowns also exist in other countries. In the United States, the example of the city of Maynard, Massachusetts, can be mentioned. Initially, a city was formed under the influence of a textile factory, and then, because of its transformation, the city became location of the headquarters of the world's largest computer manufacturers [5]. In Canada, such cities might include Forges Saint Maurice or Garden Island. However, it should be noted that the experience of building monotowns in other countries was rather negative.

Currently, in Russia, the city of Nizhnekamsk is among most eloquent examples of monotowns. Its territory comprises an industrial zone, hosting city-forming enterprises of TATNEFT Group of companies and of PJSC SIBUR-Holding.

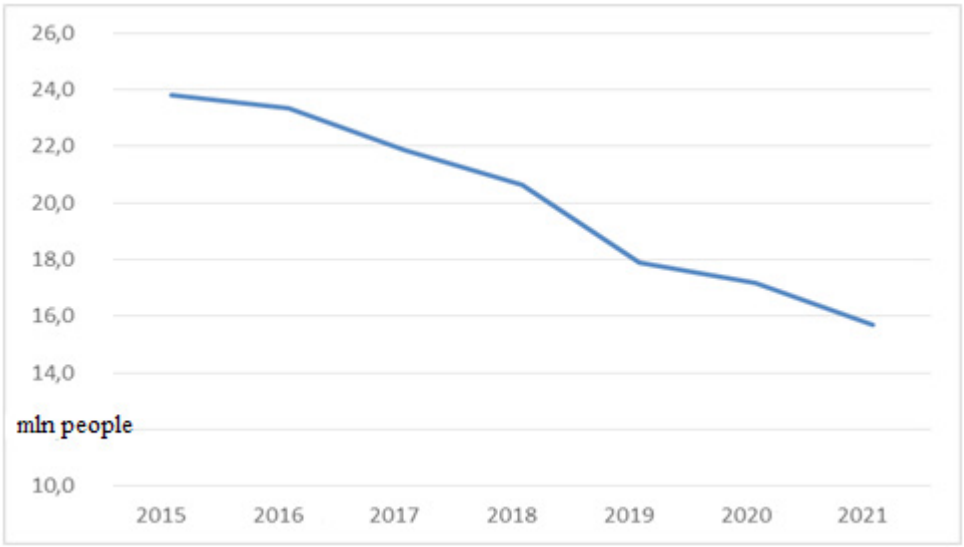
When analysing the existing situation in the field of public transport, it was revealed that two systems operate in parallel in the city:

• The first transport system operates exclusively in residential areas and serves the so-called *urban routes*. This system is represented by four tram and ten bus routes.

• The second transport system moves employees to the industrial zone serving the so-called *contracted routes*. This system is represented by three tram and 67 bus routes.

Each system solves its own problems and does not consider the peculiarities and positive aspects of the other system.

The system of urban routes is quite developed in residential areas. Bus routes run along almost all streets of the city. Tram routes run along the main arterial streets and connect the most important destinations in the city.



Pic. 1. The level of passenger turnover in the city of Nizhnekamsk (2015–2021) (performed by the authors based on data provided by the Executive Committee of Nizhnekamsk municipal district).

The system of contracted routes is not optimal, because each company orders routes for its needs from third-party companies, and there is an increased level of duplication with the routes of other companies. In fact, businesses pay for the same routes, while the total amount of transport vehicles is excessive.

Contracted routes for all passengers are free, for city residents it is a big plus, because if the route of the city and the contracted route coincide, residents of the city have the chance to use the free contracted route within a short distance in the city and not to pay for urban public transport.

Obviously, with such a coincidence, city residents choose free (contracted) routes. However, if the itineraries of city residents do not coincide with the contracted routes, they must wait and use only city public transport.

Since city routes are underutilised during peak hours, due to the outflow of passengers to contracted routes, city carriers are forced to increase the intervals between vehicles, to change type of vehicle fleet switching to less capacious one.

Currently, the average interval between urban buses is about 45–60 minutes, which is unacceptable for the city of Nizhnekamsk.

As a result, in recent years, the volume of passenger traffic served by public transport in the residential area has fallen by more than 25 % and continues to decline (Pic. 1).

The main tasks of development of route networks of public urban passenger transport, both in single-industry cities and in other cities of Russia, are:

• Systematic analysis [6] of a city's route network.

• Organisation of surveys of passenger traffic on passenger transport routes.

• Organisation of sociological survey to identify transport needs and problems of transport services for the population.

• Formulation of proposals for creation of an efficient system of public passenger transport.

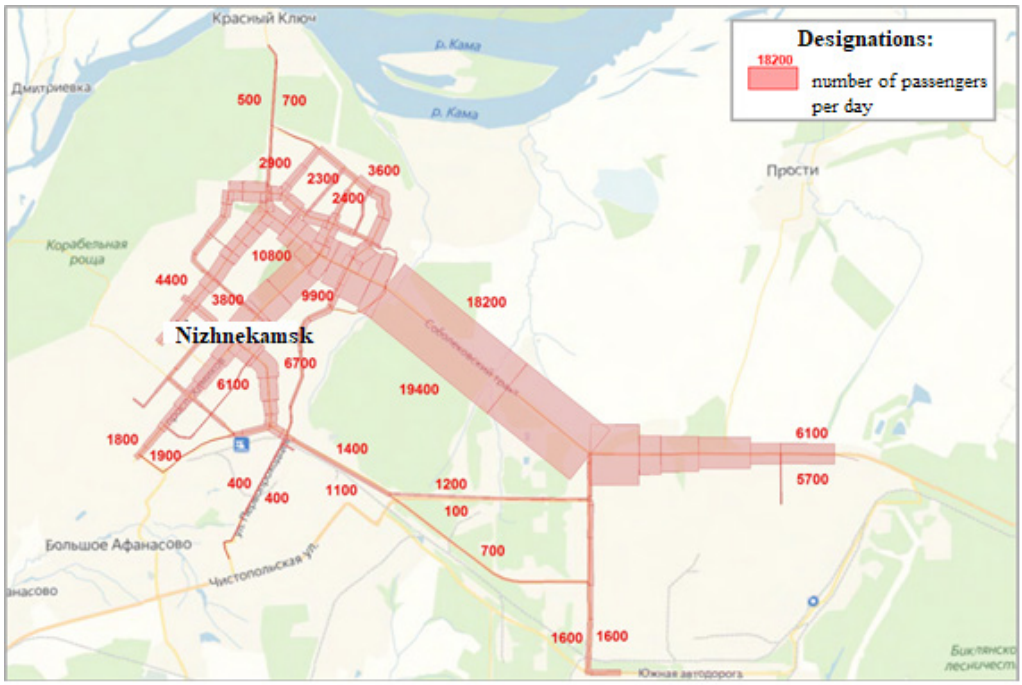
• Development of a transport model of the project.

• Development of a financial model of the project.

• Preparation of a plan for implementation of a new route network.

At the initial stage, it is necessary to analyse operation of the city's route network. Unlike other cities in Russia, in singe-industry cities, it is necessary to analyse the work of not only municipal, but also of contracted (intended for shift rotation) transport since a significant share of transportation will be transportation of workers of city-forming enterprises to and from work.

Next, it is necessary to conduct a survey of passenger traffic on the routes of municipal and contracted transport for a more detailed analysis of the current situation in the city's transport industry.



Pic. 2. The number of passengers carried per day per sections (carried out by the authors based on the results of transport surveys in 2019).

Transport surveys can be carried out both at stopping points and inside the rolling stock using sensors for the entry and exit of passengers or with the help of meters, and it is also possible to use a combined survey method.

At present, public transport is mostly not equipped with sensors for entry and exit of passengers, and attraction of accounting personnel requires many people. In this regard, the most preferable is the combined survey method.

The combined survey method is less costly than the on-board survey method. And the quality of the received data on passenger traffic is sufficient for analysis, decision-making and planning of development of passenger transport in the future.

When conducting a visual inspection at stopping points, all passenger vehicles are recorded, including contracted and illegal ones. The counters visually determine the filling of the vehicle according to the conditional point table [7], as well as the number of passengers entering and leaving.

In single-industry cities, surveys inside rolling stock must be carried out both on municipal routes and on the routes of contracted vehicles.

Not all enterprises can agree that sensors for entry and exit of passengers are installed in their vehicles or that there is a meter in the rolling stock. This can be due to many factors, particularly to the fact that the transportation for enterprises should be carried out by buses intended exclusively for sitting, and the occupancy of buses can be 100 %.

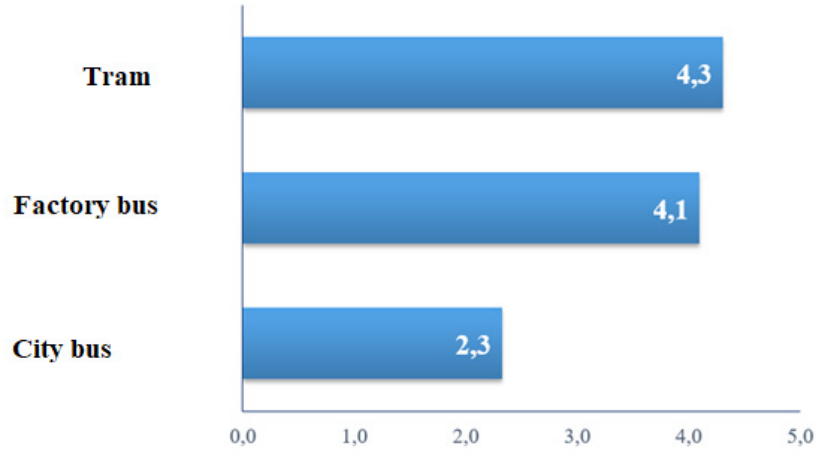
In this case, it is necessary to conduct surveys at stopping points, both in the city and in the industrial zone.

Surveys at stopping points are usually carried out during the morning, afternoon, and evening rush hour.

In monocities, in most cases, industrial enterprises start working earlier than enterprises, institutions and social facilities in the residential area of the city. In this case, this feature should be taken into account, and surveys should be carried out not within an hour, but within several hours, i.e. peak hours, both in residential and industrial areas.

When determining the stopping points for inspection in an industrial zone, it is necessary to pay attention to the stopping points located in the area at the proximity to checkpoints and, if possible, conduct examinations at them, as they are the busiest stopping points.

In Nizhnekamsk, surveys were carried out both inside the rolling stock and at stopping points. Transport survey data showed that the main passenger traffic is observed between the city and the industrial zone (Pic. 2).



Pic. 3. Assessment of quality of work of passenger transport (compiled by the authors based on the results of a sociological survey in 2019, 5-point scale).

When conducting a survey for this study, the main feature was that it was necessary to interview users, both of public and contracted vehicles. This is necessary to obtain up-to-date and objective information. When polling, for example, only users of municipal transport, it is possible to get a large number of negative reviews, and when polling users only of contracted transport, most responses may be positive.

According to a sociological survey, the population of the city of Nizhnekamsk is satisfied with the work of trams and contracted buses and is not satisfied with the work of city buses (Pic. 3).

The main problems in the work of Nizhnekamsk city bus transport are non-observance of the schedule and long intervals between the vehicles.

The respondents were also asked the question: «Under which circumstances are you ready to switch from personal to public transport»? About 40 % of the respondents answered that they are ready to switch to public transport, provided that its performance improves (Pic. 4).

Thus, the survey showed that almost half of the city's population is ready to switch to public transport if its work is normalised.

DISCUSSION

The basis of the revenue part of passenger traffic in all cities of the Russian Federation is travelling for work purposes, namely travel to and from work. The income part from social transportation is usually not enough to pay for capital costs [8].

For the majority of single-industry cities, another feature is that the basis of passenger transportation is made up of trips to the industrial zone, and all of them are not municipal, but contracted routes. For example, in Nizhnekamsk, their share reaches half of all traffic in the city.

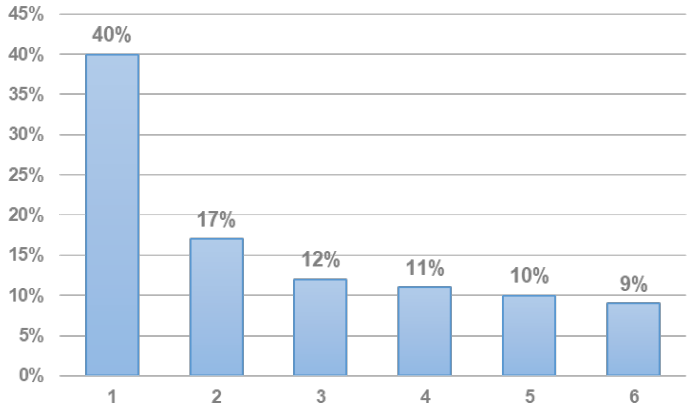
In addition, most enterprises transport their employees to work in soft-seated buses. An industrial zone, as a rule, is located either within the city limits, or at a short distance from it (about 10 km). With an average bus speed of 25–30 km/h, the travel time takes no more than 20–25 minutes one way, which is acceptable for organising movement of city buses with standing places.

As a result, municipal transport incurs colossal losses estimated at hundreds of millions of roubles.

Thus, the main idea of building an efficient system for operation of passenger transport in single-industry towns is to combine contracted and urban networks into a single system of public passenger transport in order to increase the efficiency of public transport and its attractiveness for passengers thanks to the quality of services provided [9].

As a result, it is quite possible to organise the work of urban passenger transport without deteriorating the work of contracted routes, and this will not require additional investments both from the city-forming enterprises and from the city budget.

As a result of such a merger of the networks of contracted and municipal routes, the mileage



Pic. 4. Conditions for switching to public transport (compiled by the authors based on the results of a sociological survey in 2019):
1 – When operation of public transport improves.
2 – Under no circumstances.
3 – Under other conditions.
4 – Travel time by car will start to exceed travel time by public transport.
5 – The cost of gasoline will rise.

of rolling stock will be reduced; the total number of vehicles on city streets will also diminish, the number of passengers will grow, the number of journeys and the cost of transportation will reduce, while resulting in profitability of municipal transportation.

At present, the administration of the city of Nizhnekamsk, together with PJSC TATNEFT, is working on implementation of a project to introduce a new optimised route network. The Centre for Dispatching and Organisation of Passenger Transportation has been created and started work, development of the transport and financial model of the project has been completed, the mechanism of interaction with the operator of «Social Card» [for beneficiaries of social allowances and discounts] has been worked out, as well as the mutual settlements of commissioners and contractors. In addition, a test bus route to the industrial zone was launched, operating without a conductor, with installed payment terminals and cameras for counting passengers.

For successful and sustainable functioning of the new route network, it is necessary to additionally perform some steps:

• To create a structure of the organising body of transportation, which will perform the functions of planning, monitoring, and control of implementation of urban passenger transportation.

• To introduce a single tariff for the new transport network.

• To create a single operator of automatic fare collection.

• To change the organisation of traffic at several intersections in the city.

• To organise a dedicated lane on the route to the industrial zone.

Those suggestions could be additionally substantiated.

One of the main conditions for functioning of the new route network is introduction of a single tariff on all public transport routes and organisation of a single operator of automatic fare collection. When organising a single operator, it is necessary to create an automated fare payment system and equip transport with the necessary equipment.

The main advantages of creating the structure of a transport organising body are:

• Monitoring and control over the execution of municipal contracts for passenger transportation.

• Operational management of passenger traffic.

• Development of comprehensive proposals for development of urban passenger transport.

• Provision of information services.

One of the advantages of this system is introduction of a universal ticket, which can be used both on contracted buses and on municipal routes within the city.

Besides, the city will be able to optimise public transport costs, and carriers will be able to equip vehicles with on-board devices for calculating passenger traffic, and, therefore, will be able to control fares and increase the company's revenue.

The industrial zone of Nizhnekamsk is located at an insignificant distance from the city, about ten kilometres. In case of emergency situations such as traffic accidents, road repairs, etc. traffic jams are formed at the entrance to the industrial zone. To increase the attractiveness of public transport as compared to personal, it is proposed to organise a dedicated lane to the industrial zone of the city. The organisation of a dedicated lane is a very effective method of ensuring traffic safety, contributing to a significant decrease in delays and an increase in the transit capacity of the carriageway [10].

CONCLUSION

If this development option is implemented, the main positive result for the population will be a reduction in travel and waiting time, increase in the availability of public transport and the quality of passenger service.

The positive aspects for the city will be the ability to monitor and manage operation of public transport in real time, improve the environmental situation, reduce the burden on the city budget and, as a result, increase the attractiveness of the city.

For carriers, the indisputable advantages will be an increase in profits from transportation, a decrease in costs and an increase in the priority for public transport traffic.

As a result, the enterprises of the industrial zone will save money and improve the quality of services. In addition, it will affect the image of the companies as well since the population of the city will see that the management of the enterprises really cares not only about their employees, but also about their family members and residents of the entire city.

REFERENCES

1. Guketlev, Yu. Kh., Tkacheva, Ya. S., Guketlev, E. Yu. Foreign experience in development of urban passenger transport [*Zarubezhniy opyt razvitiya gorodskogo passazhirskogo transporta*]. *Novie tekhnologii*, 2016, Iss. 4, pp. 27–32. [Electronic resource]: https://elibrary.ru/item.asp?id=28096758. Last accessed 18.10.2021.

2. Gorev, A. E. Fundamentals of the theory of transport systems: Study guide [*Osnovy teorii transportnykh sistem: Ucheb.posobie*]. St. Petersburg, SPbGASU publ., 2010, 214 p. ISBN 978-5-9227-0266-9. [Electronic resource]: https://www.spbgasu.ru/documents/docs_231.pdf. Last accessed 18.10.2021.

3. Martynova, Yu. A. Formalisation of the problem of organising route networks of urban passenger transport [*Formalizatsiya zadachi organizatsii marshrutnykh setei gorodskogo passazhirskogo transporta*]. *Naukovedenie*, 2014, Iss. 6, pp. 1–13. [Electronic resource]: https://cyberleninka.ru/article/n/formalizatsiya-zadachi-organizatsii-marshrutnyh-setey-gorodskogo-passazhirskogo-transporta/viewer. Last accessed 18.10.2021.

4. Ishchenko, A. I. Features of monocities of the Russian Federation and their main problems [*Osobennosti monogorodov Rossiiskoi Federatsii i ikh osnovnie problemy*]. *Skif. Student science questions*, 2021, Iss. 2, pp. 142–147. [Electronic resource]: https://sciff.ru/osobennosti-monogorodov/. Last accessed 18.10.2021.

5. Mullin, J., Armstrong, J., Kavanagh, J. From Mill Town to Mill Town: The Transition of a New England Town from a Textile to a High-Technology Economy. *Journal of the American Planning Association*, 1986, Vol. 52, pp. 47–59. [Electronic resource]: https://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1007&context=larp_faculty_pubs. Last accessed 18.10.2021.

6. Larin, O. N. Organisation of passenger transportation: Study guide [*Organizatsiya passazhirskikh perevozok: Ucheb. posobie*]. Chelyabinsk, SUSU Publishing House, 2005, 104 p. [Electronic resource]: https://www.studmed.ru/larin-on-organizaciya-passazhirskih-perevozok_647d49b702d.html. Last accessed 18.10.2021.

7. Petrova, D. V. Modern approaches to organisation of monitoring of public transport passenger traffic in urban agglomerations [*Sovremennie podkhody k organizatsii monitoringa passazhiropotokov obshchestvennogo transporta gorodskikh aglomeratsii*]. *International Journal of Open Information Technologies*, 2020, Iss. 1, pp. 47–57. [Electronic resource]: https://elibrary.ru/item.asp?id=42340332. Last accessed 18.10.2021.

8. Lebedeva, O. A., Gozbenko, V. E., Kargapoltsev, S. K. Optimisation of the transport network taking into account assessment of the quality of public transport services [*Optimizatsiya transportnoi seti s uchetom otsenki kachestva uslug obshchestvennogo transporta*]. *Sovremennie tekhnologii. Sistemniy analiz. Modelirovanie*, 2019, Iss. 1, pp. 112–118. DOI: 10.26731/1813-9108.2019.1(61).112-118.

9. Wetzel, D. Innovation ways of financing public transport. *World Transport Policy & Practice,* 2006, Vol. 12, Iss. 1, pp. 40–46. [Electronic resource]: http://www.ecologica.co.uk/pdf/WTPP12.1.pdf. Last accessed 18.10.2021.

10. Zhirkova, A. A., Basov, K. A., Ivlev, V. Yu., Titova, P. A. Substantiation of introduction of dedicated lanes for route passenger transport [*Obosnovanie vvedeniya vydelennykh polos dlya marshrutnogo passazhirskogo transporta*]. *Evraziiskiy soyuz uchenykh*, 2016, Iss. 1–2, pp. 52–55. [Electronic resource]: https://elibrary.ru/item.asp?id=27471360. Last accessed 18.10.2021. ●

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