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Logistic Integration and Coordination of Urban Public Transport Management[1]

The paper explores the issues of urban public transport development as the principal element of infrastructure of modern city, its essential social institution. The authors emphasize the importance of providing high-quality transport services in conditions of scattered public transport, technological obsolescence of vehicles, poor organisational procedures, absence of logistic integration and coordination of various means of urban transport. The paper reveals the problems in modernisation of urban passenger transport. The authors examine efficient systems of urban public transport management in different cities worldwide and classify scenarios of interaction between local government and operators in transport services market. Having analysed the system of public transport management in a largest city the authors suggest an alternative for development of the urban public transport based on logistic integration and cooperation and principles of multimodality with creation of a centre for urban public transport management to ensure efficient coordination of passenger traffic.

JEL classification: L92, R41

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Introduction

With the transition of Russia's economy to market, urban public transport (UPT) has practically lost the elements of comprehensive planning of its development, which was done

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under planned economy. Russian cities took the path of deregulation of the transport services sphere and disintegration of the systems of urban public transport [12].

Currently, scattered urban public transport is not always ready to provide passengers with high-quality transport services. Despite this, the growing population of cities is increasingly pressing new demands on organisation of transport services: ensuring reliably high speed of transportation, road and transport security, environmental safety, supplying passengers with timely information about location of vehicles, creating comfortable and aesthetically appealing conditions of transportation and transfer from one means of transport to another, etc. These circumstances resulted in the relevance of the present research and determined its objective, which is to study the issues of logistic integration and coordination of various forms of transport using the case of a largest city. The research investigates urban public transport of the city of Yekaterinburg and cities worldwide with successfully operating transport systems and particularly focuses on the system of urban public transport management.

Theoretical approaches to logistic integration and coordination in the sphere of urban public transport

Poor coordination and integration in the existing system of urban public transport management in the Russian Federation is mentioned in the studies of E. Kh.-M. Eldarkhanov [13]. The economist argues that the system has neither technological and technical, nor legal possibilities for implementation of logistic integration and coordination, because it is represented by separated dispatcher services of transport companies. According to V. A. Fedorov [12], current problems in modernisation of urban passenger transport are actually identical in all cities and towns of the Russian Federation. These problems can be conditionally grouped into two types:

1) knotty problems of complex nature, the solution of which requires fundamental research, and most importantly, political will and significant resources;

2) problems, which can be handled during self-adjustment of transport systems.

To explore the issue of logistic integration and coordination of UPT we scrutinized the European experience of organising interaction between transport operators and municipal authorities.

V. Vuchik, a noted urbanist, highlighted that transport problems of different cities worldwide, as a rule, are rooted not in technological obsolescence of vehicles, but in short-sighted policy and weak organisational procedures, lack of logistic integration and coordination of forms of transport. N. Jaiac, L. Marović, and T. Hanák in their work [15] emphasized that urban transport management is a complex process both from organisational and technical-economic perspective. The major attention in this research was directed to the processes of managerial decision-making based on multi-criteria methods and artificial neural network. The authors of another study [16] also suggested using an intellectual system of decision-making support when managing urban public transport.

A number of authors researched the public transport priority right in traffic in urban agglomerations [17; 18]. The work [20] demonstrated that in Vienna, if the public transport operated efficiently, the share of personal transport halved, and the use of public transport tended to increase. Yet the author contrasted these positive trends with a series of problems, which would exacerbate in recent years because of the growing population. To counter them, Vienna municipal authorities developed *public transport package,* which will allow choosing the right strategy and tactics while managing passenger transport in this metropolis.

In Milan, the operation of urban public transport is managed by the ATM Group [14], which integrates metro, tram, trolleybus networks and bus lines with a system of car and bike sharing, parking, and funicular.

The *Prague Transportation Yearbook* [19] reflects stages and elements of creating an efficient system of urban public transport management in Prague on the basis of the integration and coordination principles. It is worth noting that Prague is quite comparable with

Yekaterinburg in terms of area, population, administrative division, but differs in density of road network, the number of trips in public transport and other organisational and infrastructure indicators (Table 1).

Table 1

Comparison of urban public transport systems in Prague and Yekaterinburg [11]

Indicator	Yekaterinburg	Prague
City area, sq km	490	496
Population, million	1.462	1.373
Number of administrative units	7	10
Motorisation rate, passenger cars per 1 000 inhabitants	497	764
Number of trips in public transport annually per inhabitant	161	536
Road density, km per sq km	2.71	8.08
Ratio of road area to total city area, %	2.93	11.56
Presence of a single dispatcher centre (amodal transport)	None	Present

Table 1 explicitly shows that though the population in two cities is virtually the same, the inhabitants of Prague use urban public transport three times more actively than inhabitants of Yekaterinburg. However, the main difference is the availability of a single dispatcher centre for urban public transport management and the organisation of the so-called *amodal* transport (a kind of multimodal transport, in which traffic management is carried out from a single dispatcher centre [6]). At present, the transport system of Prague is reported to be one of the best in Europe, and it is important to take this experience into account when organising the UPT system in Yekaterinburg.

The analysis of transport service systems in the cities worldwide [4; 14–20] allowed briefly classifying the alternatives for interaction between municipal authorities and operators in the transport services market (Table 2).

Table 2

Scenarios for interaction between municipal authorities and transport operators (cases of the Western European cities)

Scenario for interaction	Competition in transport services market	Coordination of UPT operation
1. Modal service	No	No
2. Deregulation	Present	No
3. Municipal authorities and one operator	No	Present
4. Municipal authorities and multiple operators	Present	Present

At this stage of the research the authors considered four groups of scenarios for interaction between municipal authorities and operators in transport services market, though each of the scenarios in Table 2 has many variants inside. However, the analysis of them is not the subject of the present paper.

The first scenario implies there is no competition and no coordination / integration of different forms of transport (bus, tram, trolleybus, metro, city train, etc.) into a single system. Passengers are serviced by transport companies controlled by federal or local authorities. The companies are responsible for transport policy and management in their form of transport. The activities of various forms of urban public transport are not coordinated, and every transport operator pursues its own transport policy and manages its vehicles independently of the others. Currently, such organisational structure is hardly met in Western Europe, it is more often found in the cities of the Russian Federation. However, for large Russian cities of the second scenario is more typical.

In the second scenario (deregulation) there is competition in the transport services market, though there is no coordination of work. In this case, passenger bus transportation is carried out on a commercial basis by private companies. The authorities' interference in the organisation of transportation is limited by establishing transport safety standards and certain general requirements.

In Western Europe, such model is rare. It is present in some cities and regions of the UK. Private companies operate in the market, although the government still subsidizes some socially significant but non-revenue-generating routes. For transport services, which are not offered by the operators, a tender is arranged. Usually these services include transportation in the morning and night hours, Sunday transportation, routes with small passenger traffic and school transportation.

In the third scenario, the work of transport is coordinated, but there is no competition. Here two structures interact:

1) a municipal authority that is responsible for determining the service area, the level of subsidizing of the UPT operators' costs, and pricing policies;

2) transport companies that are responsible for maintenance and operation of the vehicles, as well as for planning their work and personnel management.

Therefore, on the one hand, the responsibility for transport company strategy lies on municipal authorities, but on the other hand, on transport companies themselves.

The peculiarity of the third scenario is the absence of competition. In case when more than one company provides a service, a municipal authority delineates zones with either different service area or different forms of transport. Such organisation of the UPT operation requires companies to obtain a special licence to provide transport services; at this, the companies can be both state- or partially state-owned and privately owned. In the Western European countries, this scenario is the most widespread, because it invokes a range of logistic principles: coordinated operation of companies with different forms of ownership towards a common goal and agreed pricing policy.

The fourth scenario of interaction presupposes ultimate division between a municipal authority, responsible for the transport policy, and transport operators, which are privately owned and state-owned companies working under agreement with the authority. In such scenario, there is a single pricing policy in all forms of transport and among different transport companies, yet in the market (first of all, for bus services) a system of tenders is applied. The right for operating in transport services market is given to a company with the most attractive conditions, for instance, with the smallest amount of state subsidies. As a rule, an authority arranges a tender for servicing a specified route or within a certain service area.

There are two major types of the tenders:

1) *a full cost tender*, when an authority determines the nature of services, type of vehicles and undertakes all costs. The authority controls the system of fares, and all money paid as a fare remain at its disposal. Transport companies do not bear any financial risk in this situation and should only rationalize the operation costs;

2) *a net subsidy tender*, when an operator requests a certain amount for providing transport services, as well as retains money paid as a fare. At this, the system of travel passes keeps on functioning, and the revenues derived from it come to the authorities.

The fourth is the most promising scenario, because it ensures coordination of urban public transport operation in conditions of competition in transport services market.

Analysis of the system of public transport management and identification of the problems

The system of public transport in Yekaterinburg includes bus, tram, trolleybus, metro, city train, and taxi. Currently, these forms of transport are poorly integrated. As a result, all means of urban public transport in the city (except for metro) see a substantial decrease in the number of passengers (Fig. 1).

Fig. 1. Number of passengers of the urban public transport in Yekaterinburg, million people a year

The analysis of the system of the UPT management in Yekaterinburg revealed that it is closer to the second scenario, because in the passenger transport services market there is competition, but there is no coordination: private carriers do not keep to schedule, ignore the use of dispatcher control and switch off the radios on the route, fiercely compete for passengers with municipal transport and among themselves (sometimes with gross violations of traffic rules). For the reason that private transport companies usually do not have special garages, they keep their vehicles in private parking (most often, near the place, where a driver or an owner of a bus lives), what leads to the absence of medical control of a driver on a route and regular maintenance of the vehicle [1].

Thus, under the current system of urban public transport management in Yekaterinburg, the municipal transport is being squeezed out from the city streets. There is a strong need to reform the system of urban public transport management on the basis of logistic integration and coordination principles.

Methodological approaches to the development of logistic integration and coordination of forms of transport in the structure of urban passenger transport

Logistic integration and coordination of forms of urban passenger transport in the cities worldwide with efficient UPT systems is implemented on the basis of the multimodality principles. Multimodal passenger transportation is transportation of passengers by two or more means of transport under the responsibility of one operator with a single ticket to satisfy inhabitants' demand for transportation [6].

Switching to multimodal technologies is a complex and multi-stage process. The city has to take a complex of measures to integrate various forms of passenger transport into a single urban transport system in a way that it would be comfortable for passengers, as well as profitable and reliable for transport companies. The set of measures includes:

- creation of a network of transport hubs;
- organisation of a single dispatcher centre for management of the urban public transport;
- design of a single travel document for all means of transport – a single ticket with efficient system of fares.

Currently, the issues of organisation of transport hubs are being extensively discussed in the scientific literature [2; 3; 5; 6; 8; 10]. Yet there are almost no works devoted to integrated centres of the UPT management, as well as to the issues of pricing in UPT in conditions of switching to multimodal technologies. As for the present paper, it mainly focuses on the organisation of an integrated centre for urban public transport management (Fig. 2).

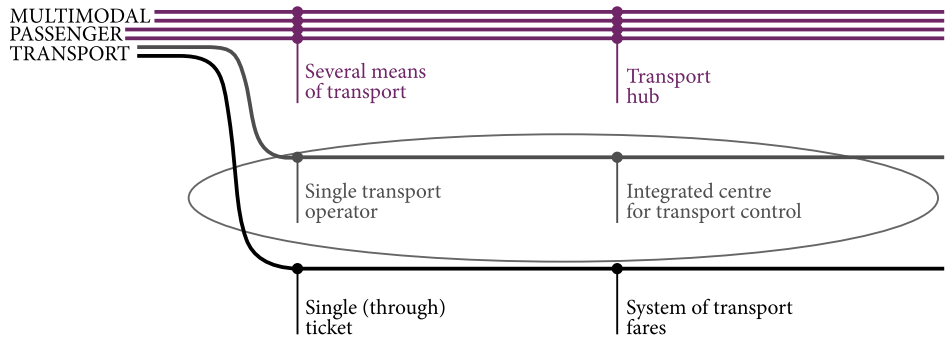

Fig. 2. Main characteristics of multimodal passenger transport [11]

Creation of an integrated centre for transport management will ensure efficient control of public transport and allow receiving objective timely information about its functioning. For this, it is necessary to unite dispatcher services of municipalities and transport companies on the basis of informational and analytical system of public transport management. The system of dispatcher management of public transport will be able to meet inhabitants' demands due to:

- constant monitoring of transport operation in real time;
- coordination of vehicles movement on contacting routes;
- rational use of vehicles and building up the reserves in the most loaded services areas;
- information support of all measures for liquidating consequences of road accidents and emergencies;
- provision of timely information on the public transport schedule;
- integration of railway stations, bus stations, transport companies and vehicles into a single information space.

Urban public transport of Yekaterinburg is under the jurisdiction of the city's municipal authorities. All routes in the city are serviced under agreements with the municipal authority. Metro, tram and trolleybus networks are serviced exclusively by Yekaterinburg municipal unitary enterprises (YMUE) "Yekaterinburg Metro" and "Tram & Trolleybus Administration". Routes of the city train are operated by OAO "Sverdlovskaya prigorodnaya kompaniya" ("Sverdlovsk Regional Company") incorporated by OAO "Rossiyskie zheleznye dorogi" ("Russian Railways") and the Government of the Sverdlovsk oblast. Bus routes are operated by YMUE "Municipal Association of Motor Transport Enterprises" and 30 privately-owned companies. Transport operators for bus routes are chosen on a competitive basis. The scheme of passenger transport management and organization in Yekaterinburg is presented in Fig. 3.

The presented scheme does not include such an important form of the public transport as taxi. Unfortunately, this segment of the transport services market currently remains almost unregulated. The organisation of taxi traffic management deserves special attention, and can be a topic of a separate study, so is not considered in this paper. The main emphasis here is on enhancing the city's passenger transport management system. With this end in view, the authors studied the best practices of the European cities and the possibility of employing them in Yekaterinburg.

To improve the management of the city's transport system, it is proposed to establish a single centre for urban public transport management, allowing for the experience of Prague in particular [19]. The quality of Prague passenger transport operation is close to the ideal model. The Prague integrated transport system can be a prototype model for the creation of an effective public transport management system in Yekaterinburg.

Such a structure should undertake the management of all urban transport flows. The new centre would assume the functions of managing urban passenger traffic, planning and optimizing the new route network, servicing routes, as well as control and dispatcher

functions. Now this work is performed by the specialists of Tram & Trolleybus Administration and Municipal Association of Motor Transport Enterprises. In a single control centre, these enterprises will work together within one new organisation. The single control centre will improve the interaction of the dispatcher services of all levels and departments, emergency services and units of the Ministry of Emergency Situations, both in normal mode and when irregularities occur in operation of devices and equipment (Fig. 4).

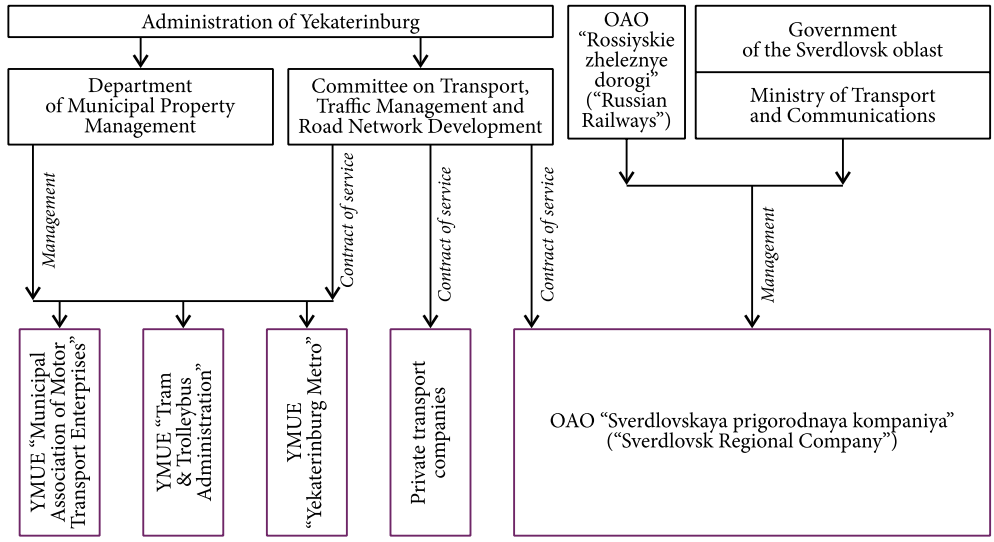

Fig. 3. Scheme of the urban public transport management in Yekaterinburg [11]

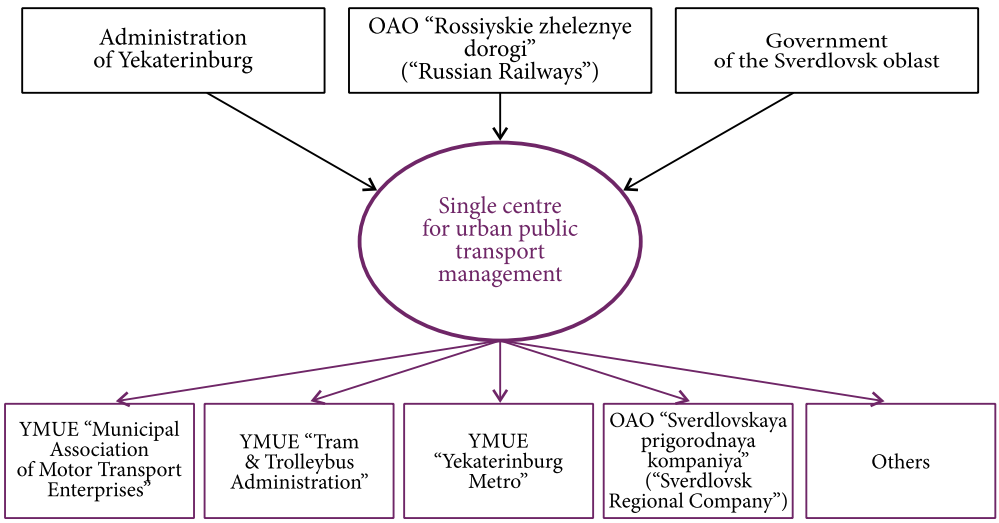

Fig. 4. Suggested scheme for urban public transport management in Yekaterinburg [11]

Forms of urban public transport are integrated and coordinated on the basis of automated system of dispatcher management (ASDM). The operation of such system relies on the principles of advanced information and intellectual technologies, what allows regulating the traffic of different means of urban passenger transport in the optimisation mode with the use of self-organising and self-learning programmes [7]. The most effective regulatory measures encompass:

- redeploying vehicles on the route;
- using a more manoeuvrable form of motor transport;
- stopping on demand (reduction of unclaimed stops);
- delaying the departure of a suburban electric train or motor transport until the arrival of a passenger train;
- changing a route in case of abnormal situations;
- replacing a vehicle, etc.

A single centre for urban public transport management will be able to ensure effective coordination of passenger traffic, including during mass public events, as well as congestion of passengers, while using traffic control mechanisms.

Conclusion

The availability, affordability, and accessibility of public transport for different categories of inhabitants determine how high the real standard of living of the population is, and the quality of urban public transport operation allows assessing the social climate in an urban agglomeration and the efficiency of the authorities [9]. The main goal of transport is to create a convenient, comfortable, friendly environment for transport and logistic interaction between municipal authorities, carriers and city residents. The goal can be achieved by switching to the principles of logistic integration and coordination.

Regarding the enterprises of urban passenger transport, it is possible to identify a number motives driving the switch to these principles. In particular, they include a synergistic effect, possibility to use a flexible fare policy, decreasing need for working capital as a result of the route network optimisation, improvement of the quality of management including through maintaining traffic schedules [12]. A single dispatcher centre as an effective tool for managing urban passenger transport can significantly increase the reliability of its operation, which will attract an even greater number of passengers to the use of public transport.

In our view, creation of an integrated system of urban public transport management is a necessary stage in modernisation of urban public transport in Yekaterinburg on basis of the principles of logistic integration and cooperation.

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Логистическая интеграция и координация управления городским общественным транспортом[1]

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Статья посвящена вопросам развития городского общественного транспорта как основного инфраструктурного элемента современного города, его важнейшего социального института. Подчеркивается значимость предоставления пассажирам качественных транспортных услуг в условиях разрозненного общественного транспорта, технологической отсталости автопарка, слабых организационных процедур, отсутствия логистической интеграции и координации видов городского транспорта. Выявлены проблемы модернизации городских пассажирских транспортных комплексов. Изучены эффективные системы управления городским общественным транспортом в различных городах мира. Составлена классификация сценариев взаимодействия городских властей и операторов рынка транспортных услуг. Проведен анализ системы управления общественным транспортом крупнейшего города. Предложен вариант развития городского общественного транспорта на основе логистической интеграции и кооперации на принципах мультимодализма с созданием единого центра управления городским общественным транспортом для обеспечения эффективной координации пассажиропотоков.

Ключевые слова: логистика; интеграция; общественный транспорт; мультимодальные пассажирские перевозки; управление.

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