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CHANGES IN THE PARAMETERS OF FUNCTIONING OF INTERCITY PASSENGER TRANSPORTATION SYSTEM

Taking into account the geographical location of transport hubs, their social and economic characteristics are used as factors of attractiveness or resistance to passenger correspondence, which affects the parameters of the elements of operation of vehicles. At the same time, at this stage of development of scientific approaches to the formalization of the parameters of passenger transport correspondence, the complex level of taking into account the flow of technical and economic parameters of driving to meet demand has been insufficiently determined. Therefore, the study of a comprehensive approach to the modeling of passenger transport correspondence, taking into account certain parameters is relevant. The analysis of modern scientific methods for the calculation of passenger transport correspondence during the operation of vehicles revealed that they are not sufficiently studied. This necessitates the conduct of experimental studies of the parameters of the experimental system and the subsequent establishment of correction factors for the known dependencies of the definition of passenger correspondence in the system. It is advisable to gravitational modeling of passenger transport correspondence, as acceptable for research.

Keywords: *transport system, intercity passenger transport route, basic parameters of transportation, efficiency, model.*

Introduction

The paper examined issues of studying the basis of intercity passenger transport routes. It is established that the system of intercity passenger route transportation is not isolated. This causes the influence of the environment on the quantitative indicators of the parameters of the functioning of these systems, which is due to the possibility of quantitative changes in the parameters entering the system. It was determined that the current state of scientific approaches does not fully take into account the interrelation of elements of the intercity passenger route system when calculating the basic parameters of the functioning of this system. It is proved that the issues of further development of scientific approaches regarding the features of accounting for the mutual influence of the quantitative characteristics of the elements of the system of intercity passenger route traffic is relevant and subject to study.

Theoretical Background

Modern scientific approaches to planning parameters of transport systems determine methods based on the consideration of passenger correspondence between the nodes of the transport network. The authors of the work [1] presented an approach to intelligent route planning in public transport systems. The approach focuses on the formal simulation of a semi-dynamic, intelligent planning and route optimization. To this end, it is important to have a well-developed formal model that covers cosmic aspects in real time. The proposed solution allows developers to expand the public transport system with additional routes that are dynamically generated based on requests from passengers. The model can be used within the framework of a sustainable city for both (fully or partially) autonomous transport systems and decision support systems of smart transport systems. In the work [2], vertical bus routes were developed, which reach the system of railway stations, as well as bus lines that have connection with the city center, turning into regional bus lines. The authors of the work [3] addressed the issue of route planning for public transport systems and proposed the presentation of a multi-modal transport network using a multi-criteria routing algorithm for modeling. In the work of the authors [4] the model of the probabilistic process of the bus service is defined. The authors of the work [5] have determined that the choice of a route by a multitude of passengers plays a primary role in estimating flows and forecasting demand. In the works [6, 7], the question of determining the time of the provision of transport services depending on the location of stopping points was considered. The authors in their work [8–10] revealed the issues of estimating the number of transported passengers by the public transport system taking into account the behavioral model of people and their influence on the choice of mode of transportation. The authors of the work [11–13] determined the parameters for optimizing the transit railway route and the bus routes of the transit corridor. The result of the study is the definition of a multipurpose model that maximizes the rail transit passenger traffic and minimizes the total time of the passenger transit route.

Materials and Experiments

According to the one considered in the work, the process of redistributing passenger correspondences takes place between passenger route systems. It has been determined that the quantitative indicators of this redistribution (the choice of a passenger network) are influenced by a set of characteristics of alternative route networks. It can be assumed that with the redistribution of passenger transport correspondences, fluctuations in the actual values of quantitative indicators of basic indicators of the functioning of the route networks themselves occur. To determine the patterns of changes in certain parameters from the redistribution of passenger transport correspondence between the networks, appropriate calculations have been carried out for a set of options for a certain redistribution of passenger traffic between the automobile and railway networks. Dependence 1 proposed to be used to determine the function of redistribution of passenger traffic by type of transport (FP):

$$FP = \frac{\tau_{cep}^{2} \; k_{\tau} PR_{cep}^{2} \; k_{PR} (IFL)_{cep}^{2} \; I_z k_{IFL} \sum_{zv=1}^{n} PM_{zv}}{\text{[illegible]}}, \quad (1)$$

where: PM_{zv} – number of passenger seats on routes of type of transport V;

Iz – the intensity of the vehicles movement on the Z route;

k_{PR}, k_{IFL}, k_{τ} – respectively, coefficients that take into account the weight of the corresponding parameter;

τ_z та τ_{cep} – respectively, time of movement at Z route and the average travel time on alternative routes;

PR_z та PR_{cep} – respectively, the price for the movement at Z route and the average price for alternative routes;

$IFL`_z$ and $IFL_{cep}$ IFL`z and IFLcer measure both the level of passenger fatigue on route Z and the average level of fatigue on alternative routes (interpreted by the passenger capacity).

Based on the results of calculations, the basic indicators of the functioning of the networks for the next set of passenger traffic distribution are obtained, namely: 15/85%, 20/80%, 25/75%, 30/70%, 35/65% and 40/60%. The results of calculations are summarized in Tables 1 and 2.

Taking into account the geographical location of transport hubs, their social and economic characteristics are used as factors of attractiveness or resistance to passenger correspondence, which affects the parameters of the elements of operation of vehicles. At the same time, at this stage of development of scientific approaches to the formalization of the parameters of passenger transport correspondence, the complex level of taking into account the flow of technical and economic parameters of driving to meet demand has been insufficiently determined.

Table 1.

Basic performance indicators of the automobile route network with maintenance of 15%, 20%, 25%, 30%, 35% and 40% of the total passenger traffic – FP

The value of the function of redistribution of passenger transportation volumes on the automobile type of transport (FP)					
15%	20%	25%	30%	35%	40%
6047	8062	10078	12093	14108	16124
7053	9404	11755	14105	16455	18807
0,24	0,27	0,29	0,3	0,31	0,32
183	220	256	294	327	364

Table 2.

The basic performance indicators of the railway route network when servicing of 85%, 80%, 75%, 70% and 60% of the total passenger traffic – FP.

The value of the function of redistribution of passenger transportation volumes on the rail type of transport (FP)					
85%	80%	75%	70%	65%	60%
526,72	526,75	526,74	526,77	526,75	526,75
569,9	569,91	569,93	569,94	569,92	569,91
0,38	0,38	0,37	0,37	0,37	0,37
900	845	801	747	702	653

Results

Based on the results of the calculations performed using the quantitative values of the calculated basic indicators of the functioning of the networks for the distribution of FP between the automobile and railway networks, it was possible to construct graphs for changes in certain parameters. Fig. 1 shows a graph of changes in the number of movements in the automobile route network when changing the FP distribution between automobile and rail network.

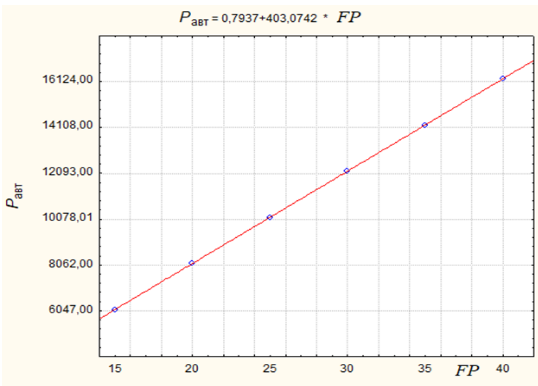

Fig. 1. T^{lp} changes over time during the day on a weekday, for routes optimized by T^{lp} and l_p.

$$P_{авт} = 0{,}7937 + 403{,}0742FP, \quad (2)$$

Let us construct the function (2) of the response for $P_{авт}$ – the number of movements by automobile routes.

where: $P_{авт}$ – number of movements by automobile routes;

FP – the value of the function of redistribution of passenger transportation volumes on a rail type of transport.

Let us carry out calculations on dependence (2) and compare the results obtained with the baseline data. The calculation results are summarized in Table 3.

Table 3.

Results of calculation $P_{авт}$ – the number of movements by road routes according to the dependence (2).

$P_{авт}$,од units	$P`_{авт}$ calculated, units	Deviation between $\lvert P`_{авт}\rvert$ and $\lvert P_{авт}\rvert$, %
6046,9067	6047	0,00%
8062,2777	8062	0,00%
10077,648	10078,01	0,00%
12093,019	12093	0,00%
14108,390	14108	0,00%
16123,761	16124	0,00%
	Total:	0,00%

According to the obtained results it can be stated that it is possible to predict $P_{авт}$ – the number of movements by automobile routes in accordance with the proposed dependence (2) with a definite deviation.

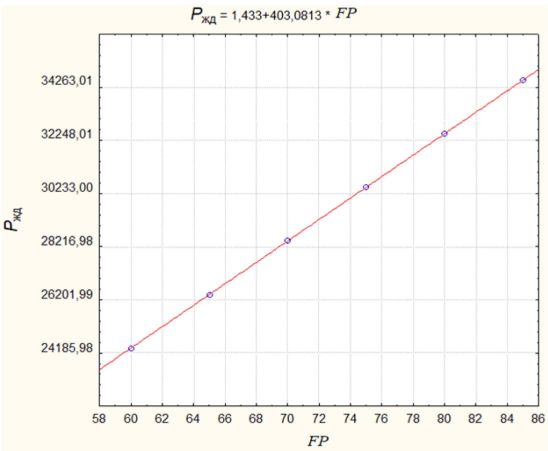

Fig. 2 shows a graph of the change in $P_{жд}$ – the number of rail route movements when changing the *FP* distribution between automobile and rail network routes.

$$P_{жд} = 1{,}433 + 403{,}0813FP, \quad (3)$$

Let us carry out calculations on the dependence (3) and compare the results obtained with the baseline data. The calculation results are summarized in Table 4.

Table 4.

Results of calculating the number of movements by automobile routes according to the dependence (3).

$P_{жд}$, units	$P`_{жд}$ calculated, units	Deviation between $\lvert P`_{жд}\rvert$ and $\lvert P_{жд}\rvert$, %
34263,3435	34263,01	0,00%
32247,937	32248,01	0,00%
30232,5305	30233	0,00%
28217,124	28216,98	0,00%
26201,7175	26201,99	0,00%
24186,311	24185,98	0,00%
	Total:	0,00%

According to the obtained results of the comparison of the basic indicators of the $P_{жд}$ – the number of rail network movements with the values determined by the results of calculations of the same value according to the dependence (3), the parameters of such a deviation are established.

Increasing the function of redistribution of volumes of transportation in relation to any route of different types of transport, with a constant total number of movements, causes an increase in the number of transported passengers, transport operation of the route network, the average carrying capacity, the number of vehicles. The regularities of changing the basic indicators of the operation of the intercity passenger routes from the proposed function of redistribution of traffic volumes, connection speed and passenger capacity utilization coefficient are determined. The function of redistribution of passenger traffic volumes by types of transport ensures that the total number of passenger seats in the route network of the corresponding type of transport is taken into account when calculating the redistribution of passenger transportation volumes by type of transport

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ІМІТАЦІЙНЕ МОДЕЛЮВАННЯ ПАРАМЕТРІВ ФУНКЦІОНУВАННЯ ПРОЕКТІВ НА ЗАЛІЗНИЦІ

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Аналіз сучасних наукових методів розрахунку відповідності пасажирських перевезень при експлуатації транспортних засобів показав, що вони недостатньо вивчені. Це обумовлює необхідність проведення експериментальних досліджень параметрів експериментальної системи і подальшого встановлення поправочних коефіцієнтів для відомих залежностей визначення відповідності пасажирів в системі. Доцільно гравітаційне моделювання кореспонденції пасажирських перевезень, як прийнятне для дослідження. Це обумовлює вплив зовнішнього середовища на кількісні показники параметрів функціонування цих систем, що обумовлено можливістю кількісної зміни параметрів, що входять в систему. При зміні параметрів розподілу пасажиропотоку між автомобільними і залізничними маршрутними мережами кількісні середні значення середньої протяжності маршруту і середньої дальності руху мережі змінюються менш ніж на 0,01%. Визначено, що зміна швидкості їзди є таким фактором, який не впливає на кількісні значення кількості переміщень в мережі, передавального відношення, середньої дальності поїздки. Водночас доведено існування поліноміальної залежності середнього коефіцієнта використання пасажиромісткості та кількості автобусів від швидкості маршрутно-мережевих поїздок. Функції перерозподілу обсягів перевезень по відношенню до *будь-якого маршруту різних видів транспорту, при постійній загальній кількості переміщень, обумовлюють збільшення кількості перевезених пасажирів, транспортної роботи маршрутної мережі, середнього коефіцієнта пасажиромісткості, кількості транспортних засобів. Тому вивчення комплексного підходу до моделювання відповідності пасажирських перевезень з урахуванням певних параметрів є актуальним. Встановлено, що сучасний стан наукових підходів не повною мірою враховує взаємозв'язок елементів системи міжміських пасажирських маршрутів при розрахунку основних параметрів функціонування цієї системи. Доведено, що питання подальшого розвитку наукових підходів щодо особливостей врахування взаємного впливу кількісних характеристик елементів системи міжміських пасажирських маршрутних перевезень є актуальними та такими, що підлягають вивченню.*

Ключові слова: *транспортна система, міжміський пасажирський транспортний маршрут, основні параметри перевезень, ефективність, модель.*

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