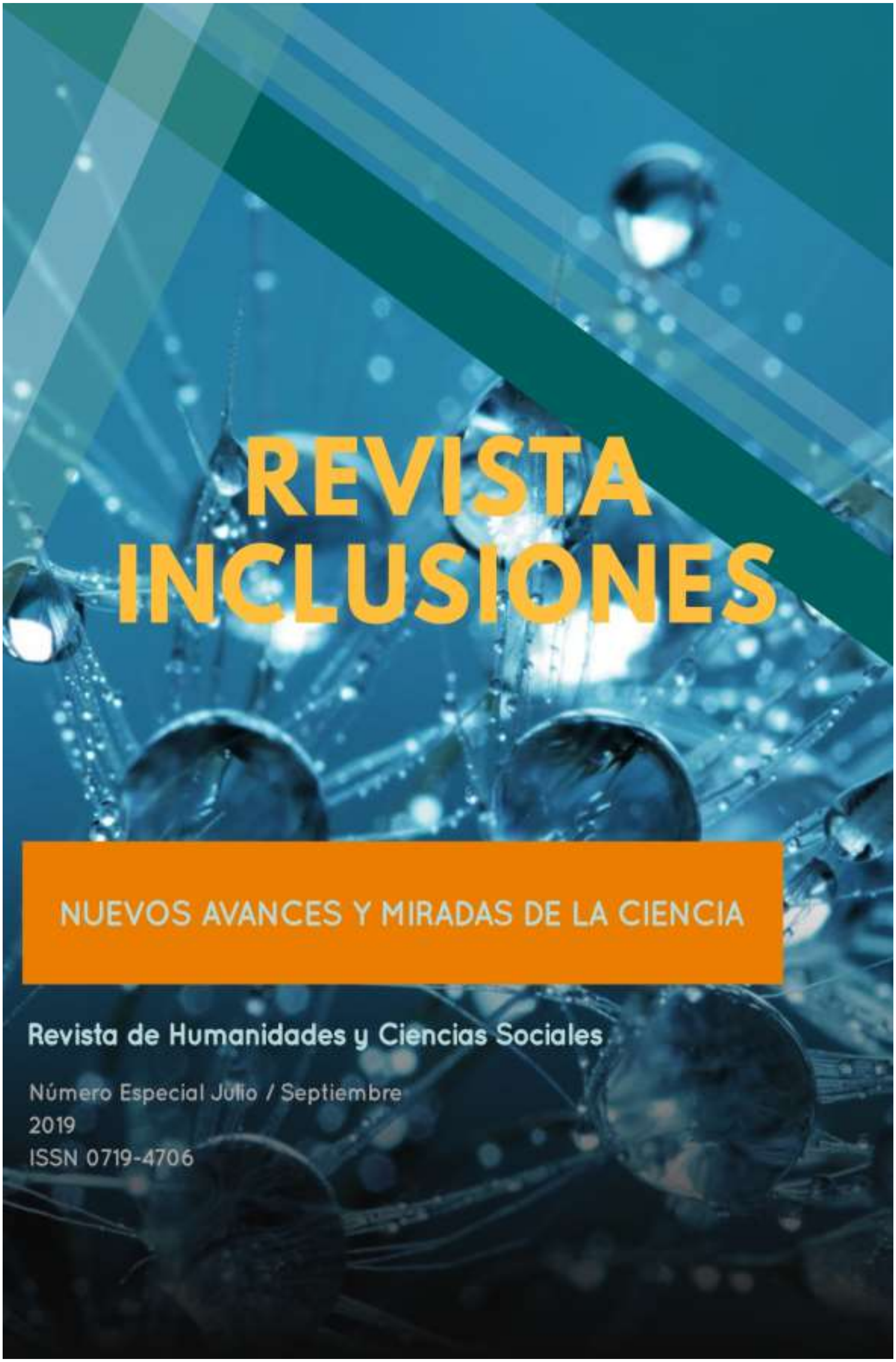
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OPTIMIZATION MANAGEMENT OF FORMAT OF MOTOR TRANSPORTATION SERVICE OF POPULATION IN SEASONAL CONDITIONS OF RESORT TESTING

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Abstract

In this paper, a rational approach to optimizing the format of motor transport services for the population (MTSP) in seasonal conditions of resort agglomerations is proposed. Moreover, a criterion for determining the absolute integral effect of optimization of the MTSP format in resort agglomerations (RA) has been developed.

Keywords

Regional Resort Agglomerations – Markets for Passenger Transport Services – Route Network

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Introduction

Our planet is becoming more urbanized. One of the urbanization stages is the formation of urban agglomerations. At present, the urban population has exceeded the rural population. About 55% of the world's population lives in cities, about a quarter (23.9%) of the world's population lives in urban areas with a population of 1,000,000 or more. In the Russian Federation, the level of urbanization is higher than the average in the world, and the level of agglomerations development corresponds to the world's average. seventy four percent of the population lives in cities of Russia. At the same time, about 24% of the country's population lives in cities - "millionaire-population" and cities with a population close to 1 million people. In the zone of the above and several other cities, urban agglomerations were formed, including resort ones (for example, in the Krasnodar Territory: Sochi, Tuapse, Novorossiysk, Gelendzhik, Anapa, and Krasnodar agglomerations).

The total population of resort and non-resort agglomerations (according to various estimates) reaches about 49 million people that are one third of the country's population.

Resort agglomeration (RA) is a set of compactly located settlements and urban districts, within whose territory, there are a complex and dynamically developing resort system with a seasonal-pendulous external and internal migration of the population, intensive production, infrastructure, social, economic, marketing communications, transport links, with the general use of adjacent territories (including coastal), resource and recreational development potential.

The development of spacecraft is associated with a number of problems, including transport. In particular, suburban residents often bear unnecessarily high transport costs, are not able to use public transport in the evening and at night, do not have internal routes, forced to use buses of insufficient capacity, etc. Moreover, during the "peak" periods of the summer holiday season, this problem is aggravated by the impulse influx of potential vacationers and tourists (up to 3 times longer than that in the winter period)[1]. In a spacecraft environment, the local population's quality of life and the comfortable stay of holidaymakers and tourists are closely related to the scope of passenger transport services (PTS), around which a certain infrastructure is created, marketing links, financial and credit relations, etc.[2]

Needs of the population for ATP services are related to both the production activities of the local population (trips to the place of work, business trips, etc.) and cultural and everyday necessities (tourist and sightseeing trips, trips to sanatoriums and boarding houses, rest homes, beach, etc.). PTS is the most important component of the spacecraft economy's territorial structure. In general, the sphere of transport services includes the issues faced by residents and guests of cities every day and most often. Passenger transport in the Russian Federation covers a special place, primarily because of the vast territory (17 million km^2); it is natural geographic, geo-economic and geopolitical conditions, and is an integral part in the organization of cultural and economic relations,

[1] A. E. Kravchenko; E. A. Kravchenko and A. V. Osennyaya, Geographic Information Systems in Logistics Processes in Passenger Transport: Theory and Practice: Monograph (Krasnodar: Izd. KubGTU, 2018).
[2] A. E. Kravchenko & E. A. Kravchenko, Management of the Quality of Passenger Transport Service: Theory, Methodology, Technology: Monograph (Krasnodar: Ed. KubGTU, 2017).

both intra-regional and inter-regional. In country scale, it provides movement for industrial and personal needs, unites into a single complex remote area of large cities and urban agglomerations, contributing to social and economic nomic, scientific, and technical progress.

Passenger transport meets one of the most significant human needs - the need for movement and communication with each other. The effectiveness of the operation as well as the level of development of passenger transport affects many areas of the society. The distinction between the economic and social functions performed by it can only be conditional: a specific result of transport activity usually gives both a social and an economic effect, not always amenable to a rigorous quantitative assessment.

Theoretically, the production of passenger transport is the result of movement, i.e. useful effect created by the technological process[3]. It is important to emphasize that, according to the legislation of the Russian Federation, transport activities are related to the service sector, in which road transport has a special position. Hence, for example, in spacecraft, especially during the peak period of the summer season, PTS services play a strategic role in satisfying consumers in quality recreation, and have a significant impact on: a) their free time structure and mobility; b) the nature of transport communications both within the agglomeration environment and beyond it (that is, the establishment of effective transport links between urban and rural areas with the complex development of various types of passenger transport services both on a regular and customized basis); c) sustainable functioning of the transport infrastructure, and d) the quantity and quality of the contribution and additional services.

As a result, it determines the socio-economic efficiency, competitiveness, image and development of regional spacecraft, creating a multiplicative effect of the PTS service sector[4].

Theoretical and methodological aspect of optimization of the format of motor transport service of population in seasonal spa agglomerations

The rolling stock of road transport is a strategic element of the passenger transport system in general and the service infrastructure of the spacecraft in particular, from a rational format[5], significantly depending on the efficiency and effectiveness of the entire field of transport services in spacecraft. The most important characteristics of this type of resource are its quantity, structure and distribution of rolling stock on a regular route network according to classification types, whose number is determined by the requirements of consumer demand and the level of quality of transport services.

[3] A. E. Kravchenko, Passenger Motor Transportation Complex of Resort Areas of the Krasnodar Territory: Methodology of Organization, Technology, Evaluation, Management: Monograph (Krasnodar: Ed. KubGTU, 2015).

[4] A. E. Kravchenko, Theory of Passenger Transport Systems in Road Transport in Resort Areas: A Monograph (Krasnodar: Izd. KubGTU, 2011).

[5] The format of the passenger motor transport service of the population is a transport-technological product (from technical-technological resource) ready for realization on the passenger transport services markets, with an increased consumer demand formed under the stated level of quality of transport services considering transport-planning features of a satellite, and with adaptive seasonal organizational characteristics (regarding the dynamics of the seasonal activity of the population and the segment of passengers).

The solution to the problem of optimizing the MTSP format (structure and number of rolling stock) under seasonal conditions of a spacecraft should be according to the following assumptions[6]:

1. Rolling stock for PTS services should be selected from the conditions for the most complete satisfaction of the needs of the population and holidaymakers in mass transport. At the same time, the level of quality of transport services should be determined by the norm on the terms of balancing the interests of market participants (Customer-Carrier-Consumer).

2. Optimization of the structure and quantity of the fleet of road vehicles should be carried out "from bottom to top", i.e. from the lowest level of management to the highest, using special economic regulators, forming retrospective statistical databases on the volumes of passenger traffic, quality of transport services, profits, risks, taxes, business entities (MS) and the technical and technological resources allocated by them to a set of quality level transportation services in the context of seasonal consumer restrictions.

These assumptions are applicable for solving the problem under consideration both by regular and registered buses and by passenger taxis. Their practical implementation should consider the specific working conditions of each type of passenger transport (climatic, seasonal activity of the population, etc.).

Such an idea of solving the problem of optimizing the MTSP format allows[7]:

- considering the specific transport and operational conditions for the operation of rolling stock on the regular route network of the spacecraft, not only based on statistical data of carriers, but also using service information and communication centers, thereby expressing their real (most complete, normative) need for quality satisfaction of consumer's demand on the seasons of the year and create objective prerequisites for systematic adjustment of decision-making in the issue of formation of the demand Bitel MTSP format;
- abandoning the development of various averaged standards obtained based on solving the problem for typical conditions;
- ensuring the regulation of the intervals of rolling stock on the regular route network under the standard filling of buses in the "peak" of passenger demand (summer: 4 people/m2 for the usual mode of movement of buses and 3 people/m2 for high-speed mode; winter: 6 people/m2 for the usual mode of movement of buses and 4 people/m2 for high-speed mode). The proposed approach creates objective prerequisites for continuous adjustment of management decisions, reflecting objective changes in consumer demand for the format and quality level of MTSP.

To the best of our knowledge, the optimal frequency of solving the problem of optimizing the MTSP format (the number and structure of the rolling stock) for the autumn-winter and spring-summer periods of the year is three years. This is explained by the fact

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6 A. E. Kravchenko; D. A. Gura and A. Yu. Dernovoy, "Flexible Approach to Municipal Route Network Optimization for Regular Bus Transport of General Use", International Journal of Economic Perspectives Issue 3 (2017).

7 A. E. Kravchenko & E. A. Kravchenko, The Main Directions of Improving the Quality of Public Services, Problems and Achievements of the Motor Transport Complex: Scientific and Technical Materials (Yekaterinburg: USTU-UPI, 2008).

that this task should precede the task of collecting and analyzing information on the actual values of passenger traffic and their dynamics on the regular route network of the spacecraft, assessing the effectiveness, efficiency and quality of transport services, identifying violations of the regularity of transportation processes and transport safety, streamlining the distribution of buses on the route networks, development of territories of agglomeration and transport infrastructure, etc.

The noted connection between the two tasks again confirms the necessity and correctness of the proposed principle of optimizing the number and structure of the rolling stock of automobile transport “from bottom to top”, allowing us to more objectively solve the problem of rational building of the MTSP format for the stated level of service quality in seasonal spacecraft.

Statement of the Problem

We present a formalized description of the problem of optimizing the MTSP format, using the example of a regular public bus transport (RAPP), defined as the route network in the spacecraft. It is required to determine the required number and type of buses for the summer and winter periods of the year for a given level of quality of transport services under the existing restrictions on the technical and technological resources of carriers. For optimizing the entire route network for RAPP, spacecraft should have known (predicted) volumes of passenger correspondence between transport areas (TR), and analyzed the nature of their formation for the winter and summer periods of the year, on the basis of which the periods of their constancy during the day week, month, and year are determined.

Studies have established that the formation of volumes of passenger correspondence (Q_{ij}) between the estimated TR KA depends on[8]: C - seasonal activity of the population and weather conditions, N_o shows the number of tourists in resort areas, $P_{ж.ф.}$ - the capacity of the housing stock of the resort agglomeration (local residents + means of accommodating guests and tourists), $P_{пл.т}$ is beach areas capacity (standard 4.5-5 m^2 for 1 person), $P_{с.р.о.}$ represents sports and leisure entertainment facilities, $r_{дост}$ - transport accessibility (distance) of the target objects, $j_{об}$ shows transport provision (development of the route network) and territorial provision of transport services (saturation of the route network with rolling stock), RV is the rhythm of interaction of various types of passenger transport, RTON - regularity of transport services for the population, T stands for fare and its flexibility, $t_{корр.}$ is the time spent by passengers on correspondence between transport areas of a regional spacecraft, I represents information and communication support, and KPS - comfort and transport safety in a spacecraft.

Considering the aforementioned features of the formation of the volume of passenger correspondence between the spacecraft TR, the following equations can be expressed[9]:

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[8] A. E. Kravchenko; E. A. Kravchenko and A. V. Osennyaya, Geographic Information Systems… y A. E. Kravchenko; E. A. Kravchenko & M. O. Levitsky, The Method of Forming Possible Options for the Redistribution of Buses on the UDS of the Municipality throughUsing Transport on Orders, Polytechnic Bulletin of KubGTU: “Science and Technology” (Krasnodar: Ed. Publishing House–SOUTH, 2013)

[9] E. A. Kravchenko & A. E. Kravchenko, Modernization of the Development Strategy of the Passenger Transportation Organization System in Municipalities and Their Management in Terms

- for the summer period:

$$Q_{ij} = f(C, N_о, P_{ж.ф.}, P_{пл.т}, P_{с.р.о.}, r_{дост}, j_{об}, RV, R_{ТОН}, T, t_{корр.}, I, K_{ПС});$$

- for the winter period:

$$Q_{ij} = f(P_{ж.ф.}, r_{дост.}, j_{об}, R_{ТОН}, T, t_{корр.}, RV, K_{ПС}).$$

(1)

The relationship between the estimated volume of passenger correspondence ΣQij of all the spacecraft TR and the necessary amount of rolling stock (PS) of the RAPP for timely and quality service to the local population, and tourists from these areas is expressed by the equation: $\sum Q_{ij} = \sum_{i=1}^{k} A_i \cdot \frac{\omega}{l_{ср}}$, where ω is the transport work of one mobile unit, pass * km; $\ell_{ср}$ stands for the average distance traveled by the passengers, km; A_i represents the number of PS RAPOP units serving passenger correspondence to the spacecraft route network.

The pattern of formation of volumes of passenger correspondences between the spacecraft TR should be considered, as shown above, with the help of two models linked to the seasonal factor, namely:

1) “Winter - local people” model:

$$Q_{ij}^{зима} = \frac{Q_j^{м.нас} \cdot f(P_{ж.ф.}, r_{дост}, j_{об}, R_{ТОН}, T, t_{корр}, RV, K_{ПС})}{\sum_j Q_j^{м.нас} \cdot f(P_{ж.ф.}, r_{дост}, j_{об}, R_{ТОН}, T, t_{корр}, RV, K_{ПС})} \cdot \sum_i Q_i^{м.нас} \cdot f(P_{ж.ф.}, r_{дост}, j_{об}, R_{ТОН}, T, t_{корр}, RV, K_{ПС})$$

, (2)

Where Q_i, Q_j – accordingly, the volume of correspondence of departure (i) and arrival (j) from the TP of a regional spacecraft are proportional to the competing objectives of the trip.

2) The “Summer” model - local population + vacationers, tourists and transit passengers without overnight stay”:

$$Q_{ij}^{лето} = [\frac{Q_j^{о.т.тр} \cdot f(C, N_о, P_{ж.ф.}, P_{пл.т}, P_{с.р.о}, r_{дост}, j_{об}, RV, R_{ТОН}, T, t_{корр}, I, K_{ПС})}{\sum_j Q_j^{о.т.тр} \cdot f(C, N_о, P_{ж.ф.}, P_{пл.т}, P_{с.р.о}, r_{дост}, j_{об}, RV, R_{ТОН}, T, t_{корр}, I, K_{ПС})} \cdot \sum_i Q_i^{о.т.тр} \cdot f(C, N_о, P_{ж.ф.}, P_{пл.т}, P_{с.р.о}, r_{дост}, j_{об}, RV, R_{ТОН}, T, t_{корр}, I, K_{ПС})] + $$
$$+ [\frac{Q_j^{м.нас} \cdot f(P_{ж.ф.}, r_{дост}, j_{об}, RV, R_{ТОН}, T, t_{корр}, K_{ПС})}{\sum_j Q_j^{м.нас} \cdot f(P_{ж.ф.}, r_{дост}, j_{об}, RV, R_{ТОН}, T, t_{корр}, K_{ПС})} \cdot \sum_i Q_i^{м.нас} \cdot f(P_{ж.ф.}, r_{дост}, j_{об}, RV, R_{ТОН}, T, t_{корр}, K_{ПС})] \quad (3)$$

Optimization of the PS fleet structure for RAPP in the spacecraft should also include its transport-planning feature, psychology (motives) of the transport behavior of the local population and tourists, which can be identified by a survey method and filled out special questionnaires. According to the results of such a survey, key factors influencing the activity of consumer demand for RAPP services for the winter and summer periods of the year are determined. It is important to consider that the volumes of passenger correspondence between the spacecraft TR are formed as stable - for the winter period, and as flexible - for the summer period of the year, respectively:

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of Seasonality (Cases Study: the Krasnodar Territory), Problems of Quality and Operation of Vehicles: Materials VIII int. in absentia Scientific and Technical conf (Penza: PGUAS, 2014).

- Correspondence for the model <winter - local population>:

$$\sum_j \sum_a Q_{ija} = Q_i f(S^{ks}_{i_{нас}}), \quad \sum_i \sum_a Q_{ija} = Q_j f(L^{sz}_{j_{нас}}), \quad \sum_i \sum_j Q_{ija} = Q_a f(P^{C_0}_{a_{нас}});$$

- Correspondence for the model <summer - local population + vacationers + tourists + transit passengers:

$$\sum_j \sum_a Q_{ija} = Q_i^{\max} f(S^{ks}_{i_{нас+отд}}), \quad \sum_i \sum_a Q_{ija} = Q_j^{\max} f(L_{j_{нас+отд}}), \quad \sum \sum_j Q_{ija} = Q_a^{\max} f(P^{C_0}_{a_{нас+отд}}), \qquad (4)$$

where S^{ks}_i, L^{sz}_j, P^{C0}_a – the factors of the influence function respectively are the segmentation of the source (i) passengers, the structure of the attracting target location (j) and the cost estimate (C0) of the choice of the type of passenger transport (a) for moving around the spacecraft.

When forming "stable" volumes of passenger correspondences (for the winter period), the influence on the purpose of the passengers' travel considers the structure of the corresponding attracting object.

In such conditions, the profitability of its location does not practically play any role (since mainly compulsory working trips for the local population were made). Thus, a condition arises in which the segmented passenger traffic (correspondence) is considered when the RAPP is distributed on the route network of the SC as stable, in which the time spent on the trip plays a decisive role choosing the route by the local population.

The formation of "flexible" volumes of passenger correspondences (for the summer period) considers the influence of the location of objects of interest (beach, park, rest house, etc.), playing a significant role in the choice of RAPP travelers to travel around the spacecraft. In such conditions, the expected value of the segmented passenger traffic is no longer derived only due to the structure of the attracting place.

Given the peculiarities of the formation of daily volumes of correspondence between all TRs in the spacecraft, it is proposed to optimize the structure of the PS fleet for RAPP under the stated level of quality of transport services by the following equations[10]:

- For the winter period - "local population":

$$A^{зима} = \sum_{k=1}^{n} \sum_{m=1}^{l} \sum_{g=1}^{h} \frac{Q^{м.нас}_{сут} \cdot \sqrt[4]{\prod_{i=1}^{4} K_{\phi_i}} \cdot BOP_{t_{об}}}{NBB_{q_{мак}} \cdot КИВ_{\gamma} \cdot HB_{T_н} \cdot КСП_{\eta_{см}}}; \qquad (5)$$

10 A. E. Kravchenko, Optimization of the Transport System of the Resort Agglomeration, Considering the Organization of Flexible Transport Services in Terms of Seasonal Activity of the Population, Development and Modernization of the UDS of Large Cities, Considering the Peculiarities of the Organization and Holding of Mass Events of International Importance (in preparation for the 2018 FIFA World Cup): Proceedings of the International scientific and practical conf (Volgograd: VolgGUAS, 2014).

- For the summer period - “local population + tourists + transit passengers”:

$$A^{лето} = \sum_{k=1}^{n} \sum_{m=1}^{l} \sum_{g=1}^{h} \frac{Q_{сут}^{м.нас+отд+тур+тр} \cdot \sqrt[3]{\prod_{j=1}^{3} K_{c_j}} \cdot \sqrt[4]{\prod_{i=1}^{4} K_{ф_i}} \cdot BOP_{t_{об}}}{NBB_{q_{ном}} \cdot КИВ_{\gamma} \cdot HB_{T_н} \cdot КСП_{\eta_{см}}},$$

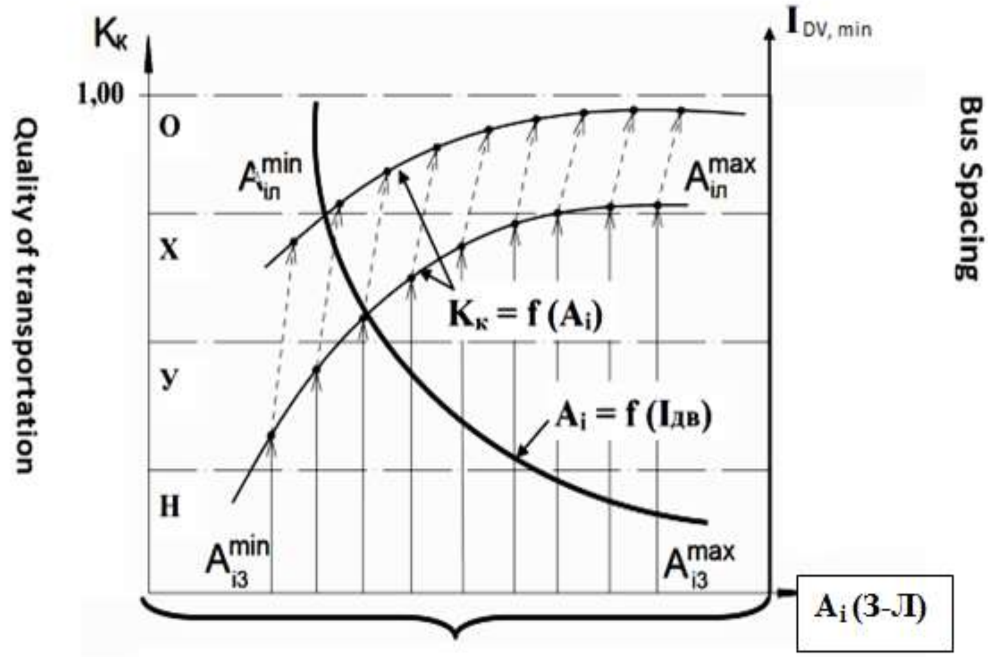
(6)

Where a is the optimal number of PS RAPOP fleet units necessary for the full and timely development of passenger traffic for the winter and summer periods of the year, respectively; k, m, g are the segmentation of groups of passengers, the structure of the PS RAPP park by types, the number of RATOP routes served, respectively. $Q_{сут}$ is the daily volume of passenger correspondence between the TR spacecraft by periods. $КИВ_{\gamma}$ stands for static capacity utilization ratio of PS RAPP; $НВВq_{ном}$, $НВВq_{мак}$ represent the nominal and maximum capacity of the substation, respectively (summer period: 4 persons/m^2 - for the usual mode of movement of buses and 3 people/m^2 - for high-speed mode; winter period: 6 people/m^2 - for the usual mode of movement of buses and 4 people/m^2 - for high-speed mode). $НВ_{Тн}$ shows the elegant working hours of RAPP on the route, h; $КСП_{\eta см}$ is the shift coefficient of passengers on the route; $К_к$ stands for quality criterion of transport services (with exemplary service $К_к$ > 0,96, with good 0,68-0,96, satisfactory 0,38-0,67, and unsatisfactory< 0,38) quality). $ВОР_{тоб}$ shows the time of the circulating flight RAPP on the route, h.; $К_{ci}$, $К_{фi}$ respectively represent, the coefficient of uneven demand for RATOP services, as the product of the values of the indicators below the root, for the summer period: by half, quarter, and month of the year; for the winter period, as the product of the values of the indicators below the root: by the hour of the day, RATOP movement directions, route sections, days of the week).

It is important to emphasize that in optimizing the number and structure of the fleet of substations for RAPP in the satellite, the quality factor should satisfy the needs of the segment groups of the local population, passengers and tourists, while maintaining the nominal filling characteristics of the rolling stock. The optimal number of PS RAPP (A) on the route network in the spacecraft should provide the necessary range of motion (I) meeting the stated level of quality of transport services while maintaining its nominal filling characteristics of the rolling stock.

The relationship between the quality of transport services, the quantitative structure of the bus fleet and the traffic interval on the route is shown in Fig. 1.

The presented interrelation of criteria in Fig. 1 makes it possible to consider the peculiarities of transport services for the population in seasonal spacecraft conditions, provided for various managerial decisions regarding the optimization of the number and structure of the rolling stock fleet under the stated level of quality of transport services. The Fig. shows that with an increase in the number of fleet units on the route, the quality of transport services increases and, accordingly, the interval of buses movement decreases, while maintaining the standard for filling buses.



number and structure of buses on the route, pcs

Fig. 1

The schedule for determining the seasonal number and structure of the rolling stock of buses (Ai (winter-summer)), given the quality levels of transport services ($K_к$) and interval (I_{DV}) traffic on the route:

H, У, X, O - levels of quality of transport services, respectively, unsatisfactory (Кк<0,38), satisfactory (Кк = 0,38-0,67), good (Кк = 0,68-0,96), exemplary (Кк > 0,96)

Valid Solutions for Determining the Optimal Format of Passenger Road Transport Service

Assume that the volumes of passenger (correspondence) traffic do not change when the number and type of buses on a route and their capacity changes, i.e. when the quality of transport services changes. This means that the presence of feedbacks between the quality and volume of passenger traffic is neglected, which is true for buses mainly carrying the local population in the autumn-winter period for the purpose of employment in regional spacecraft.

We introduce the necessary notation[11]:

Ajikis the number of buses of the *i* mark (or the *i* group) on the *j* route in the *k* interval of constancy of the flow of passengers;

$\delta^{\kappa}{}_{ij}$ $\begin{cases} 1, \text{ if a } i \text{ is the mark corresponds to the } j \text{ route in the } k \text{ period;} \\ 0, \text{ otherwise.} \end{cases}$

Value $\delta^{\kappa}{}_{ij}$ is pre-determined by the condition of compliance with the type of bus road conditions, technology of transportation, traffic safety requirements, etc. T is the period of optimization of the solution of the problem (0.5 years).

The process of optimizing the desired parameters of the PS RAPP Park consists of two stages.

In the first stage we find all permissible brands of buses by value $\delta^{\kappa}{}_{ij}$ for the first period of constancy K = 1.

For each brand of buses, we determine their number, range of traffic, as well as technical, operational and economic indicators of work on a regular route network.

The solution of this problem is carried out by statistical modeling of the route based on data characterizing the segmentation of passenger traffic on the route during a given period, the length of routes, the number of stopping points, the volume of passenger traffic, etc. the brand of buses, as well as those values of the number of buses allowing to ensure the minimum level of quality of transport services corner. At the same time, the quality of transport services can be characterized by a whole set of parameters: travel comfort, safety of the transportation process, traffic regularity, environmental safety, reliability of the transport service, interval of traffic, probability of failure to board, etc. The method for determining the permissible number of buses for different periods of the year (conventionally winter and summer) is shown in Fig. 1.

The process of finding the permissible values of the number of buses (according to the maximum capacity for the autumn-winter period) is similarly performed for all routes, for all periods of passenger traffic constancy during the period of consideration of the process T = 0.5 year (for the autumn-winter period). As a result, a set of bus numbers will be obtained. $\{A^{dop}_{ijk}\}$, with each triple indices of $\{i, j, k\}$ will correspond not to one value, but to a set from the range $[A^{min}_{i}, A^{max}_{i}]$ (Fig. 1).

For each value A^{dop}_{ijk} by modeling, you can get a whole set of indicators characterizing this solution, i.e. compliance will be determined:

$$\{A^{don}_{ijk} \leftrightarrow \beta_1, \beta_2, \ldots \beta_m\}$$

This ends the first stage of solving the problem of optimizing the number and structure of the bus fleet, the purpose of which was to obtain the necessary information characterizing permissible solutions.

In a similar way, determining the number and structure of the bus fleet for the spring-summer period (T = 0.5 years).

Based on the information received, an optimal solution should be obtained meeting the entire set of constraints and optimizing the selected criterion.

At the second stage, an optimal solution is sought, for which it is necessary to develop a mathematical model of the problem. Consider the prerequisites that, with a formalized description of the task, will constitute its limitations or will be included as components in the objective function. For further consideration, we introduce additional notation:

$$\xi^{\kappa}_{ij} \begin{cases} 1, \text{ if the } i \text{ bus brand is working on the } j \text{ route to the } k \text{ period;} \\ 0, \text{ otherwise.} \end{cases} \quad (9)$$

In this case, the condition $\sum_j \xi^{\kappa}_{ij} = 1$, meaning that on each route in a certain period of consistency of passenger traffic there are buses of the declared brand (one classification group).

As a result of the solution, a set of values of A^{dop}_{jik} should be obtained from among the valid A^{dop}_{jik}, showing how many and which buses should operate on each served route in each period of consistency of passenger traffic at a nominal PS load.

Using the entered designation, you can easily record all the characteristics of the buses on the routes, the quality of transport services, express all cost and income components, i.e. eventually build a mathematical model of the problem in question:

a) The number of buses on the route in any period:

$$\sum_j A_{ijk}\xi^k_{ij}; \quad (10)$$

b) The number of buses of each brand on all routes served in each period considered:

$$\sum_j \sum_i A_{ijk}\xi^k_{ij}; \quad (11)$$

c) The required number of buses of each brand to service the routes for the entire period under consideration:

$$max_k \sum_j \sum_i A_{ijk}\xi^k_{ij}, \quad (12)$$

The maximum value is taken for all periods of consistency of passenger traffic;

d) The required number of drivers and conductors in each period:

$$\sum_i \sum_j A_{ijk}\xi^k_{ij}; \quad (13)$$

d) The required number of drivers and conductors for working on the route in the mentioned year:

$$max_k \sum_j \sum_i A_{ijk}\xi^k_{ij}. \quad (14)$$

Thus, it is possible to determine the operation mode of drivers, which must comply with the established limit on the total duration. In addition, the mode of operation of drivers and conductors must meet a variety of requirements making it convenient for staff, since this greatly depends on the attractiveness of work for people of this specialty, which is very important given the shortage of labor resources, especially over peak periods of the holiday season. Such data also makes it possible to formulate a limitation in the model of the task of driver's personnel and conductors, which is one of the most important and significant issues, especially for peak periods of the holiday season in the AC.

e) the number of buses, their structure and standards, determining the required number of repair workers, engineering and technical workers as well as support staff, i.e. all required number of employees for servicing in the spacecraft;

g) The technical base, its cost and the cost of rolling stock;

h) The organization of the work of buses on the line, dispatching management, technical and operational technical and economic indicators, including idle and empty runs, associated with the transfer of buses from route to route, temporary characteristics, etc.;

i) All valid solutions must be evaluated for stability, reliability and manageability.

Buses of large and very large capacities are preferable, first, from the position of the required number of drivers and conductors, but the descent of such a bus from the line for any reason changes the system characteristics more dramatically than the descent of a bus of small and very small capacities. Dispatch control for buses of large and extra-large capacities becomes coarser, has more deficiencies in the system than when using buses of small and extra small capacity.

Hence, the more stringent requirements for technical and operational services, the less possibility of maneuvering will be. Therefore, the evaluation of the park structure by these indicators is very important and requires reasonable restrictions or it is necessary to find a way of its monetary expression in order to be included in functional tasks.

Before defining in detail which of the listed characteristics will be included in the constraints of the task, and which ones in its functionality, i.e. before developing a mathematical model of the problem, let us point out some approaches to the definition of the objective function.

If we assume that there is no connection between quality (within acceptable limits) and the volume of passenger traffic (for the autumn-winter period), we can assume that transportation revenues do not change. In this case, the minimum reduced costs for the carriage of passengers for the studied entire period can be taken as the objective function of the task. At the same time, restrictions on the quality of passenger service for each route should be met.

For the spring-summer period in spacecraft, on the contrary, to a greater extent, it is necessary to consider the relationship between the quality and volume of passenger traffic, since revenues (effect) from transportation vary significantly. In this case, as the target function of the task, the maximum of the received profit from the transportation of passengers can be taken. To reduce the scope of the search for optimal solution of the problem under consideration, and to bring it closer to the actual possibilities of practice, it is proposed to consider one of the possible rational approaches. The use of a rational approach is that the optimal solution of the problem itself is not found, but only its deviation from either the actual solution, i.e. the actual structure of the PS Park is calculated. This approach is based on the assumption that the number and structure of the bus fleet for a number of years varies based on the needs of the population in transportation, i.e. because of the operation of an objective mechanism and, therefore, approaches its rational value. In addition, changes in the number and structure of the bus fleet from the actual are more easily realized than the implementation of an unrelated optimal structure, which in this approach is needed as a guideline and it should be determined for a more remote period (using the projected values of the transport planning and infrastructure development KA, and therefore transport mobility of the population).

Unlike the first approach, allowing you to get the optimal structure of the PS Park for all period of the year under consideration, the second (predictive) approach provides a rational solution. Identifying the advantages and disadvantages of each of the considered approaches should be one of the tasks of solving the general problem of optimizing the MTSP format in a spacecraft.

Considering the lesser (for the autumn-winter period) and the greater (for the spring-summer period) degrees of interrelation of quality, volumes and revenues from the transportation of passengers, it is proposed to determine the absolute integral effect from the functioning of passenger vehicles in the AC using the following formula[11]:

$$IME_R = \Delta_{a-w} \cdot \sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{z} \frac{X_{ijk} \cdot \left[\left[\frac{t_o \cdot f(L_m, V_e, t_{p,k}, H_A, U_P, R_D, B_U)}{I_{\partial в} \cdot f(q_{MAX}, g_c, E_s, T_R)} \cdot \frac{P}{l_c} \cdot D - C_b \right] \cdot (1 - N \cdot f(s)) - C_a \cdot f(c_1, c_2, c_3) + AO \cdot f(T, L, F) \right]}{1 + (1 - K_{ijk}^{f})^{1/t}} + \tag{15}$$

$$+ \Delta_{v-s} \cdot \sum_{i=1}^{n}\sum_{j=1}^{m}\sum_{k=1}^{z} \frac{Y_{ijk} \cdot \left[\left[\left(\frac{t_o \cdot f(L_m, V_e, t_{p,k}, H_A, U_P, R_D, B_U)}{I_{\partial в} \cdot f(SK_{ARP}, q_{NOM}, g_c, E_s, T_R)} \cdot \frac{P + \Delta P}{l_c + \Delta l_c} \right) \cdot D - C_b \right] \cdot (1 - N \cdot f(s)) - C_a) + (AO + \Delta AO) \right]}{1 + (1 - K_{ijk}^{f})^{1/t}} + \sum_{j=1}^{b} C_{Lj} + \sum_{u=1}^{p} VTE_u,$$

Where Δ_{a-w} is the autumn-winter period (6 months - not a resort period) - base; Δ_{v-s} represents spring-summer period (6 months - resort period) - adaptive; *i* stands for the number of routes in the spacecraft; *j* shows the number of types of rolling stock on the considered routes (especially very small, small, medium, large and very large capacity). k shows market type (saturated, developing, with limited growth potential) of transport services with segmented passenger traffic; t is the number of days of operation of various types of rolling stock on routes in each considered period. the required number of units of rolling stock on the route is obtained as $A=t_o/I_2$, unit, where t_o is the circulating flight time as a function of route length (L_m), rolling stock speed (V_e), idle time at intermediate and final points of the route ($t_{p,k}$), road conditions (H_A), driver's skill (experience) (U_p), dynamic characteristics of the rolling stock (R_D), efficiency of dispatching control of transportation

[11] A. E. Kravchenko, Motor Transport Development Management in Regional Resort Agglomerations: Theoretical and Methodological Aspects, A. E. Kravchenko and D. A. Gura, Orbis, Vol. 14 Issue 41 (2018): 35-45; A. E. Kravchenko, "Passenger Service Market Functioning and Development Management in Urban…; A. E. Kravchenko; E. A. Kravchenko and A. V. Osennyaya, Geographic Information Systems… and E. A. Kravchenko & A. E. Kravchenko, Modernization of the Development Strategy of…

processes (B_U), min .; l_2 stands for rolling stock spacing as a function of SK_{ARP} – seasonal additional attraction of buses, capacity (q) of rolling stock (maximum in the autumn-winter period and nominal in the spring-summer period), time of day (g_c) operation of rolling stock on the route network, intensity of formation of transport demand (E_S), and technological modes (T_R) of transportation processes (normal, high-speed, express, shortened, etc.), min .

The daily volume of passenger traffic on the route can be determined based on the results of a passenger traffic survey, or according to the standards of transport mobility of the population or according to the formula $Q=P/l_c$, pass .; P is the transport work of rolling stock, pass. * km; ΔP represents increase in transport work, pass. * km;l_c and Δ l_c respectively are the average travel distance of passengers and its seasonal increment, km, is determined either based on the survey of the route network, or the proposed empirical formulas:

For the autumn-winter period - $l_c = a + в \cdot K_p \cdot \sqrt{F_o - F_p}$.

For spring-summer period – $l_c = (a + в \cdot K_p \cdot \sqrt{F_o}) \cdot K_u$.

Where F_o is the total area of the built-up part of the spacecraft with coastal territories, in which the transport service of the population is organized, km^2. F_p is the area of the coastal territories of the spacecraft with boarding houses, sanatoriums, hotels, etc., in which transport services for the population and the others (passengers and tourists) are organized during the holiday season, km^2. a is an indicator characterizing the maximum distance at which the population begins to use various types of passenger transport, taking values in the range from 1.1 to 3.0 (depending on the type of passenger transport: passenger taxi, custom or regular passenger transport, etc.) , km. в is the correction factor, taking values in the range of 0,258 to 0,3); $К_p$- coefficient of non-straightness of the road network of a regional spacecraft (can take values in the range of 1.05 to 1.5); K_U shows the coefficient taking into account the increase in the average distance of the journey of passengers due to non-urban trips to the spacecraft determined by the formula: $K_U = N / N_c$, where N is the total population of spacecraft, covered by passenger transport services, people; and N_c is the population of the considered zones of the spacecraft, covered by passenger road transport services, people. X_{jik}, Y_{jik} are the probabilities of receiving the planned profit from passenger traffic on the spacecraft route network for the considered periods of the year, in fractions of a unit. D is the average fare for various modes of the transportation process on the route rub/pass.; C_b stands for the total cost of transportation of passengers as a function of the permanent (C_f) and variables (C_v) costs, including depreciation (AO), RUB. as a function of T,AO is the duration of operation of rolling stock, years, L is the mileage of rolling stock, km. F represents the cost of rolling stock, as the main production fund, rubles. ΔAO is the increment of depreciation deductions due to the activation of pendulous (seasonal) integration processes, rubles.; *N*f(s)* is the tax rate as a function of the type of taxation system (*s*) (imputed tax, simplified system, ordinary taxation system), in unit shares; Ca shows additional costs (non-regulatory) associated with the violation of safety requirements for the transport of passengers and baggage (c_1), regularity of transportation processes (c_2), environmental safety (c_3), rubles.. K^f is a discount assessment indicator of the quality of transport services, characterizing the functional aspect of MTSP in KA (it can take different values over assessment periods), in unit fractions; C_{Lj} shows the liquidation market (residual) cost of *i* CS rolling stock minus income tax, rubles (it can be up to 25% of the initial value of depreciable fixed assets). VTE_U is the cumulative extra-transport effect of improving the quality of transport services in spacecraft, rubles, including the effects (u) of development of the relevant types and the formation of new types of business; improving the efficiency of production of goods and services in related areas of business, in which the population is engaged, using passenger transport. Acceleration of working capital turnover and renewal of MS production capacities due to the growth of labor productivity and systematic increment of consumption of goods and services through the development of transport infrastructure and services for all segments of the population with different levels of effective demand increase tax collection. VTE (according to experts) can take values from 15 to 30% of the total effect.

The interrelation of the influence of the quality level of transport services for RAPP on the formation of the integral multiplicative effect, on the example of the agglomeration of Anapa showed the following results:

year 2010, 26614415,7 rubles.; *year 2011,* 31781150,17 rubles; *year 2012,* 42158297,7 rubles; *year 2013,* 42524068 rubles; *year 2014*–50813433 rubles; *year 2015,* 60759268 rubles.; *year 2016,* 69369354,47 rubles; *year 2017*, 78251229,76 rubles; *year 2020 (forecasted),* 100036841 rubles.

The main advantages of using the criterion (IME_R) are a) a high degree of reliability of the initial data for calculating the effect (statistics, results of consumer demand surveys, etc.), b) ease of calculation, c) connection between the technical and economic, technical and operational, and qualitative indicators of the functioning of passenger road transport in the interconnected markets of transport services, d) the possibility of using various scenarios for the functioning of MTSP in a spacecraft, e) consideration of the seasonal (temporary) factor in the activity of consumer demand for spacecraft transportation services, f) the possibility of assessing the effect on certain types of passenger transport services and the scale of the markets for transport services, and g) the possibility of considering the balance of benefits for all stakeholders (Customer - Carrier - Consumer).

Conclusion

In the seasonal conditions of spacecraft, quality of life of the local population and the comfortable stay of vacationers and tourists are closely related to the scope of passenger transport services. In this connection, optimization of the MTSP format for the stated level of QOS and the volume of consumer demand is the main management guideline in attracting the resource and technical capabilities of carriers as well as their rational distribution on the spacecraft route network

Findings

1. A rational approach was proposed to optimize the MTSP format in the spacecraft by the number and structure of the fleet of bus vehicles for the stated quality level of transport services, considering the influence of the seasonal factor of consumer activity. Using a rational approach allows you to find not only the most optimal solution to the problem, but also its deviation from the actual solution. This approach is based on the assumption that the number and structure of the bus fleet for a number of years varies according to the needs of the population in transportation, and, therefore, it is a rational value.

2. A criterion has been developed for determining the absolute integral effect of the optimization of the MTSP format, allowing to consider in a lesser (for the autumn-winter period) and a greater (for the spring-summer period) interrelation of quality, volumes and income received from the transportation of passengers to the spacecraft.

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