International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2019): 7.583

Methods of Rational Allocation of Buses on Routes of Local Traffic

G. G. E. Abdurayeva[1], D. K. Bakei[2]

The Karaganda State university of E.A.Buketova Karaganda
Guleke_60[at]mail.ru , dinara_bak[at]mail.ru

Abstract: ***The article deals with a number of problems related to the development of urban transport, the problems of transport system management, which are one of the main components of urban infrastructure that provides vital needs of the population. In particular, one of the main tasks of urban bus transport management was to find ways to solve the problems associated with the need to accurately determine the passenger flow and its distribution by time of day to create optimal routes for buses. Since the optimal solution of such issues will reduce the downtime of buses, improve the efficiency of rolling stock, as well as optimally plan transportation, increase the productivity of buses, reduce the number of rolling stock included in the route, which in turn will save material resources of the fleet. In accordance with the purpose of the study, it was envisaged to create a mathematical model for solving the routing problem associated with the nature of the spread of passenger and transport flows in the city, taking into account the specifics of passenger traffic.***

Keywords: passenger: traffic, rolling stock, modeling, route, dispatching control, correspondence

The rapid growth of the urban population and the increase in its mobility cause a number of problems related to the development of transport in cities. The management of the transport system is one of the main components of the city's infrastructure, which meets the vital needs of the population.

One of the main tasks of urban bus transport management is to create optimal routes and intervals for the movement of buses. The complexity of its solution lies in the need to accurately determine the flow of passengers and its distribution over time during the day. The solution to this problem can reduce the downtime of buses, improve the efficiency of rolling stock. At the same time, optimal planning of transportation can improve the performance of buses, while reducing the number of rolling stock included in the route with the same passenger traffic and release from circulation significant material resources of the fleet.

The aim of the study was to build a mathematical model for solving the problem of routing in the distribution of passenger and traffic flows, taking into account the specifics of passenger traffic in the city. The traffic flow of the city network has a complex structural composition, i.e. it includes many flows: internal flows of individual transport, flows of public transport (urban and route) and others. The peculiarity of passenger traffic is its different volume at each point of the city network. At the same time, transport networks are objects of graph structure, and therefore graph theory methods are applicable for their study. But algorithms and models based on these methods do not allow to take into account dynamically changing characteristics and random factor in the functioning of transport systems.

It is proposed to use a simulation package to determine the most rational variant of the organization of the urban transport network and the study of passenger traffic on the urban network. Accordingly, for the formation of a reasonable route network of urban public passenger transport, it is first necessary to determine the parameters and characteristics of passenger traffic moving around the city.

Thus, we need a mathematical model that adequately describes the processes taking place and allows us to obtain the necessary statistical material with minimal labor [9].

Subsequently, it is necessary to calculate the number of rolling stock on the routes of the urban transport system, taking into account the criterion based on the equality of the need for the transportation process for passenger services and drawing up the necessary intervals on the route.

In the system of receiving matrices of correspondence, distribution of passengers between stops of the route, with this flight and the direction of movement of the rolling stock, the method of balancing Yu.a. Shatsky was used. This method is a universal method of balancing and calculating correspondence matrices, proven over many years of experience in the calculation of transport, simple and intuitive, converging on a very small number of steps. This is a fairly efficient and fast way to obtain correspondence matrices (CM) on modern computers.

1) First, a special base matrix is selected, which most fully reflects the nature of the distribution of passengers between stops - the matrix of probabilities of correspondence between the stopping points.
2) This probability matrix is used to construct the weighted matrix necessary for the convergence of the matrix.
3) Many times is balancing the inputs and output of passengers on the line, to achieve the required accuracy.
4) Resolve conflicts arising from the multiple balancing phase.

Here it is necessary to note the following difficulties that may arise at the stage of balancing:

1) It is Necessary to perform the equality of inputs and outputs of passengers (the number of those who entered must be equal to the number of those who left the bus), otherwise the balancing will not be feasible;
2) It is Necessary to take into account the feature of the resulting probability matrix, in particular if all the elements of the row or column of the matrix are zero, it is possible to divide by zero;

3) The Numerical data on the entrance and exit of passengers from the bus must logically correspond to reality, otherwise the balancing will be reduced to the looping of the basic algorithm.

All these difficulties were eliminated at the stage of analysis and testing of the algorithm.

You can imagine the following mathematical model of the third stage (multiple balancing):

The matrix of entrance A and exit of Passengers from the bus is given.

A[i] number of people entering the i-th stop and B[j] number of people leaving the j-th stop moving from the i-th to the j-th stop.

Let ost be the number of stops on the route, then the dimension of the matrices:

$$|A| = A_{ost}, |B| = B_{ost}, \ |M| = MK_{ost*ost} \qquad (1)$$

Step 1: calculate the probability matrix reflecting the law of distribution of passengers between stops.
Step 2: calculation of the scaled medieval correspondence matrix, each element of the probability matrix must be multiplied by the coefficient calculated as the sum of the elements of the array released, divided by the sum of all the elements of MV.

$$MK0[i,j] = MV[i,j] * \sum_{k=1}^{k=ost} B[k] / \sum_{l=1}^{l=ost} \sum_{m=1}^{m=ost} MV[l,m] \qquad (2)$$

Step 3: balancing columns and rows of the matrix by formulas. By lines: each element of the matrix is multiplied by the corresponding input and divided by the sum of the lines (2.3).

$$MK[i,j] = MK[i,j] * A[i] / \sum_{k=1}^{k=ost} MK[i,k] \qquad (3)$$

Columns: each column element of the matrix is multiplied by the corresponding output and divided by the sum of columns (2.4).

$$MK[i,j] = MK[i,j] * B[j] / \sum_{k=1}^{k=ost} MK[k,j] \qquad (4)$$

Check for convergence:

$$1 - A[i] / \sum_{j=1}^{j=ost} MK[k,j] < 0.01, \forall i \qquad (5)$$

If condition (5) is met, the matrix is balanced, otherwise repeat step 3.

The efficiency or accuracy of the MC calculations depends on the 1st stage, i.e. on the strategy of choice, the law of distribution of passengers between the stops of the route. If you choose the wrong strategy, the error may exceed 100%.

The strategy was chosen in accordance with the law of normal distribution. The probability of the distribution of passengers between stops depends strictly on the average length of the trip, with the average length of the trip calculated using the input and output (matrices A and B) and the lengths between the stretches of the route.

The normal distribution law between stops can be written as follows:

$$MV[i,j] = \frac{1}{sigma * \sqrt{2\pi}} e^{-\frac{L-M}{sigma}} \qquad (6)$$

where L is the length from the i-th point to the end of the route,

M – mathematical expectation, equal to the average length of the trip, sigma - standard deviation is calculated according to the rule of three Sigma:

$$sigma = \max(M, L-M)/3 \qquad (7)$$

The normal distribution law is the probability density distribution, which depends on the height of the curve (figures.1.2). For greater accuracy, it is necessary to take the dependence not on the height of the curve, and the area of the bounded curve MV[i,j].

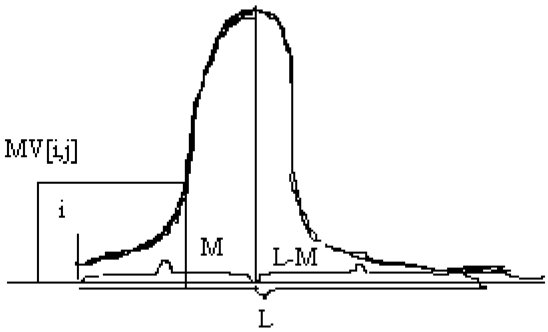

Figure 1: Density of probability distribution between stops

It is necessary to use the area limited from a mathematical expectation to a stop i.e. S(j, M), and to correct it under the normal law:

$$MV[i,j] = 1 - 2 * S(j,M) \qquad (8)$$

where the area of a bounded curve is calculated numerically by the trapezoid method.

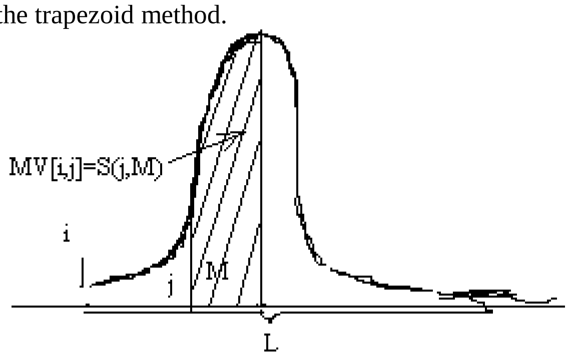

Figure 2: Probability density distribution between stops, as the area of the formula (8)

When justifying and choosing the parameters of the route network, it is necessary to take into account the volume of passenger traffic, the graphic design of which is called the

Paper ID: SR21105170105 DOI: 10.21275/SR21105170105

cartogram of passenger traffic. The distribution of traffic intensity on the transport network of Karaganda is shown in the form of a cartogram of passenger traffic (figure 3), which characterizes the traffic intensity in the sections of the transport network on the day of the survey [2].

In practice, there are different methods of collecting, processing information about the transport movements of the urban population along the routes [2]. To order the methods, they need to be classified in a certain way. Methods can be classified according to the following features:

- According to the method of the survey;
- On the proper use of;
- The specifics of the application of the collected information, etc.

For classification as a major feature of take the target survey due to the fact that using this basis determine the level, structure, and procedures of collecting and processing information database, as well as a solution for its practical use.

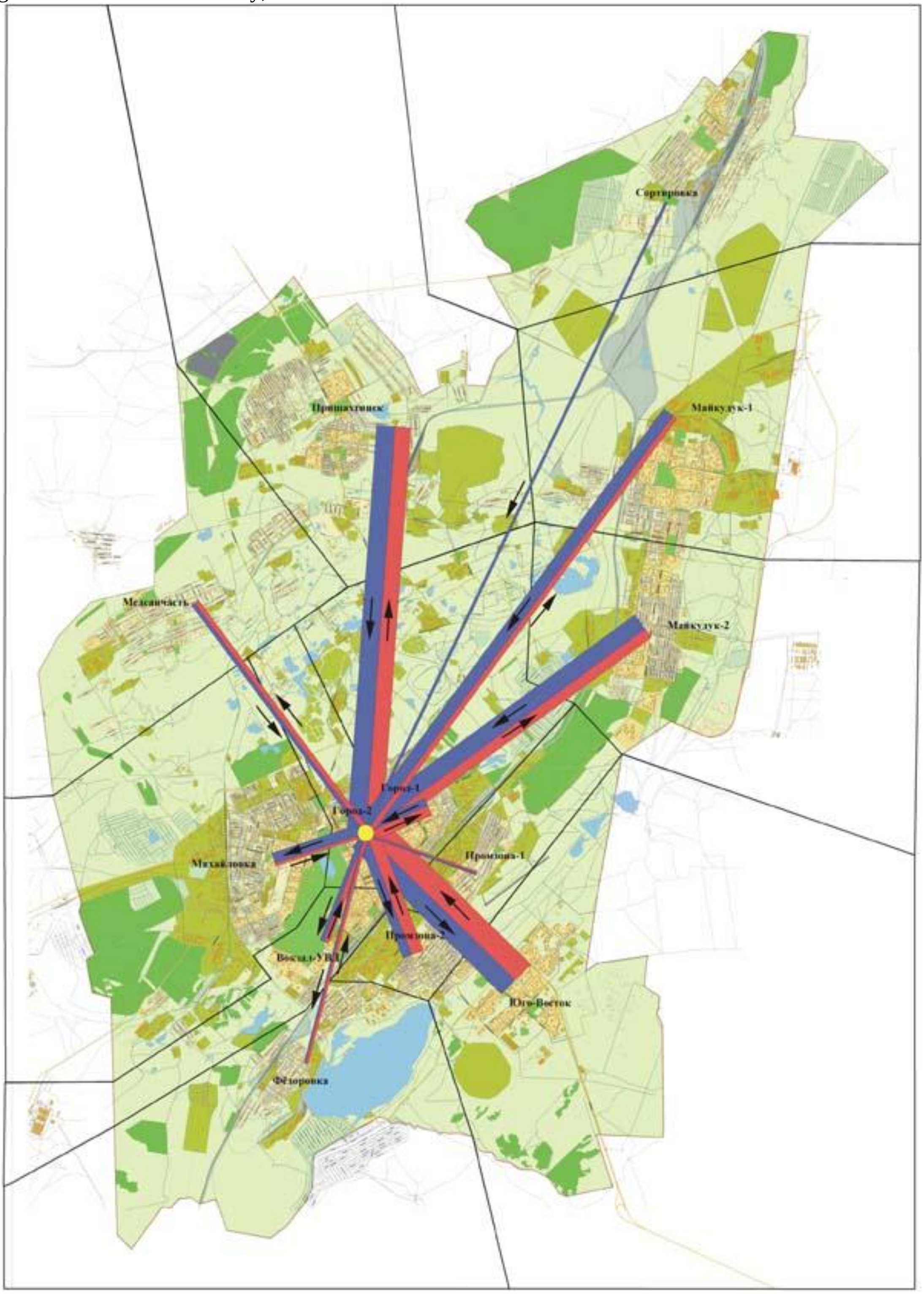

Figure 3: Cartogram of passenger traffic between the area of the City-2 and the rest of the city [2].

Certain patterns of changes in the intensity of movement are associated with the geometric properties of urban space: the maximum intensity of movement is observed in the Central zones of the city, the smaller – in the middle and the minimum – in the peripheral. They reflect the uneven location in terms of the city centers of origin and absorption of passenger traffic, as well as the fundamental geometric properties of urban space, which determine the comparative transport congestion of the city center of Karaganda and reduce it as it moves away to the periphery [4].

It is practically important to have data on the maximum traffic intensity in the sections of the transport network, as it determines the conditions and possibilities of traffic organization and, consequently, economic indicators of traffic and its economic efficiency [2].

The main task in the organization of urban passenger transport is to determine the need for rolling stock in the organization of routes. This task includes two subtasks: the choice of the number and capacity of buses and the optimal distribution of routes.

Based on the solution of the main problem, both the economic results of the work of road transport enterprises and passenger service indicators, such as the time that passengers spend waiting for boarding, the occupancy of bus passengers, the likely possibility of their refusal to ride [2, 3].

In General, the complex task of determining the need for rolling stock is presented in figure 3. [5].

The problem of distribution of buses on routes is solved at development of more perfect plans of transportations, change of operating conditions, specification of data on passenger flows and changes in structure of the bus fleet caused by purchase or write-off of part of the rolling stock. In addition, this problem is solved in the operational redistribution of buses between routes in the process of dispatching traffic management [5].

The difference between the task of distributing buses on routes and the task of choosing their capacity and number is that the distribution of buses is based on the actual number of buses and their brand structure of carriers. The class of buses for the routes is chosen based on the rolling stock produced by the industry of different countries. As a result, in both tasks, ultimately, determine the capacity and number of buses for each route [5, 6].

In solving the problems of selection and distribution of buses on routes, according to a number of scientists [2, 3], should be taken into account:

- The possibility of obtaining baseline information (data of passenger traffic);
- Stochastic nature of the transportation process [5];
- The need to optimize two interrelated parameters: the number and capacity of buses on the route [5,];
- The requirement to reduce complexity in the preparation of input data and obtaining a solution [5];
- Existing technological limitations [1] when operating on bus routes [1] (when operating on the road settlements, the load of the roadway, the possibility of turning the vehicle, etc.).

References

[1] Artynov AP automating the processes of planning and management of transportation systems [Text] / A. P. Artynov, I. I. Skalecki. - Moscow: Transport, 1981. - 280 p.

[2] Abduraeva, G. E. On the application of modern technologies in the organization of transportations of passengers in the city bus routes [Text] / G. E. Abduraeva // Young scientist. - Kazan, 2015. - № 21 (101). – P 117 to 120.

[3] Abduraeva, G. E. On the tasks of selection of capacity and number of buses on urban route [Text] / G. E. Abduraeva // Young scientist. - Kazan, 2015. - № 22 (102). - P. 113-115.

[4] Passenger road transport [Text]: studies. for high schools / [by L. L. Afanas'ev, A. I. Vorkuta, A. Dyakov et al.]; ed. B. Ostrovsky. - Moscow: Transport, 1986. - 220 p.

[5] Yatsenko, S. A., Improving the quality of passenger service on urban bus routes in terms of the use of rolling stock of different capacity [text]: dis. ... kand. technical Sciences: 054.22.10 / S. A. Yatsenko. - Irkutsk, 2012. - 20 p.