UDK 625.08

OPTIMIZATION OF ROUTE VEHICLES SCHEDULE THAT TRANSPORT PASSENGERS IN MICRODISTRICT "SHVEDSKAYA GORKA"

L. S. Feizullaeva, master student
Belarusian State University of Transport

The life process of any city largely depends on the state of the transport system. Proper functioning of the transport system is one of the most important components of the city's economic well-being. In the context of urban growth, increased motorization, changes in the labor and cultural needs of the population, reliable and efficient operation of urban passenger transport is of particular importance. Due to the ability of passenger road transport to respond quickly to changes in demand for transportation, the ability to adjust the route network, passenger capacity and frequency of movement of passenger vehicles, this type of transport has become the most widespread and occupies a leading position in passenger transportation [1].

The goal of increasing the level of passenger comfort and high efficiency of public transport is to align the intervals of movement of schedules of various routes on duplicating stretches, which contributes to a more uniform interval of movement and bus occupancy.

Duplicating stretches are two or more routes where the movement of vehicles in whole or in part coincides with the movement of vehicles on other routes. Duplicating routes on shared stretches of the route share the same transport stops (usually more than 70% of the total number of transport stops on one of the routes).

One of the main characteristics that shows the level of public service by urban transport is the regularity of route vehicle traffic, which ensures the accuracy, timeliness and continuity of transportation.

In order to increase the level of passenger comfort and high efficiency of public transport, it is necessary to ensure that the traffic intervals between route vehicles arriving at transport stop are as equal as possible. In other words, it is necessary to minimize the size of the spread of intervals between successive public transport.

There are a number of methods and algorithms for solving the problem of drawing up and optimizing the schedule of urban passenger transport.

To optimize schedule in the city of Gomel, scheduling technique of route vehicles on duplicating stretches proposed in [2, 3] was used.

For the study was taken duplicating stretch "Microdistrict "Shvedskaya Gorka" – Karbysheva street", which provides for the movement of buses № 52 and № 26 buses and trolleybuses № 24.

The main characteristics of the quality of original traffic schedule for the period between rush hours and for rush hours were calculated. This article provides an example of calculation for rush hours period from 17 to 18 hours for transport stop "Seregina street":

– the optimal time interval between arrivals to transport stop of route vehicles:

$$I_D^* = \frac{60}{5+2+1} = 8 \text{ мин};$$

– optimal time interval between the arrival of vehicles on routes № 52, № 26 and № 24 at transport stop:

$$I_{52}^* = \frac{60}{5} = 12 \text{ min};$$

$$I_{26}^* = \frac{60}{2} = 30 \text{ min};$$

$$I_{24}^* = \frac{60}{1} = 60 \text{ min};$$

– waiting time for passengers of vehicles:

$$T_W = \sum_{i=1}^{14} 1 \cdot 2 + 2 \cdot 2 + 3 \cdot 2 + \ldots + 13 \cdot 2 + 14 \cdot 2 \ = 210 \text{ min};$$

$$|I_D^* - I_i| = |8 - (17{:}13 - 17{:}01)| = 4 \text{ min}.$$

According to the calculated optimal time interval between the arrival at transport stop of route vehicles of duplicating stretch "Microdistrict "Shvedskaya Gorka" – Karbysheva street", the arrival time of buses № 52, № 26 and trolleybus № 24 was shifted so that the difference between their optimal and real values was minimal. At the same time, the traffic intensity between buses and trolleybuses on the same route was taken into account to exclude the possibility of deterioration of existing schedule. As a result, the total waiting time for passengers of vehicles on duplicating stretch decreased.

Figure 1 shows the scheme of shifting the arrival time of buses № 52, № 26 and trolleybus № 24 at transport stop "Seregina street" in the time period from 17 to 18 hours.

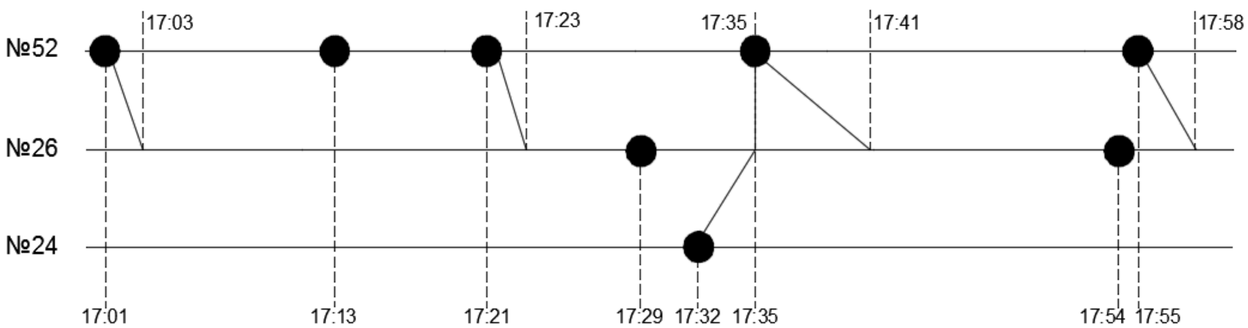


Figure 1 – Diagram of shifting of route vehicles at transport stop "Seregina street" in the time period from 17 to 18 hours

Assignment matrix for duplicating stretch "Microdistrict "Shvedskaya Gorka" – Karbysheva street" in the time period from 17 to 18 hours with existing and optimized schedule are presented in tables 1-2.

When optimizing existing schedule, special attention was paid to reducing the waiting time for passengers to arrive at transport stop "Seregina street". This parameter affects the level of satisfaction from the trip of passengers, and the alignment of the time intervals between the arrival of successive vehicles of different routes on duplicating stretch contributes to the uniform filling of vehicles, which increases the level of comfort for passengers.

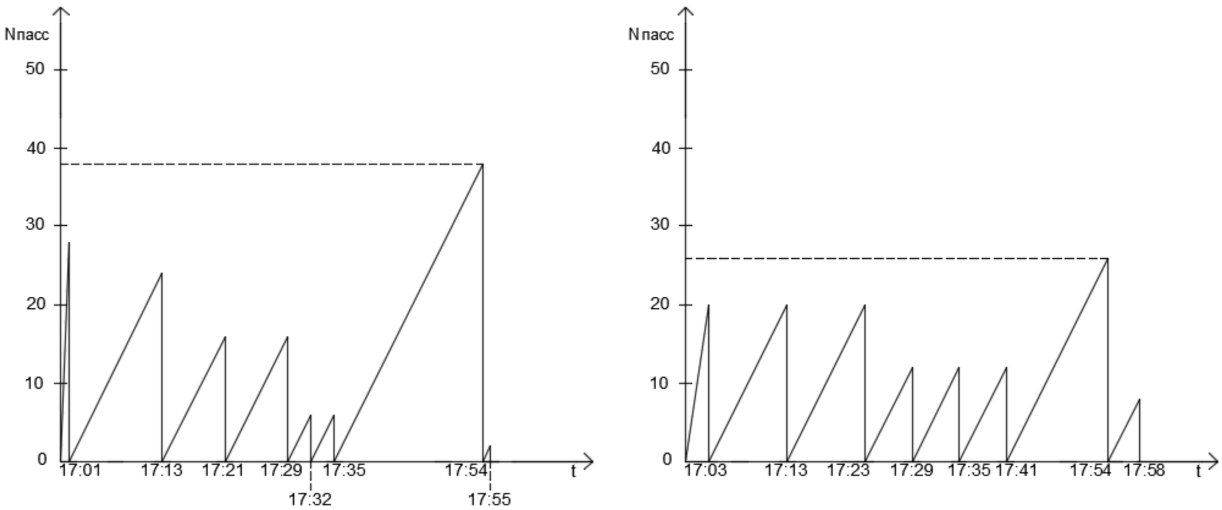
Table 1 – Assignment matrix for duplicating stretch in the time period from 17 to 18 hours for existing schedule

Time arrivals	Duplicating stretch "Microdistrict "Shvedskaya Gorka" – Karbysheva street"									
	№ 52	№ 26	№ 24	K_{D1}	$\lvert I_D^* - I_i \rvert$	T_W	N_{pass}	I_{52}	I_{26}	I_{24}
17:01	1	0	0	1	–	210	28	2		
17:13	1	0	0	1	4	156	24	0		
17:21	1	0	0	1	0	72	16	4	19	
17:29	0	1	0	1	1	72	16			12
17:32	0	0	1	1	5	12	6			
17:35	1	0	0	1	5	12	6	2		
17:54	0	1	0	1	11	380	38		5	
17:55	1	0	0	1	7	2	2	8		
Sum	5	2	1	7	33	916	136	16	24	12

Table 2 – Assignment matrix for duplicating stretch in the time period from 17 to 18 hours for optimized schedule

Time arrivals	Duplicating stretch "Microdistrict "Shvedskaya Gorka" – Karbysheva street"									
	№ 52	№ 26	№ 24	K_{D1}	$\lvert I_D^* - I_i \rvert$	T_W	N_{pass}	I_{52}	I_{26}	I_{24}
17:03	1	0	0	1	–	110	20	2		
17:13	1	0	0	1	2	110	20	2		
17:23	1	0	0	1	2	110	20	2	18	
17:29	0	1	0	1	2	42	12			12
17:35	0	0	1	1	2	42	12			
17:41	1	0	0	1	2	42	12	6		
17:54	0	1	0	1	5	182	26		5	
17:58	1	0	0	1	4	20	8	5		
Sum	5	2	1	7	19	658	130	17	23	12

Based on the above calculations, they were obtained schedules for the formation of passenger time spent waiting for boarding in the time period from 17 to 18 hours (figure 2), with existing and optimized schedule, respectively.



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gure 2 – Schedule of passengers time spent waiting for boarding during the time period from 17 to 18 hours with existing and optimized schedule

During the implementation of scheduling technique, the traffic intensity between buses and trolleybuses of the same route was either left the same or slightly shifted, taking into account a certain value of the optimal time interval between arrivals at transport stop of route vehicles for this route. As a result, the total deviation of the intervals between consecutive route vehicles from the optimal value for the time period from 17 to 18 hours decreased from 33 to 19 minutes, and the total waiting time for passengers of vehicles decreased by 28%.

References:

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2. Kravchenya I. N., Podkolzin A. M. Optimization of public transport schedule of different routes on duplicating stretches // Organization and road safety. – Tyumen: TIU, 2019. – V.2. – P. 54–61. (In Russian)

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