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INCREASING MOBILITY OF POPULATION IN SUBURBAN SETTLEMENTS THROUGH OPTIMIZATION OF PUBLIC TRANSPORT LINES

Key Words

Public transport;
Rural
settlement;
Optimization

Abstract

People who live in the suburbs, largely rely on the cities for jobs, shops and other facilities. They choose to live in and around cities, in urban city centers, in quiet areas, depending on the needs they have. Road construction in cities and low-income areas is the most important task in creating the conditions for designing efficient transportation solutions. It is well known that rural residents realize less movement, but in doing so they cross longer distances from the beginning to the end of the journey. Therefore, the topic of the paper is related to the optimization of the operation of two lines in the public urban passenger transport system in Niš, rationalization and improvement of transport on the line where there are higher transport requirements in relation to the number of departures. The study also refers to a real understanding of the needs of residents of the two suburbs using PT (line 7 and 27Lb) because of the possibility of linking and connecting two lines

into one line with the central part of the city, to improve living conditions in the suburbs. Also, the aim of the research is to reduce exploitation, ie more rational use of resources (vehicle costs, working, etc.) that can be better utilized.

1. INTRODUCTION

Building roads in cities and areas with low revenue is most important task in creating the conditions for designing efficient transport solutions. Urban planning and designing for cities with middle and higher level of revenue, is critical to reduce distances and increase accessibility to transport solutions. Urban planning and designing should be focused on connecting people and places, making cities more accessible to inhabitant, but not just on increasing in the length of the roads or increasing extent of movement of people and goods. Now, the most of cities are built to make pretty inefficient use of infrastructure when most residents going in the same direction.

Increasing sustainability of public transport systems may be achieved by increasing the share of public transport and non-motorized modes of transport (walking and cycling) and reducing private transport. Of course, it is encouraged by the fact od switching to a non-motorized mode, however, it can be confirmed that such models are the best for local trip and that such motorized traffic plays an important part during long distance trip.

There is a lot of ways to accomplish city travel. Different models of travel are conditioned for different purposes, but all of these trips are part of an urban transport system. Cars are ideal for wide specter of travel purposes, including long distance travel, transporting more than one person, or heavy cargo, which is not available with other models of transport. When everyone drives car, by either choice or lack of options, the roads in every city become more congested [one]. Public urban transport is ideal for transporting many people's o key locations, without using a lot of space for lanes and parking places.

Traditional public transport means the movement of vehicles on a fixed route, fixed stops and according to a predefined time schedule of departures. Therefore, the main disadvantage of this mode of transport is the incompatibility of passenger requirements. This practically means that rural residents, if they do not have another transport alternative, have to adapt their transportation needs to the defined way of public transport functioning. In this way, many residents are forced to give up certain travel, and it is often the case that this implies the abandonment of job search outside the place of residence, the abandonment of education, health care, cultural and sporting events, and the like [2,3].

Public transport can reduce social and economic inequalities by improving the mobility of residents. Many of them are without cars and jobs near the areas where they live. Such jobs serve us an important source of income for those who face with limited employment opportunities. Finally, using public transport residents make lower household costs and it releases resources for other uses.

Only 32% of all rural municipalities have access to public transport services, so if 28% of communities which have limited access to public transport are taken into account, it becomes clear that the remaining 40% of population in suburban areas is left without an option for public transport [4]. A recent survey has determined that 92% of Canadians thinks that public transport makes their community a better place for living [5].

The purpose of the labor is to optimize the operation of lines 7 and 27lb in the system of public urban transport in Niš, for rationalization and improvement of transport on the line where more transport requirements than the number of departures are. The research was also conducted to realistically insight needs of residents of the two suburban settlements for the use of public urban transport, due to the possibility of connecting two lines into one single line, with the central part of the city, in order to improve the living conditions in the suburban settlements.

In the beginning of labor, the introduction explains the importance of the existence of a public transport system in suburban settlements and how it works. Also, it include some of the authors researches on mobility in suburban settlement. The second chapter describes the operation of the line 7 and 27lb in the system of public urban transport in Niš. The third chapter contains the results of the researches of transport requirements on this lines. Looking for public urban transport services.

2. FUNCTIONING OF LINE 7 AND 27LB IN PUBLIC TRANSPORT SYSTEM IN NIS

Looking for public urban transport services should be proportionate to the accessibility it provides: better accessibility should reflect greater demand. It is considered from the point of view of how much potential passenger (residents) really have the opportunity to realize transport needs from suburban settlements according to the contents or activities that are mainly concentrated in the central city center.

Line 7 (Pavle Stojković's Square – Medoševac) as a urban line connects the suburban settlement with the downtown and it is 2.9 km long ,while line 27lb (K. Aleksandra's Square – Popovac) is defined as a suburban line and it is 7.3 km long (Figure 1). At line 7 the turnaround time is 30 minutes and at the line 27lb the turnaround time is 50 minutes. During the day, two vehicles operate on these lines.

Vehicles that operate on line 7 and 27lb are solo vehicles, with a capacitance of at least 70 passenger. However, on line 7, the contract stipulates between the Public transport direction and operator that on line have to operate a Type A solo vehicle containing minimum of three doors, which two of them are at least 1.00 m wide.

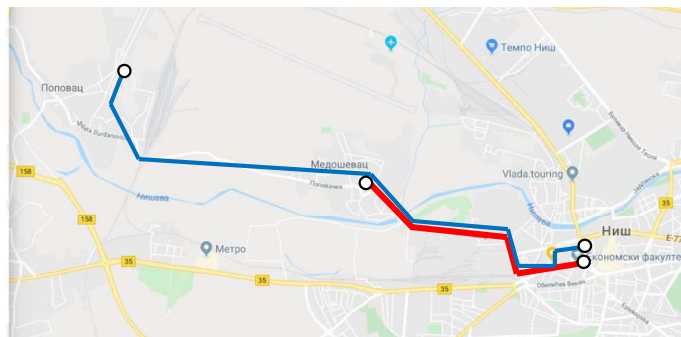


Figure 1. The route of the lines 7 i 27Lb

The line 27lb stipulates that it have to operate a type B solo vehicle, intended for suburban traffic, which has seating and staying position, with a minimum of two doors that do not need to be double-leafed and with a minimum capacitance of 70 passengers.

3. RESEARCH OF TRANSPORTATION REQUIREMENTS ON OBSERVED LINES

Due to the constant changes in the urban structure resulting from the construction of residential, business and other zones and building or their reconstructions the locations of the sources and destinations of passengers in the urban area are changing and therefore the characteristics of the passenger flows and their respective value are changing.

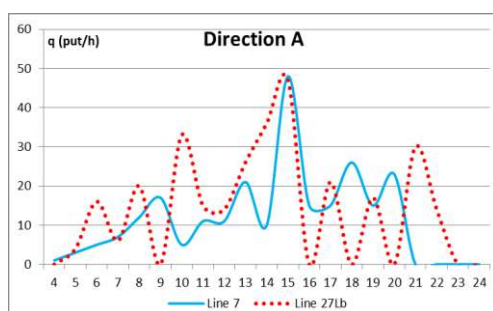


Figure 2. Passenger flow in direction A

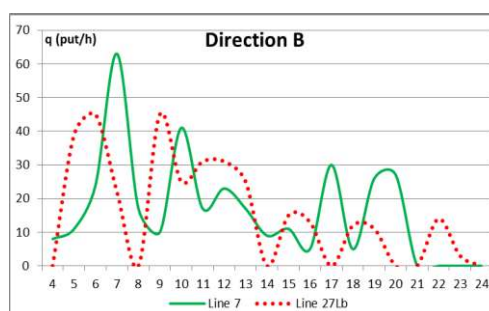


Figure 3. Passenger flow in direction B

The numbering of passengers in the public transport system was made from 07.08 to 18.08.2019. year, at working days, Saturday and Sunday. The results obtained after processing the data, passenger flow (Figures 2 and 3), passenger change factor, flow unevenness..., for the working day (Table 1 and 2) are shown below.

Table 1. Research results for line 7, direction A

Time of departure	P	$q_{\max}$	q_{sr}	l_{srv}	η_{sm}	η_p	NTR
4:50	1	1	0.2	639.2	1.0	4.6	639
5:20	3	3	0.6	639.2	1.0	4.6	1918
6:00	5	5	2.8	1626.4	1.0	1.8	8132
7:01	3	3	0.2	213.1	1.0	13.9	639
7:30	4	4	1.3	970.9	1.0	3.0	3884
8:00	7	7	3.8	1587.0	1.0	1.9	11109
8:50	5	5	2.2	1272.4	1.0	2.3	6362
9:40	17	16	9.8	1709.4	1.1	1.6	29060
10:20	5	5	3.1	1805.5	1.0	1.6	9027
11:22	11	11	5.3	1422.3	1.0	2.1	15645
12:11	11	11	6.5	1747.0	1.0	1.7	19218
13:09	15	15	8.7	1710.9	1.0	1.7	25663
13:40	6	6	3.0	1479.2	1.0	2.0	8875
14:45	10	10	6.2	1832.2	1.0	1.6	18322
15:15	20	20	11.6	1708.3	1.0	1.7	34167
15:46	28	28	17.6	1861.3	1.0	1.6	52117
16:30	15	15	10.0	1966.1	1.0	1.5	29491
17:20	15	15	9.4	1859.0	1.0	1.6	27885
18:05	14	14	9.1	1920.4	1.0	1.5	26886
18:45	12	12	7.5	1855.5	1.0	1.6	22266
19:26	15	15	9.0	1770.5	1.0	1.7	26558
20:00	8	8	5.3	1966.1	1.0	1.5	15729
20:30	15	15	9.5	1877.6	1.0	1.6	28165

P – number of passengers; $q_{\max}$ – maximal flow of passengers; q_{sr} –average passenger flow; l_{srv} –median driving length; η_{sm} –passenger change factor; η_p –flow unevenness along the line; NTR – neto transport work (passenger km).

Table 2. Research results for line 271b, direction A

Time of departure	P	$q_{\max}$	q_{sr}	l_{srv}	η_{sm}	η_p	NTR
5:25	4	4	0.3	520.0	1.0	13.7	2080
6:15	16	16	2.8	1228.5	1.0	5.8	19656
7:20	8	6	1.4	1215.6	1.3	4.4	9725
8:20	22	20	7.0	2257.5	1.1	2.9	49665
10:15	34	33	18.4	3856.8	1.0	1.8	131130
11:15	17	15	8.0	3342.8	1.1	1.9	56827
12:21	17	14	8.4	3511.2	1.2	1.7	59691
13:30	26	26	13.1	3609.6	1.0	2.0	93848
14:40	37	36	18.5	3573.1	1.0	1.9	132206
15:45	47	47	20.3	3081.2	1.0	2.3	144817
17:45	24	21	10.7	3177.5	1.1	2.0	76259
19:00	18	17	8.2	3239.0	1.1	2.1	58303
21:30	31	30	15.7	3622.3	1.0	1.9	112292
22:40	14	14	6.4	3259.5	1.0	2.2	45632

The 7 and 271b lines can be optimized into a single line, where users of public transport from Medoševac would have reduced comfort of traveling, but from the economic aspect, relevant savings are achieved in terms of vehicle exploitation, manpower and other basic assets of work (fuels, lubricants ...). It should be noted that this would also reduce the pollution of the ecological system by the exhaust gases that greatly affect to global warming of the planet. This also leaves the possibility of transferring the vehicle to work on another city line, which is more frequent, where it is really necessary to increase the frequency of the vehicle to reduce the interval. The line could be formed as a city line, even though it operate to a suburban settlement, because it would use some of the existing two terminuses located in an urban city area.

The terminus at line 7 in direction A is Pavle Stojkovic's Square, and the 271b line in direction A is King Aleksandar's Square. These two terminals are less than 100 meters away from each other and could easily integrate the terminus because of their proximity, which is acceptable on the passenger side, since they would not need to walk longer. It is suggested that this terminus should be located on King Aleksandar's Square as there is a larger street space where a bus can be stopped and parked. Other city lines pass at this stop, so again it will be more convenient for public transport users, because of the easy and efficient transfer, and because there are more eaves at the bus stop that protect passengers from atmospheric precipitation.

4. CONCLUSION

The population in suburban areas is constantly declining and this trend will continue in the coming period. Retaining the existing population (households) is the basic task of any suburban development planner in one city territory. Increasing accessibility to basic living needs and amenities is a major prerequisite for survival and possible return of residents.

In order for rural areas to be competitive for life and attractive for economic investments, it is necessary to provide adequate infrastructure and quality public transport, apropos accessibility to transport. Due to the specificities decided by the rural communities, their transport requirements are also specific, and their deeper understanding is needed in order to take correct measures for the social, economic and environmental development of rural areas.

The survey was carried out in the summer, that is, according to the summer regime of the schedule, where the schedule is reduced in regard to the winter regime, respectively to the regime when educational institutions do not work and when the holiday season is over. From the obtained results it can be noticed that the utilization of the transport capacity on the line 7 is very small, there is no drastic number of transport requests throughout the day, it should also be noted that the route of the line with 271b is partially the same. The routes of the line 7 and 271b also use lines 271a and 28, but not completely.

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