ANALYSIS OF FUNCTIONING PUBLIC TRANSPORTATION SYSTEM IN SUBURBAN AREAS

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Abstract: *The existence of passengers in the public transport system puts extremely high demands on the organizers of this process, because any disturbance in the carriage of passengers reflects the satisfaction of the quality of transport services. The quality of public transport depends on the policy planning of the city development and mobility that is now developing. The main objective of the work is reflected in the presentation of the importance of a system of public transport and good connections lines for people who live in the peripheral areas of the city. Better access to the locations of jobs, the city center and other facilities is a priority towards sustainable development of the village. As a special part of this work will be presented research of counting of passengers in vehicles on suburban routes 33 and 39 in Nis. Based on that graphical representations are made passenger flow by driving directions for each departure, taking into account the working day, saturday and sunday. They will also be given a description of the route of line with the basic data for the two lines. The results were analyzed, graphically presented and carried out on the basis of their conclusion.*

Key words: *settlement, public transportation, availability.*

1. INTRODUCTION

The importance of public transport is preempting all available transport infrastructure resources to participate in the development of its functionality, efficiency and multimodality.
Neglected in some countries during a period of rapid increase in motorization, public transport of passengers (JGPP) is now considered necessary for the establishment of aesthetic, attractive, environmentally cleaner, financially and energetically rational cities from the aspect of transport services. As such, JGPP has received increasing support from city administrations in transport policy and financing in recent years.

The functioning of large cities is impossible without public transport. A large number of residents and a large number of jobs create a deficit of space. Public transport is therefore one of the most important sectors whose task is to create a "justified urban environment, in a world defined under the concept of sustainable development.

JGPP is the most important mode of transport under limited space per passenger and is currently the best response to transport needs in densely populated urban areas. JGPP is a more economical view of cars in cities where the density of the dwelling is greater than 20 inhabitants per hectare. JGPP consumes 4 times less energy per passenger, and ultimately, the surface JGPP uses considerably less road space than the car. Successful JGPP requires a combination of measures that control excessive use of cars with the development of a JGPP competitive service. [1]

JGPP causes traffic problems in cities in cases where it is not available or when it is not sufficiently developed. Nowadays, a special contribution to quality JGPP is given to the expert public, which in the first line points out that the existence of the JGPP is not enough, but it is necessary to keep up and not neglect, but to upgrade and modernize the principles of its functioning.

JGPP, as the most complex system in the city, was observed through two characteristic principles: in the top clock and outside the clock.

As a special part of this paper, a survey of passenger counting in vehicles on lines 33 (Niš-Sečanica) and 39 (Niš-Supovac-Sečanica) is presented. Based on this, graphic representations of the flow of passengers by driving directions for each departure for a working day were made. Also, a description of the route line with basic data for these two lines is given.

2. CHARACTERISTICS OF PUBLIC TRANSPORTATION IN SUBURBAN SETTLEMENTS

Suburban transport is a mode of transport with poor passenger flows, where often the lines are defined by the departure of vehicles to certain places, often with related time and with quite unfavorable infrastructure.

Accessibility to the city center and other important facilities is important for residents of peripheral parts of the city. The density of the JGPP line network as the frequency of vehicles, are important for the reason that the real estate in the settlement can substantially redistribute the value of the site, creating an area more or less attractive for housing than before.

The basis of the urban strategy is to establish a balance between the number of jobs and the density of population. The results of the research in the world reveal that the condition for such a connection is actually improvement of public transport, with the goal of more balanced development of rural areas. Access to public transport, both to an individual and to low-income families, can become limited to most households living in suburban areas. Also, many authors state that public urban transport encourages and promotes independence and allows the redistribution of the home budget to other things within the household.

Improving suburban mobility is a great challenge. Suburban development had several major consequences for the provision of transport services [2]:

- Suburban regions are larger than traditional cities and have significantly lower density. This means higher travel distance for most journeys, less access to destinations at pedestrian distances and more mileage in everyday activities than in urban areas.
- If there is diversity in the purpose of traveling in one suburban settlement, the requirements will be much more pronounced at different times of the day, depending on the purpose of the trip. In order to maintain a reasonable level of service and efficiency, the service must be adapted to different route path patterns and terrain configurations.

Lower average density in suburban areas means not only less generating of travel and hiking destinations, but also that the distance traveled between points is on average higher. The lack of connected street systems leads to less direct travel and more mileage kilometers for some activities than in urban areas.

When planning transport, other factors must be taken into account, for example, to be competitive with respect to private cars, so that [3]:

- minimizes travel time ensuring good connectivity; - provides connection with the possibility of short walking; - considers mechanisms for the formation of one price of the whole trip; - provides a direct, comfortable connection between the station and the destination.

The challenges of sustainability of public transport in suburban settlements are enormous. He compete today with cars in suburban areas, the amount of free parking space, and the unfavorable relief of the hiking area. Effective planning and promotion of a range of market-oriented services should help to capture a higher share of the suburban travel market and

thereby help communities and pay attention to their mobility and environmental problems.

The term "attachment" is a generic identification applied to the developed areas of surrounding traditional urban centers, and this implies a homogeneous type of settlement characterized by family houses and buildings.

The subassembly network is designed to apply the following principles:

- To achieve technological unity of urban and suburban transport, by integrating these two types of transport in basic technological elements (common positions, unity of the tariff system, ticket system and payment system);
- Public transport must be available to all residents;
- Equalize the conditions for users to use the existing suburban bus station.

3. ANALYSIS OF THE EXISTING SITUATION ON LINE 33 AND 39 IN NIŠ

In the requirements for transportation in the JGPP system, Niš has a marked number of trips from the perimeter to the city center due to the high concentration in the central city area and its activities in it. On the other hand, the elongated position of the city along the Nisava River, where the highest concentration of housing and work places, significantly highlights the basic corridor, along which the greatest transport operation of the system is realized, as a result of the strongest passenger flows.

The needs for such transportation requirements are met with a network of radial and diametral lines. The basic problem that can arise is the establishment of a link between offered capacities and requirements when they are not objectively determined. In addition, account should be taken of the relationship between JGPP and other modes of transport, due to the increase in congestion in the center of the street, the lack of parking space ...

The total exploitation length of the suburban line network in Nis is 561.8 km, while the construction length of the network has not changed and remained at the level of 241.40 km. This means that the network overlap index is 2.33 compared to 2.29 in 2006, which is a consequence of the need to bend the line mainly after a longer common part of the route, to connect distant settlements, so it is not rare that the line defines a minimum number of passes to such a line places. Such lines are essentially only the sub-lines of other suburban lines with a partially altered track. [4]

The total number of stops is 420, and the mean length of the interstate distance on the network of suburban lines is 1.05 km.

In the territory of the city of Niš, in the urban and suburban passenger transport, the zone tariff system is applied. The first and second zones are urban, and the third and fourth suburban. Within this research, the suburban settlement Sečanica was selected, characterized by the fact that there are two lines to this settlement with two different routes.

Sečnica is a populated place in the city municipality of Crveni krst in the area of Niš in Nisava district. It is located in the Mali Jastrebac valley, in front of the entrance to Supovo passage, about 14 km northwest of the center of Nis. There are 723 adult population, and the average age of the population is 44.8 years (43.3 in males and 46.4 in females). There are 259 households in the settlement, and the average number of members per household is 3.37. [5]

Suburban town Sečanica belongs to the third zone of the existing zone system in Niš. Line 33 length is 18.7 km and the time of the craft is 90 minutes. Line length 39 is 25.0 km, while the turning time is 100 minutes. Route lines 33 and 39 are shown in Figure 1:

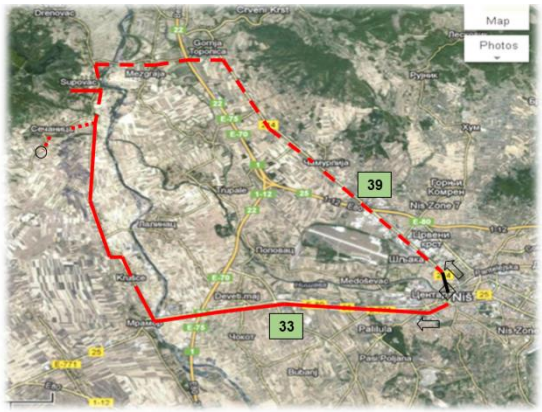

Figure 1: Route lines 33 and 39 with start and end terminals

3.1. DISPLAY OF THE NUMBER OF PASSENGERS ON LINE ON LINE 33 AND 39

In order to understand the movement of people living in Sečanica, which are conditioned by the use of suburban transport, the total number of passengers that is being reported for each departure from Niš and Niš is analyzed. On the basis of the obtained graphic representation, it is possible to analyze the time period in which greater mobility occurs and, therefore, determine the most pressing departures, find the solution for their reduction and more uniform load, as well as the target aspects, due to which in some parts of the day there is no departure.

Diagram 1: Number of passengers by directions on line 33 for a working day

In diagram 1, the oscillations in the number of passengers in direction A can be more pronounced, in which the maximum value of the number of passengers appears at the seventh and ninth departures and reaches 60 or 61 passengers. Starting from the first departure, the number of passengers gradually increases until the third departure when it begins to decline and grow alternately. From the 9th departure, the number of passengers gradually decreases, so in the last departure the number of passengers is 11.

In direction B there are also oscillations of the number of passengers depending on departure, but they are in a milder form than in direction A. Since the first departure when there were 13 passengers, this number is rising rapidly to a value of 88 and up to 92 passengers in the third departure, which is also the highest value of the number of passengers in direction B. The number of passengers then drops in fifth departure to 39 passengers, and then again grows to the value of 85 passengers in the seventh departure. After that the number of passengers gradually decreases to a value of 10 passengers in the last thirteen departure.

For each departure on line 39, for which the counting of passengers on the bus was performed during the working day, changes in the number of passengers departed and departed by bus departures will be displayed during the working day.

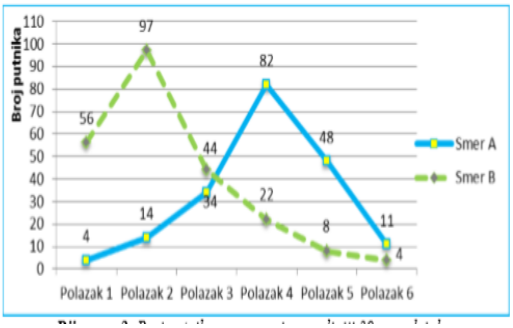

Diagram 2: Number of passengers per route on line 39 for a working day

During the working day on line 39, the first departure is 4 passengers, in order to increase this number until the fourth departure when the number of passengers is 82. Then it decreases, and in the sixth last departure there are 11 passengers. In direction B in the first departure there are 56 passengers, and in the second, there are 97 passengers, which represents the highest value. After that, in each subsequent departure, the number of passengers is reduced, in the last 4 passengers.

3.2. PASSENGER PROTECTION BY LINKS 33 AND 39 IN NIS

Knowing the number of passengers and their distribution on departures during the day, graphs can be graphically represented by the fluctuations in the value of the flow

of passengers depending on the capacity of the bus operating on that line (represented by a horizontal intermittent line). The working day will show changes in the passenger flow in diagram 3:

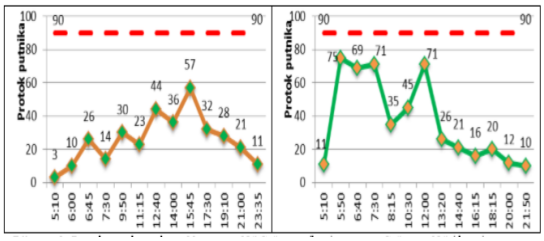

Diagram 3: Passenger traffic on line 33 in the direction of Niš-Sečanica (left) and in the direction of Sečanica-Niš (right) for a working day

Starting from the first departure at 5:10, the flow of passengers is increased with less oscillations and its maximum value reaches the departure at 15:45 and is 57 times per hour. After that, it starts to fall almost linearly. The lowest flow value was not recorded at the last departure at 23:35, but on the first departure when it was 3 times / h.

Observing the line 33 in the direction of Sečanica-Niš, we can notice the variation of the flow during the entire day line operation. On the first departure, when the lowest flow rate of 11 times / h occurs, its value extends extensively at the second departure at 5:50 and reaches 75 times / h, which represents the maximum flow value for this direction for a working day. This high flow value is retained in the next two starts when it starts to drop to 35 times per hour and then re-grows and at the end of 12:00 it is 71 times per hour. After that, it starts to decline until the last departure.

Similarly, a change in passenger flow has been made, previously calculated, at bus departures for a working day on line 39. An intermittent horizontal line indicates the maximum number of seats on the bus.

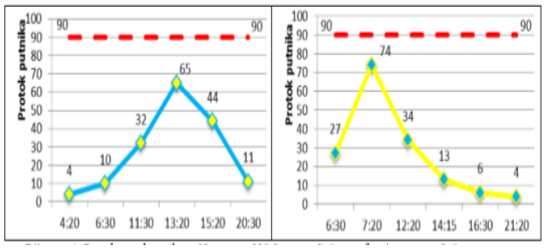

Diagram 4: The flow of passengers on the line 39 in the direction of Niš-Supovac-Sečanica (left) and in the direction of SečanicaSupovac-Niš (right) for the working day

Beginning from the first departure in which the passenger flow is 4 times a day, in other cases, it is rapidly increasing when it reaches a value of 65 times / h in the fourth departure at 13:20, which represents the highest value of the flow in this direction. It also suddenly then begins to decline when it has a value of 11 times / h in the last departure.

On the diagram 4, at the first departure at 06:30, the flow value is 27 times per hour, and already at the second exit at 07:20 it has its highest value of 74 times / h. After that it starts to decrease and its value decreases at the last departure to only 4 times / h.

Increasing the quality of public transport by reducing travel time is a gradual and slow process of realizing static and dynamic parameters that characterize public transport as a system. Planning and design of public transport must go from users who subjectively assess quality and have different attitudes and behaviors. In the case of suburban lines 33 and 39 in Nis, their operation is described by the number of passengers. Also, for each departure during the working day, the values of the flow of passengers are presented, and therefore the utilization of the capacity of the vehicle.

This study looked after users who live in suburban areas and are primarily dependent on public transport. Daily and permanent monitoring of the operation of vehicles on the lines is necessary and think about improving the existing network line by

some of the measures in the future period using intelligent transport systems.

5. LITERATURE

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