

## **BG:VOZ - CONCEPT OF URBAN RAILWAY SERVICE IN BELGRADE**

**Mirjana Bugarinović<sup>1\*</sup>, Stanko Kantar<sup>2</sup>**

<sup>1</sup>University of Belgrade, Faculty of Transport and Traffic Engineering, Belgrade, Serbia

<sup>2</sup>City of Belgrade, Secretariat for City Traffic, Directorate for Public Transport

\*Contact person: mirab@sf.bg.ac.rs

**Abstract:** *The concept of urban rail service, BG:voz, represents a new urban rail public transport in Belgrade. So far, it is functioning on a 25 km long line with 9 stations. Today, after three years of BG:voz operations, realized traffic volume, quality of service and financial results show the feasibility of this concept and justify the need to enhance the system. Analysis of the system performances indicates that with the introduction of new stations, the improvement of existing ones and increase of the number of train departures will result in even more modern rail public transport services with a comparatively small investment compared to the effect.*

**Key Words:** *BG:voz, Urban rail service*

### **1. INTRODUCTION**

Urban rail refers to passenger rail systems in urban areas, which have high capacity and provide high frequency of service, with grade separation from other traffic, typically running underground or on elevated tracks [3]. Different cities may have different names for these systems. The system is referred to as mass rapid transit in Chennai, Queensland, Singapore, metro in Madrid, Paris and Budapest, subway in New York, Chicago and Boston and tube or underground in London. What about rail service that used railway infrastructure in urban area and operate as mass rapid transit? It's called the urban railway or "almost" metro. Typical suburban rail traffic would include a trip of maximum 15km and less than 30 min. travel time. The regional railway traffic is indicatively a trip of maximum 70km and a transit time of 30 to 60 min [4]. What about services that include trips of maximum 26 km, average 38 min. travel time and with frequencies between the trains of 15 min in peak hours? It's called the urban rail service. For the customers, urban rail service is the form of passenger service in town core, but operationally it is the part of the railway system (like in Prague) or only share some tracks with mainline trains (like in Munich and Frankfurt) [6].

Belgrade has a developed system of public transport. It consists of urban road and rail systems. Urban rail system consists of services that are provided on the tram and rail network and from 2010 an urban rail service has been set up too. The concept of urban rail

service, BG:voz, represents a new urban rail public transport in Belgrade. So far, it is functioning on a 25 km long line with 9 stations and with 15 minutes interval train operation schedule in peak hours.

An urban rail service would need to attract sufficient level of patronage to ensure its financial sustainability and further expanding. Hence, cities with larger population base could support urban rail services with more halts and longer routes respectively. Results of some researches show [3,4] that higher population density would typically generate a higher rail patronage per km of the rail network, allowing the (urban) rail system to be better utilised.

## 2. CURRENT STATE OF THE BG VOZ SERVICES

BG:voz is a system of urban rail service in Belgrade that has been using the railway infrastructure of the Serbian Railways since 1st September 2010 and is part of the public urban transportation system of the city of Belgrade. In the beginning, this system functioned between Novi Beograd and Pancevacki Most, and from April 2011, the line has been extended to Batajnica (figure 1). The line is 25 km long with 7 km running through tunnels. There are 9 stations with an average of 3.4 km distance between them and 2 km in the city core. Upon completion of a two track railway between Pancevacki most and Pancevo, this first line is planned to be extended to Ovca. There is also a plan to introduce the second BG:voz line that will run between Beograd Centar (Prokop) and Resnik. The first line runs through six Belgrade municipalities: Zemun, Novi Beograd, Savski Venac, Vračar, Zvezdara and Palilula with over 700,000 inhabitants in total. However the residential areas of these municipalities through which the line directly runs have about 200,000 inhabitants.

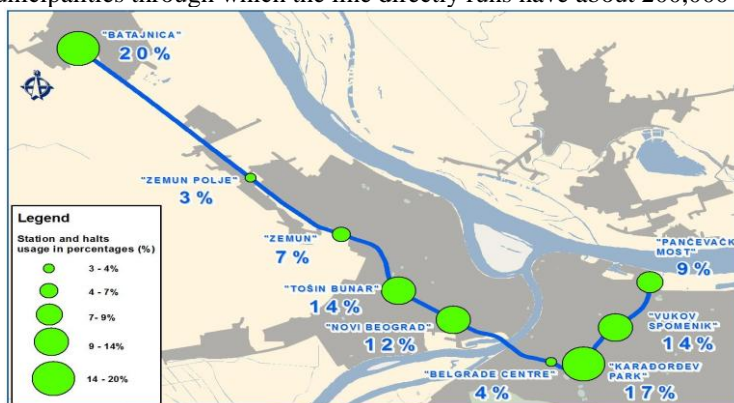


Figure 1. Route of the first BG:voz line and distribution of the number of passengers

BG:voz trains run from 6 am until 11 pm, with starting times of every 15 minutes in peak hours (from 6 am until 9 am and from 3 pm until 6 pm) and every 30 minutes during off-peak hours. On Saturdays and Sundays, the trains run every 60 minutes as they do during holidays. BG:voz system is based on a four-part RVR 412/416 EMU made in the Wagon Factory of Riga, having the capacity of 300 seats and 300 standing places<sup>1</sup>. Currently, the BG:voz system consists of 9 units out of which 7 are operating and 2 are in hot and cold

<sup>1</sup> Designed capacity of the set was changed after the overhaul in 2011

reserve respectively. Expansion of the line, introduction of new stations and shorter timetable intervals will require additional units. Travel time from start to end stations is 38 minutes. The time table of BG:voz consists of 105 departures a day. In the last three years, the first line of BG:voz has become the most attractive and the best quality line on the public urban transportation system with 99% of realized departures. Average annual delay is 9 seconds, which has made this train the most reliable means of transportation in the immediate and wider city area so far.

On working days a total of 34,000 passengers use this train<sup>2</sup> [2] which means an average of 40% of the train daily capacity. Distribution of passengers according to stations (Figure 1) indicates that some stations are very attractive, i.e. they are important connection spots. Percentage of the passengers from the Belgrade Center station is small because the station is rather unaccessible and badly connected with other means of transportation, even though it is located in the immediate city centre. A small number of passengers is recorded also on the Zemun polje halt, mostly because of the location (it is located at the very edge of Altina settlement) but when the BG:voz started running, intensive construction of buildings started as well in the vicinity of the halts and stations. On the other hand, the highest utilisation rate of the line capacity is on Batajnica station. This is due to good location of the station (near the settlement centre), opening of new local round line as well as coordination with existing bus lines schedules that connect the area with the surrounding settlements. It takes less than 30 minutes to reach the city centre, which is less than with any other means of transportation, even if people use their own cars. Comparison of the number of passengers in 2011 and 2012 indicates an increase of 33%.

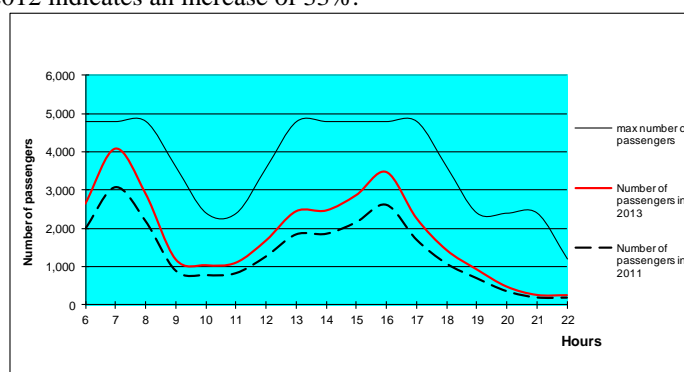


Figure 2. Hourly distribution of the total number of passengers and available capacity

Legal basis for realization of BG: voz services is defined through agreements between the Secretariat for Transport, Directorate for Public Transportation of the City of Belgrade and Serbian Railways JSC. The Directorate for Public Transportation pays access charges of EUR 4.5 per train kilometer for utilizing rail infrastructures and they have engaged Serbian Railways as an operator for transportation services. BG:voz service is part of an integrated tariff system of the city of Belgrade and the same tickets as in other means of urban public transportation are accepted here too. The Directorate for Public Transportation collects the money through “BUS PLUS” system. Monthly income from sold tickets covers only 45%

<sup>2</sup> Detailed counting of passengers was done in October 2011 and a control one in December 2012; data from the Directorate for public transport

of expenses so that the rest is covered by budget subsidies from the treasury of the city of Belgrade. Table 1 below shows total monthly expenses of the city per the type of service, i.e. unit expenses per passenger. It should be noted that unit prices of other services of urban public transportation do not include capital subsidies for purchase of new vehicles nor for infrastructure maintenance which, however, are included in the BG:voz service price.

As you can see, monthly expenses of the city in 2013 per passenger for BG:voz service is about 10% smaller than that for other public transportation services. If the total monthly expenses of the city were increased for the expenses of infrastructure maintenance in case of other public transportation services, which are included in the BG:voz service, the difference between the expenses of the city per passenger of BG:voz and other means of public transportation would be even bigger, which justifies any expansion of BG:voz services foreseen in the future.

*Table 1. Monthly expenses of the city per type of service*

Type of service	Monthly expenses of the city (EUR)	Monthly number of passengers	Unit expenses per passenger (EUR)
BG:voz	253,537	700,000	0.36
Other public transport services	17,500,000	45,000,000	0.39

In order to realize the first line of BG:voz, the city of Belgrade invested EUR 10.5 million, and Serbian Railways JSC EUR 2.5 million. Out of this amount, 65% was invested in reconstruction of existing rail infrastructure and new investments in rail infrastructure on that line. The result of increased investing in infrastructure and vehicles of 3% in regard to the value of existing infrastructure of about EUR 400 million contributed to increased infrastructure utilization from 10% to about 40%.

### **3. EXPANDING THE BG:VOZ SERVICE**

The idea to establish BG:voz service came to life mostly because of insufficient utilization of the potential and capacity of existing infrastructure of Belgrade rail network for passenger traffic in the city centre. In addition, it would improve public transportation in Belgrade. The results of first BG:voz line operation showed that existing infrastructure could be used as the city railways with relatively small investments. A service like this provides Serbian Railways with a new, stable source of income with good potential for further expansion. The city of Belgrade gets financially and environmentally more favourable means of public transportation, and passengers get higher quality service. All these make further investments in BG:voz network expansions viable.

#### **3.1. Extension of Batajnica – Pancevacki most line, opening of new stations and a new line Belgrade Centre - Resnik**

As a part of capacity expansion of the railway infrastructure in Serbia toward the Corridor IV, the second track of the railway to Pancevo will be built and it is expected to be finished next year. Construction of the second track would make it possible to extend the BG:voz line from Pancevacki most to Ovca. The length of this line would then be 32 km. This expansion includes the construction of Krnjaca most and Krnjaca halts and Ovca station. The halt Krnjaca most is located in the vicinity of the loop of Zrenjanin and Pancevo roads

and its main objective would be to take those passengers that use bus transportation and want to reach the old city centre and Novi Belgrade faster. Halt Krnjaca and station Ovca are not expected to have important number of passengers any time soon, but higher quality transportation would definitely make the whole area more attractive.

Analysis of hourly and geographic distribution of the number of passengers as well as parameters regarding movements within the areas through which this BG:voz line runs indicates the possibility to open 6 new halts on the existing line (red spots in Figure 3). Extended line from Batajnica to Ovca would have 18 stations and total travel time would be 45 minutes. Average distance between these stations is 1900 m and 950 m in the city core. Analysis of passenger flow in road traffic and basic parameters regarding movements within the areas around stations on the new BG:voz line [1,2,5,6] leads to the following conclusions: (1) Kamendin and Altina are halts in settlements with small population density but with expressed transportation problems and considerable potential for an increase in passenger number; (2) area around halt Belvi is part of one of the most attractive locations in Novi Beograd i.e. in Belgrade. It is characterized with an important number of employed people by place of residence and place of work, i.e. a large number of business buildings and shopping malls; (3) Halt Sajam has low number of local passengers due to its narrow gravitational area, but it is located in the area where 16 bus lines run and it is an important connection spot; (4) Halt Mekenzijska is located in one of the most densely populated parts of the city and also on the trolley bus lines going to the east parts of the city, which makes it the best connection spot with the left bank of the Sava and the Danube amphitheatre. The same goes for the halt Cvijiceva.

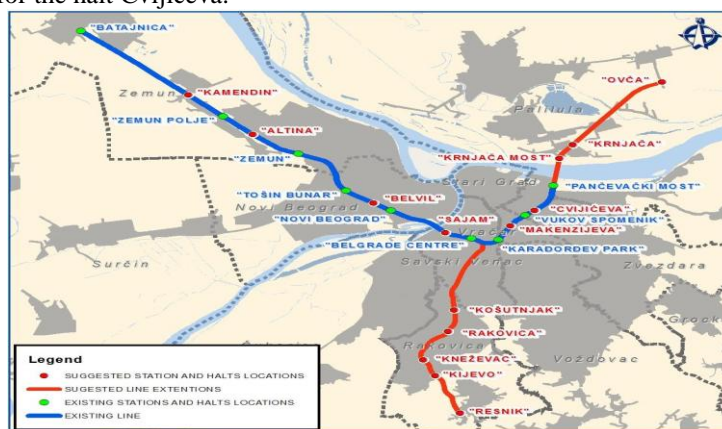


Figure 3. Locations of stations and halts (existing and new ones)

Expansion of BG:voz service to the southwest part of the city, with a new line Beograd Centar – Resnik (red line in Figure 3) would enhance mobility of the people from Rakovica and Resnik municipalities including the settlements Pinosava and Rusanj, towards those parts of the city located on the other bank of the Sava river and on the other side of the highway. This new line is 14.1 km long and has 6 stations. Average distance between stations is 2820 m. Travel time from the start to end stations is 15 minutes. With the connection spot in Beograd Centar station, the travel time from Zemun to Rakovica stations would be no longer than 20 to 25 minutes. Travel time from Rakovica to Vukov Spomenik would be under 20 minutes.

#### 4. Conclusion

Belgrade has a developed public transportation system. It consists of road and rail systems. Urban rail system includes services of tramway lines and suburban railway lines, and since 2010 city railway BG:voz too. From 2011, when the first BG:voz line was extended to Batajnica, until 2013 the number of passengers increase reached 80%. The main thing that makes people choose this transportation system is its reliable time table, speed and comfort. Indicators of the first BG:voz line operation and analyses made regarding the flow of population and passengers in the previous period lead to the conclusion that extension of this line and opening of new stations would result in almost double number of passengers [1,2]. Besides these factors, the number of passengers is also influenced by the gasoline/diesel price, which is constantly going up, There are several public transportation lines that share certain parts with BG:voz line, namely lines 73, 7, 9, 33, 45, 48, 65 and 95. If we compare, for example, bus line 65 with the BG:voz line from Tosin Bunar to Vukov spomenik – even though they are almost equal in length (8.3 km), the level of the city railway service is higher. First, travel time of BG:voz is exact and amounts to 19 min. Bus travel time is longer and cannot be precisely determined due to the characteristics of the line (streets with variable traffic density, traffic lights, traffic jams, etc.). All these make this bus line less reliable. Then, travel comfort is considerably better in the city railway units (bigger area per passenger. comfortable breaking and speeding up). On the other hand, railways generally have lower exploitation costs per capacity unit and the lowest energy consumption per tonne of vehicle [6]. Expansion of BG:voz network, which would include extension of the first line and opening of the second line, would cost about EUR 110 million, major part of which would be used for underground stations [2]. From the timetable point of view it would mean: 150 departures on the first line (with 10 minute intervals), and 100 departures on the second line (with 15 minute intervals).

Current level of the city of Belgrade development, its size and number of inhabitants qualify it to be a city worth of further development of urban public transportation to a high level [6]. Would expansion of BG:voz concept of urban railway service make development of high level urban public transport service possible?

#### 5. REFERENCES

- [1] Directorate for Land Development and Construction of Belgrade, 2008 Smartplan. 2008 Beograd
- [2] Directorate for public transportation, 2012, Internal report on realized service of BG:voz (analysis of BG:voz operation indicators, capacity of utilisation and financial indicators), Beograd
- [3] Ely, M., 2012. Urban Rail Networks in World Cities. *Journeys*, 8, 48-57
- [4] ERRAC (2006). Suburban and regional Railway landscape in Europe. Brussels Available from: [www.uitp.org/public-transport/regional-suburban-railways](http://www UITP.org/public-transport/regional-suburban-railways)
- [5] Republic Statistics Agency, „First Results of the Census in the Republic of Serbia 2011“, Bulletin #540, Beograd, 2011
- [6] Vuchic, V., 2005. *Urban transit, systems and technology*, New Jersey, 2005