

A historical review of metro in Belgrade

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Abstract –Mass passenger transport systems bring new quality through an exceptional range of transportation services, and act to completely change process and practice in development planning and management. On the basis of the Belgrade GUP from 1950., the first metro study in 1968. was made, which showed the justification of a metro network with a total length of 33 km.

Keywords –Planning, Urban Development, Mass passenger transport systems, metro.

I. INTRODUCTION

The first tram on the streets of Belgrade started on October 14, 1892, and the tram with electric traction has operated since 1894. In 1912., trams carried about 7.5 million passengers a year. In addition to all the benefits that this system of transportation had in public transport, there were also problems due to insufficient width of roads, frequent conflicts with pedestrians, vehicles, high climbs in certain sections, etc. The main reasons why the metro was created remained current and valid to this day, namely that it was and remained a completely separate, closed, determined mass transportation system, with the most capacity for regularity, efficiency and reliability in operation.(2) The basic characteristics of mass passenger transport, from an environmental point of view, is that rail systems are a favorable means of transport. There are a number of large cities that see the need for such public transport, but their financial capabilities do not allow it, however, and despite this, the number of metro cities is constantly growing. (2)

In many cities, in addition to the metro system, the tram system is being improved as a light metro system. The metro was planned in Belgrade a hundred years ago, but to date, despite many analyzes, studies, plans and constructed tunnels, it has not been realized, and the aim of this paper is to present a review of the planning of the construction of the metro in Belgrade.

II. PLANNING THE CONSTRUCTION OF THE METRO IN BELGRADE IN THE XX CENTURY

The construction of the Belgrade subway, a high-capacity and fully independent rail system, as the basis of public transport in Belgrade, was planned in 1921 in the awarded competitive work of French architects. (1) The Master plan for the city of Belgrade (GUP) from 1923, drafted by Djordje Kovaljevski, envisaged a railway tunnel that would connect the central railway station at the Sava Amphitheater to the Danube railway station.

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A study commissioned by the State Railway Construction Department provided a tunnel of 2,718 meters long, with an interior designed for double track, and exclusively for rail traffic. The design of the tunnel was hampered by high altitude differences, unfavorable soil composition, and existing sewage installations. In 1932., 2.140 motor vehicles were registered in Belgrade, while a tram network of a total length of 45 km constituted the basis of the passenger transport system. In 1938. the introduction of subways on the city's three main traffic lines was considered: King Aleksandar - Terazije - Zemun, Kalemegdan - Slavia - Autokomanda and Topcider - Sava Railway Station - Terazije - Danube Railway Station, each with 10-13 million passengers per year (third line along the existing, roundabout route)., given that Belgrade, with Zemun and the suburbs, then had about 310.000 inhabitants. Reforms in stages were proposed on all three lines, starting with the reorganization of existing tram lines, which was followed by the construction of tunnels and subways. The introduction of underground metro was first proposed on line 2, at the Kalemegdan - Terazije - Slavija - Autokomanda - Vozdovac line, with a total length of 5 km of tunnel route with 6 underground stations. This metro would be part of the city railway, which would also include an electric railway above ground in the extension of the metro at the Vozdovac - Banjica - Avala, 12,5 km long, and cable cars from the end of the railway station, at the foot of Avala to the Monument to the Unknown Hero in the length of 600m. Separation into the center and periphery encouraged the governors to further expand the public passenger transport network, so that before World War II, Belgrade had a population of 320.000 and tram lines to the borders of what was then a continuously built area. (3)

Immediately after the end of World War II, the action was directed in two directions: restoring the normal functioning of the city and drafting long-term planning documents for further development. At that time, architect Nikola Dobrovic was concerned with the spatial development of the city, whose numerous visionary moves would be understood and realized (Highway through Belgrade). Belgrade GUP adopted in 1950 he set out two tasks:

- Solve problems of complex city organization that will grow from 400.000 to 1.000.000 in 20 years.

- Design a new part of the city on the left bank of the Sava River and integrate it with urban Belgrade and Zemun.

The historic decision to move the city to the other bank of the Sava River has opened up new perspectives for Belgrade based primarily on the development of suburban and urban traffic. The 1950. Master Plan the development of the main road network is envisaged, while in public transport the orientation to the rail systems that serve the basic development directions is suggested. Within the urban area, public transport would be performed by elastic buses and trolleybuses, while the tram traffic, due to the general condition of its network and the unacceptability of the new

conditions, would be left until it was finally replaced by new modes of transport.

On the basis of the GUP from 1950., the first metro study in 1968 was conducted, led by dr. eng. Savo Janjic and in which the first comprehensive metro concept was proposed, which envisaged three lines with a total length of approximately 33 km, which would connect 35 stations with three diametral lines, which disconnect the city tissue from the center. The envisaged lines A and B followed the busiest traffic routes, and the C line was intended as a shorter transverse connection between the two lines with the construction of which would begin upon completion of the first two lines and then proceed to the densely populated residential areas of Banovo brdo and Karaburma. Line B is intended to be the location code for the new main passenger train station (later moved to Prokop at Autokomanda). The distances between the stations are projected at 600–800 m in the center and 1000–1.300 m towards the periphery. (8)

When many of the GUP's forecasts of 1950 have already been overcome, there was a need to develop a new General Urban Plan for Belgrade in 1972. and about 2.000.000 inhabitants of the city, which imposes the need to build over 4.000.000 m² of new living space on the free and slightly constructed terrain of Belgrade's development directions towards Batajnica, Vinca and Zeleznik. According to the GUP concept of 1972., the performance of commercial and public activities is realized through a system of general and specialized centers, with a special place for the main city center, the Kalemegdan-Slavia move with the most attractive public facilities and tertiary activities. The starting point for the 2.000.000 residents in Belgrade in public transport is a two-line metro. With the adoption of the GUP in 1972., a decision was made to develop a study on the development of public transport in Belgrade with the metro as the main means of fast and mass transportation of people in the city, with answers to be given regarding the choice of system, technology and economy, the final routes and locations of subway stations as well as other elements. On September 20, 1972., the President of the City Assembly, Branko Pesic, signed with the Institute for Construction and Reconstruction of the City of Belgrade an agreement on the establishment of the Metro and Underground Works Division at the Institute, headed by architect Branislav Jovin. The GUP of 1972. envisaged the formation of a network of city centers in Belgrade: central zones (main center), secondary city centers, district centers and community centers. For the metro system, the backbones on the Batajnica - Vinca and Petlovo brdo - Karaburma routes are planned, with a total length of 50 km. 500 km of the bus network were planned, as well as the reconstruction of the tram network in order to serve until 2000. In 1973., an agreement was made with the Urban Planning Authority to develop the necessary urban studies and an investment program for the railway junction in Prokop was adopted, and work began at the Urban Planning Institute on the Belgrade Stage Development Plan to 1985. (1)

The regulation plan for the central zone of Belgrade, with the first phase of the Belgrade Metro, was adopted in 1976. (A study on the technical and economic suitability of express public transport in Belgrade was adopted in 1977.). (6) More

than 100 leading engineers worked at the study. (Fig 1) The study elaborated on a number of possible solutions and as (urban and economically) most favorable highlighted the variant with five independent metro lines (I metro stages.GM) and four independent regional metro lines (RM), published in 1975. the document "Planning postulates for the year 2000".

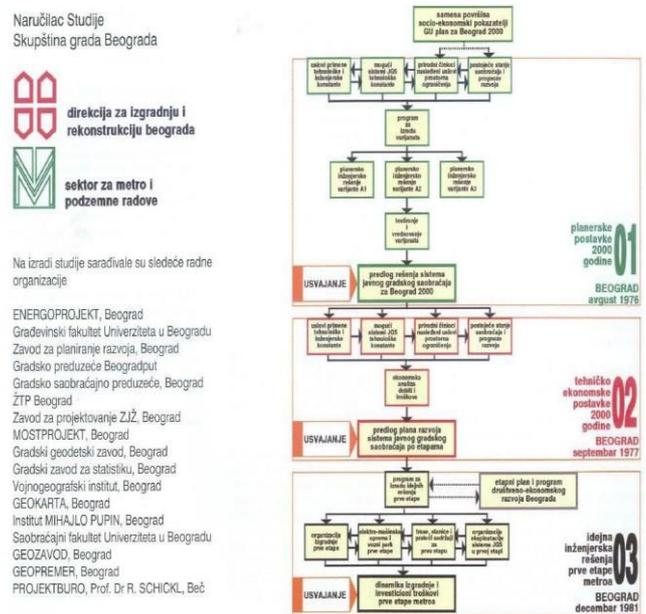


Fig 1. Study on the technical and economic suitability of high-speed public urban transport in Belgrade- associates in the study (1976.-1981.)

The proposed network of capacity systems in the continuously built area of Belgrade (up to 10km from the city center by City metro-GM) supports the distribution metro line with forked lines, which function together with interconnecting lines as a complete network system. Three points of intersection (two with regional subways) are formed in the very core of Belgrade, in order to enable fast and efficient transfer of passengers while creating the basis for the formation of a large pedestrian zone (Knez Mihailova Square, Republic Square, Terazije, Slavia). The Regional Metro Network (RM) serves development in the wider Belgrade area. It consists of two routes of general orientation East-West and North-South. With the existence of the Republic Square and the Faculty of Economics connected to the metro stations, a basic triangle is formed in the central core of Belgrade. The urban metro passenger network is provided at 7 more peripheral points. In this way, the more remote parts of the city are served quickly and efficiently, and at the same time, it creates a traffic base for the regional development of individual settlements in the wider area of Greater Belgrade (Pancevo, Indjija, Barajevo, Obrenovac, Lazarevac, etc.). The capacity is estimated at 40,000 passengers per hour in one direction. The vehicles would depart in 2-4 minutes, with a station spacing of up to 800 meters and an exploited speed of between 30-40 km / h. (GM) Regional Metro (RM) would have a station spacing of up to 2 km and develop speeds of up to 80 km / h (Fig. 2,3).



Fig. 2 The first stages of the M1 subway from Mercator to the Vukov monument

DINAMIKA ULAGANJA INVESTICIONIH SREDSTAVA

Dinamički plan ulaganja investicija izrađen je na osnovu dinamike izgradnje i predračuna radova. Pritom je bitno ukazati na međuzavisnost ovih planova, promene u dinamičkom planu građenja direktno utiču na dinamički plan ulaganja i obratno. Dinarska sredstva 1982. god. preračunata su u Euro po zvanjnoj stopi konverzije.

Izgradnja prve metro deonice (faza I) zahteva najveću koncentraciju finansijskih sredstava, tj. u trećoj i četvrtoj godini pošto se tada grade najkompleksniji objekti.

predinvestira u tehničku bazu i nabavlja više od polovine ukupno potrebnih vozničkih sredstava. U periodu izgradnje od pete do sedme godine obim godišnjih investicija je nešto uvećan (4 mrd. din./1982 god., odnosno, 115 mil. Eu/2005 god.) sa daljim smanjnjem u završnoj fazi gradnje.

Prikazani tok investicione krive karakterističan je samo za prvu etapu metroa kada se grade najložestiji metro objekti u najužem centru grada i predinvestira u buduću razvoj. Svaka sledeća etapa razvoja imaće mnogo brži ritam izgradnje i zahteva neporedivo manja godišnja ulaganja. Procenjuje se da bi obim godišnjih

ulaganja od 2,5-3,0 mrd. din./1982 god. (tj. 80-90 mil. Eu/2005 god.) obezbedilo godišnje povećanje metro mreže od 2,5 do 3,0 km. uz visok priraštaj direktnih i indirektnih društveno-ekonomskih efekata.

Na kraju, treba ukazati da su ukupna sredstva za izgradnju prve etape metroa objektivno manja u odnosu na automobilske Unutrašnji Magistralni Poliprsten - UMP reklamiran od strane gradskih činelnika. Pritom je sigurno da problem saobraćaja u Beogradu tako neće biti trajno rešen a cena je, pored ostalog, i potpuno uništenje dragocenih prostora u Topčideru.

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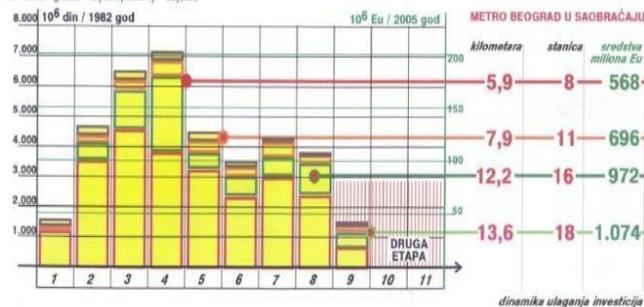


Fig. 3 The dynamics of the funds

The proposed solution would reduce the volume of surface traffic, air pollution and communal noise, increase the accessibility of attractive contents in the central zone, equalize the differences between individual dwellings, enable the revitalization and reconstruction, increase pedestrian spaces, and enable the dedication of surfaces to more attractive, economically more favorable and / or humane purposes. The study states that the proposed system is an essential prerequisite for the achievement of the objectives of the 1972. General Plan, noting that if radical measures are not taken in the public transport system, Belgrade's urban, functional and economic development will be endangered, while the spatial and environmental consequences of traffic dehumanize urban spaces and devalue the urban lifestyle. Urban and technical documentation at the level of conceptual designs as well as the financing structure for approaching the decision to build the First phase of the metro was done in 1981. The dynamic investment plan of the investment is made on the basis of the dynamics of construction and estimate of works, which requires the highest concentration of funds in the third and fourth year since then the most complex facilities are being worked, pre-invests in the technical base and procures more than half of the total required vehicles, and from fifth to fifth

the seventh year, the volume of annual investments is somewhat increased with further decrease in the final stage of construction. (6)

The new GUP of Belgrade shortens the line of the first subway stage in 1985. and proposes a subway M1 stage from Mercator to Vukov monument 7,54 km long with 11 metro stations, out of which 5,94 km underground and 1.6 km above ground and road rail bridge across the Sava, a total length of 13,5 km with 18 metro stations.

In 1995., the Vukov Monument train station was put into operation, during which a tunnel connection was made for the future metro line below King Aleksandar Boulevard and the metro tunnels at the future Prokop railway and metro station.

In 1998, work continued on the metro project. In 1998, work continued on the subway project. Two variants of the general project of the metro bridge on the Sava River were made (to the existing old bridge in the extension of Zoran Djindjic Boulevard in New Belgrade now), and then along the route through the tunnel to Nemanjina Street. (as given by the competition work from 1921).

In 2000, the Metro Division at the Institute for Construction of the City of Belgrade was abolished and work on the metro project stopped.

III. METRO IN BELGRADE AT THE BEGINNING OF THE XXI CENTURY

The analysis of the presented planned construction of the metro in Belgrade until the beginning of the XXI century can state the following:

- In Belgrade, back in 1921, the competition decision "URBS - MAGNA" confirmed that Belgrade needs a subway;
- In the Study "Conditions for running underground - railways" a metro corridor is given;
- In the "Belgrade Metro Studio", a metro with three routes was given;
- In the GUP of Belgrade in 1972, two metro lines were given, with a total length of about 50 km;
- In the "Study of techno-economic suitability of fast public city transport in Belgrade" in 1981, a metro with 5 lines of the city metro GM and 4 lines of the regional metro RM was given;
- In the "Strategy of transport systems in the long-term development of Belgrade - the strategy of development of public transport" in 1996, it was given that it is necessary to build a subway and develop a program to finance the design and construction of the subway;
- In 1998, the Assembly of the City of Belgrade passed a Decision on the preparation of a regulatory plan for the construction of the Metro M1 line with 11 stations in the length of 7.54 km;
- The general project of the dual-purpose road-rail metro bridge over the Sava was done in 2000 and revised at the session of the Audit Commission of the Ministry of Construction and Urbanism in 2000;

It is important to mention today that 35-40 years ago Belgrade was a "closed city" that could not be entered and when it could not be exited, and people traveled to and from work by existing transport (at distances up to 7 km). more than 50 min. It is also important to say that large investments are not only

financed from state and city funds, they are also financed, built and exploited by concession agreements with the state (project financing systems by methods, B.O.T and B.O.O.T.).

The GUP of Belgrade from 2003. has removed the metro from public traffic in Belgrade, considering that its construction is uneconomical, so a surface tram is planned on the metro route. (whose part of the line was partially realized). In October 2005., the author of the team of the Metro Study on the Institute for the Construction of the City of Belgrade (Branislav Jovin, Jovan Katanic, Mihailo Maletin, Savo Djakonovic) in the "Study on the Metro in Belgrade" warns that the total funds for the construction of the first stage of the subway are objectively smaller than the Automobile Inner Main Semi-Ring UMP (with a bridge over Ada Ciganlija), and that the problem of traffic in the city of Belgrade will not be permanently solved, and the cost of constructing a UMP is, among other things, the complete destruction of valuable premises in Topcider. The authoring team warns: "as many times before ... there were" experts "with" life-saving solutions ". More recently, the false dilemma of the "light" or "heavy" metro has been planned, and the dilemma that does not exist is the question: will we begin the new millennium with a cosmetically refined tramway for the 21st century or finally begin to build a rail system called " metro".

In March 2008, the Directorate for Construction Land and Construction of the Belgrade JP prepared the Traffic Master Plan of Belgrade "Smart Plan" (7).

The Academy of Architecture of Serbia in September of 2009. sends material on the Belgrade metro project to the Mayor of Belgrade and the Minister of Infrastructure of Serbia: Report on discussions with foreign traffic experts, "2009.-2016., Again-Belgrade with the metro system" and the conclusion, among other things, that is "..... a two-million city - European Belgrade a necessary-independent distribution metro system — not a street tram (LRT) of the Spanish company“ Ineco ”impersonated as“ Belgrade Metro ”. The report was prepared by the architect Branislav Jovin for the Academy of Architecture. (1)

By adopting the modification of the Regional Spatial Plan of the AP Belgrade in 2011., the metro system was reintroduced in the GUP of Belgrade for public transport in Belgrade (8 years after the interruption of work on the metro). and work continues in the newly established institution of the City of Belgrade - Directorate for Building Land and Construction Belgrade JP.

The GUP of Belgrade, adopted in 2016 (Official Gazette of the City of Belgrade No. 11/2016, dated March 7), plans to build the Belgrade Metro on three lines: Line 1 Ustanička-Aleksandra Dupčeka (Tvornička) with a technical connection to the depot in New Belgrade in block 66, Line 2, Banovo brdo-center and Line 3, connection of the direction Banovo brdo over the new bridge on Ada with line 1. The GUP reads as follows: "The mentioned routes, which are defined by the amendment of the General Plan until 2021, from 2009, represent the basis of the future network of the Belgrade Metro. Priority in the realization, for the period until 2021, is given to Line 1, which, through the narrowest central old core of Belgrade and through the central area of New Belgrade, connects the east with the western area of the city. Having in

mind the directions of development of Belgrade, as well as the previous perceptions of the possibility of further expansion of the metro network in the future, the following directions are proposed, which need to be technically and planned developed and defined in the coming period. The first phase of the construction of the Belgrade Metro, according to the current observations and on the basis of the documentation done so far, is Line 1, a stretch from Ustanička Street to Aleksandra Dupčeka Street (Tvornička Street). This plan provides a proposal for the development route of the metro network in Belgrade on the basis of previous observations and prepared technical documentation. In the following period, it is necessary to analyze the proposed routes through the preparation of study documentation, taking into account all spatial changes, needs and limiting factors, after which it is necessary to start making plans with elements of detailed planning, which will define all elements of regulation and leveling, as well as the positions of the stations on the route. "

In 2016., the City of Belgrade adopted the Traffic Master Plan by 2033, developed by the English consulting firm WSP. In the Belgrade Traffic Master Plan until 2033., the first metro line will be 22 kilometers long, connecting Makisko Polje and Mirijevo and the second line connecting Zemun and Mirijevo, 20 kilometers long. (Fig 4)

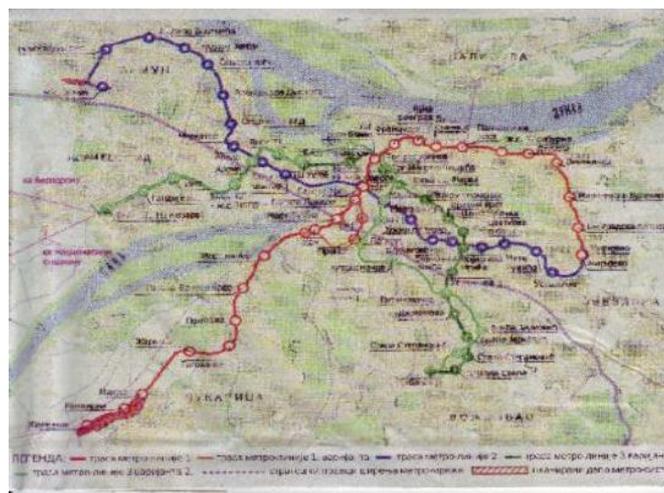


Fig 4. Belgrade Metro Stages 2016. M1-red

According to the general project with the Preliminary Feasibility Study (2019), done by the French design house EGIS Rail, the route of the first metro line from Makiš to Mirijevo is 21.3 kilometers long with 23 metro stations with a distance of about 900 m. The study on environmental protection for the corridor of the two planned metro lines (under the jurisdiction of JKP Belgrade Metro and Train), was done in 2020. A Geological Study is being prepared, which will provide precise indicators that will indicate how which part of the metro route will be built. When the first metro line was determined and when the Traffic Master Plan of Belgrade and the General Project with the Feasibility Study (which are the basis for the development of the urban plan) were made, not only traffic but also urban and economic aspects were taken into account.

IV. CONCLUSION

The awarded competition work of a team of French planners for the General Urban Plan of Belgrade in 1921. even then provided for public transport in Belgrade a trolleybus, bus and metro with three lines, with the recommendation that the tram transport be abolished over time, noting that Belgrade lies on 7 hills and that public transportation should go through the hills, not on the hills. Unfortunately, even 100 years later, the Belgrade metro was not built except for the metro tunnel in King Aleksandar Boulevard near the Vukov monument. It has been proven that for large-scale ventures it is never too late and, until they are built, they are never deleted from the plans of the development strategy - neither the planned route nor the names, an example is the Lamanche tunnel (beginning of realization in 1882. and ending in 1995.). Due to the problems of experts' views for decades, I hope that our experts will not be asked any time soon, and that the problem of construction for the metro will be solved by those who are guided by the maxim time is money, and an independent high-capacity rail system - the metro will be built in Belgrade.

"The least we can do today is not to make short-term decisions that would prevent development projects from being implemented tomorrow." (Gojko Beara)

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