Urban mobility and accessibility of public transport in Bucharest

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Abstract
The paper aims to address a current problem, namely urban mobility, which is a major challenge faced by major European cities including Bucharest, which currently offers a partially developed public transport, although the citizens of the capital want an efficient, integrated, sustainable, safe public transport system that ensures a high quality of life. Urban mobility is the ease with which people can travel between destinations in urban areas using the public transport network. A civilised and attractive public transport system requires that passengers are well informed about vehicle timetables, routes and transfer possibilities. At European level, €16.3 billion has been allocated for the period 2014-2020 and the Interconnecting Europe Facility (IEF) has allocated more than €200 million for transport in large European cities. The paper is structured on three levels: the legislative framework for urban mobility at European and national level, urban mobility in Bucharest, analysis of the accessibility of surface public transport routes and their efficiency for public transport in the capital and the implementation of concepts and systems ("intermodal node", "Park & Ride" system, passenger information system). Urban mobility in Bucharest is currently provided both by public transport (RATB, Metrorex) and by personal or company cars. Although there have been levels of growth in the total population, the capacity offered by public transport has decreased, leading to an increase in the use of personal means. This has led to overcrowding in the centre of the capital, as well as on many main roads. As a negative consequence, surface public transport has suffered, leading to a decrease in its use.

Keywords: urban mobility, accessibility, public transport, passenger information system.

1. Introduction
Transport is fundamental to our economy and society, and mobility is vital for the internal market and for the quality of life of citizens, as they enjoy the freedom to travel. Transport enables economic growth and job creation; it must be sustainable in the light of the new challenges we face. Transport is a global business, so strong international cooperation is needed to make action effective. That is why public transport must develop sustainably and environmentally friendly, with adequate safety standards, so that it becomes efficient, integrated, safe and designed to promote socially inclusive economic and territorial development and ensure a high quality of life.

2. Content
The paper is structured on three levels: the legislative framework on urban mobility at European and national level, urban mobility in Bucharest, analysis of the accessibility of surface public transport routes and their efficiency in public transport in the capital and the implementation of concepts and systems ("intermodal node", "Park & Ride" system, passenger information system).

2.1. European and national legislative framework
European and national legislative framework in this field is:

- White Paper on the future development of the common transport policy (1992) This promoted the opening of the transport market, the extension of the trans-European

transport network, improved safety and the harmonisation of social provisions. The White Paper also marked a turning point towards an integrated and intermodal approach based on the "sustainable mobility" model. Subsequently, in the White Paper of 22 July 1998 entitled "Fair payment for infrastructure use: A phased approach to a common transport infrastructure charging framework in the EU" (COM(1998)0466), it was pointed out that there were large differences between Member States in the calculation of transport charges, which led to multiple distortions of competition in intra- and intermodal transport.

- White Paper "European transport policy for 2010: time to decide" (COM(2001)0370). In June 2006, the Commission presented a mid-term review of the 2001 White Paper (COM(2006)0314), entitled "Keep Europe moving - Sustainable mobility for our continent".
- 2006 - Communication from the Commission to the Council and the European Parliament on a Thematic Strategy on the Urban Environment, COM(2005)718 final
- 2007 - Green Paper: Towards a new culture for urban mobility, COM(2007)551 final
- Regulation (EC) No 1370/2007 of the European Parliament and of the Council of 23 October 2007 on public passenger transport services by rail and by road,
- 2009 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Action Plan on Urban Mobility, COM(2009) 490 final,
- The Commission published its 2011 White Paper on the future of transport up to 2050, Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system (COM(2011)0144), on 28 March 2011. Among the 10 objectives included in the 2011 White Paper, the Commission included the creation of a Single European Transport Area by removing all remaining barriers between modes and between national systems, simplifying the integration process and facilitating the emergence of multinational and multimodal operators. On 1 July 2016, the Commission presented a report, in the form of a working document (SWD(2016)0226), on the progress made in implementing the 10-year programme set out in the 2011 White Paper. Annex II contains a detailed assessment of the activities undertaken so far.
- The Transport White Paper (2011) recognises the influence of urban transport in ensuring transport sustainability at national level and sets out 40 initiatives that contribute to increasing mobility, removing major barriers in key areas, reducing fuel consumption by removing cars from the road and increasing the number of electric cars, rail and waterborne transport taking over 50% of medium distance journeys made by road, reducing carbon emissions in air transport by at least 40%. Cities must develop urban mobility plans aligned with Integrated Urban Development Plans.
- White Paper Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system (2011)
- Guidance for the development and implementation of Sustainable Urban Mobility Plans (SUMPs) published in 2014 by the European Commission, and the main objectives are: providing transport modes for all citizens, improving transport safety and security, reducing noise, air pollution, greenhouse gas emissions, increasing the attractiveness and quality of the urban environment for the benefit of citizens and society as a whole.

- In 2016, the Commission published a Communication "A European Strategy for Low Carbon Mobility" (COM(2016)0501), in which it proposed measures to accelerate the decarbonisation of European transport.
- 2017 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Europe on the move: An agenda for a socially just transition to clean, competitive and connected mobility for all, COM(2017)283 final,
- The 'Sustainable and Smart Mobility Strategy 2021' lays the foundations for how the EU transport system can achieve its green and digital transformation and become more resilient to future crises. As outlined in the European Green Deal the result will be a 90% reduction in emissions by 2050, secured by a smart, competitive, safe, affordable and accessible transport system. Sustainable transport means stimulating the uptake of zero-emission vehicles, ships and planes, renewable and low-carbon fuels and related infrastructure, creating zero-emission airports and ports, ensuring healthy and sustainable inter-city and urban mobility, multi-modal mobility and a European Urban Mobility Scoreboard based on common targets; examining, for cities of a certain size, the possibility of imposing an approach in line with national standards and based on EU guidelines, Intelligent Transport Systems.
- Law No 350/2001 with subsequent amendments and additions on spatial planning and town planning, published in the Official Gazette, Part I, No 373 of 10 July 2001. Annex 2 to the law defines an urban mobility plan as a strategic territorial planning instrument that links the spatial development of localities, metropolitan areas with the mobility and transport of people, goods and goods.
- Romania's National Recovery and Resilience Plan [1] is a strategic document based on 6 main pillars (green transition, digital transformation, smart, sustainable and inclusive growth, social and territorial cohesion, health and economic, social and institutional resilience, policies for the New Generation) which sets out the investment priorities and reforms needed for recovery and sustainable growth, linked to the green and digital transition envisaged by the European Commission which provides 507 milestones and targets linked to the reforms and investments undertaken.

The National Recovery and Resilience Plan under the section dedicated to "Sustainable Transport" sets out a series of milestones, targets and indicators that address all modes of transport.

The first milestone relates to ensuring sustainable transport, decarbonisation and road safety - Improving the strategic, legal and procedural framework for the transition to sustainable transport by creating and implementing a new distance-based charging system for heavy goods vehicles (trucks) and higher property taxes for the most polluting passenger vehicles (cars/coaches/coaches), based on the polluter pays principle and the principle of green taxation, stimulating the use of clean vehicles and fleet renewal programmes by domestic users, private companies and public institutions, scrapping of polluting vehicles, increasing the number of zero emission vehicles, creation of a large number of charging stations for electric vehicles installed nationwide, adoption of the national road safety strategy and its implementation through the development and adoption

of road safety legislation - legislation on monitoring, enforcement and penalties for road safety violations, adoption of the rail infrastructure development strategy 2021-2025 and implementation of the action plan, publication and implementation of the European Rail Traffic Management System (ERTMS) national action plan, adoption of the Maritime Transport Strategy, approval of the Intelligent Traffic Systems (ITS) Strategy and the related legislative package [6 The National Recovery and Resilience Plan].

The second milestone concerns ensuring efficient management for quality transport - Improving institutional governance and corporate management capacity by reforming CNAIR and creating a new road investment project management company (C.N.I.R.) The law was approved by Parliament and came into force in April 2021. The primary and secondary legislation needs to be amended to allow for streamlining of the company's activities and realignment of C.N.A.I.R.'s institutional tasks and mechanisms. Selection and appointment of members of the boards of directors of state-owned transport companies (C.N.A.I.R., C.N.I.R., C.F.R., Metrorex, C.F.R. Călători . An independent assessment of the financial and operational performance of C.N.A.I.R., C.N.I.R., C.F.R. (National Railway Company), C.F.R. Călători and Metrorex will be carried out in accordance with OECD standards and the main recommendations of the assessment will be implemented.

For the independent evaluation, the Ministry of Transport and Infrastructure will select through competitive tendering procedures an international financial institution or an international audit firm, recognised for its competence and expertise in the performance of state-owned companies. An independent assessment of the financial and operational performance of C.N.A.I.R., C.F.R., C.F.R. Călători and Metrorex will be carried out in accordance with OECD standards. Another issue to be considered is the improvement of the performance of the railway system in terms of train punctuality, modernisation of railway lines, including the implementation of the European Rail Traffic Management System (ERTMS level 2), centralisation of railway stations, renewal and electrification of lines [6 The National Recovery and Resilience Plan].

The third milestone concerns the development of road infrastructure linked to the TEN-T Core network, as well as that necessary for the implementation of new tolling and control measures, road traffic management systems and road safety and the development of the metro network in Bucharest and Cluj-Napoca (M4 Bucharest: section Gara de Nord - Filaret (6 stations), length 5.2 km and M1 Cluj-Napoca): SF. Maria - Europa Unită (9 stops), length 7.5 km). In relation to the metro, contracts for works will be signed, following open and competitive tenders, and the relevant authorisations will be obtained for structural works, stations, interstations, tunnels, galleries and other constructions for the two new metro lines.

2.2. Urban mobility in Bucharest

The mobility of the population is currently ensured both by public transport (RATB, Metrorex) and by personal or company cars. Although there have been levels of growth in the total population, the capacity offered by public transport has decreased, leading to an increase in the use of personal means. This has led to overcrowding in the centre of the

capital, as well as on many main roads. As a negative consequence, surface public transport has suffered, leading to a decrease in its use.

Although investments have been made in recent years to partially replace the vehicle fleet (1000 buses, 100 trolleybuses, modernised trams), they do not compensate for the very long journey times and lack of rhythm, which makes surface public transport less attractive.

Table 1. SWOT analysis of public transport in Bucharest

Strengths (S)	**Weaknesses (W)**
Public transport in Bucharest offers a good variety of options (tram, trolleybus, buses, metro), The network is dense and has potential, The most used means of transport in Bucharest is the metro, due to the fact that the metro lines are complex and provide fast and safe transport from one end of Bucharest to the other and the waiting time is short. The metro network is very well structured with the following main lines: Dristor-Patelimon, Pipera-Berceni, Preciziei- Anghel Saligny Gare de Nord - Străulești depot Eroilor - Râul Doamnei	The journey times in the itineraries do not correspond to the real situation, Lack of parking spaces leads to frequent blockages of RATB traffic, Passenger information is very poor (no posted timetables; only connections from the same station are announced in new vehicles), There are areas where many routes overlap over long distances (especially bus routes that duplicate tram or trolleybus routes).
Opportunities (O)	**Threats (T)**
Increase the density of cycle lanes, Provide off-street public parking spaces to free up street space for other uses such as bus lanes, sidewalks/bike lanes, Increase the percentage of fully accessible public transport vehicles, Increased accessibility for pedestrians (quality of surfaces, crosswalks and crosswalks), Reduce bus travel time along key corridors on the street network, Park&Ride system - parking in peripheral areas linked to public transport terminals, Reviewing the transport network and circulation schedules for efficiency, New urban planning projects that will attract new passenger flows. Construction of the Gara de Nord-Henri Coandă Airport metro line to pass through the Băneasa and Otopeni districts of Ilfov county, Improving the traffic management system, Painting pedestrian crossings with anti-skid material and providing pedestrian crossings with level access and good visibility, Creating a safe waiting area in the middle of the street, at long pedestrian crossings and at roundabouts, Parking guidance system and variable message display system.	Surface public transport (for the most part) has no advantages over personal cars, The number of cars keeps increasing, To the suburbs, minibuses of other transport companies block the stations, Urban plans for new shopping centres or new residential areas do not provide for the integration of public transport from the outset, and various improvisations subsequently arise.

Source: Author own work

2.3. Analysis of the accessibility of surface public transport routes and their efficiency for public transport in the capital and implementation of concepts and systems ("intermodal node", "Park & Ride" system, passenger information system)

Given the poor state of the fleet used in public passenger transport and in accordance with the provisions of the Sustainable Urban Mobility Plan (PMUD) 2016-2030 developed for the Bucharest-Ilfov region, the purchase of trolleybuses is desired, as they are low carbon, low-floor vehicles are accessible to both the elderly and those with locomotor disabilities, are 100% electric with zero emissions, have intelligent technical systems and produce little noise. [3 STB activity reports 2020, 2019, 2018 STB SA]

In order to make public passenger transport more attractive and encourage citizens to give up using their own vehicles to reduce pollution and traffic congestion, 400 buses, 100 hybrid buses, 100 electric buses running on 14 routes, 100 trolleybuses and 100 trams have been purchased. The trams to be purchased will run on lines 1, 10, 21, 25, 32, 40, 41 and 55.

The newly purchased buses will have: low floor, on-board computer for the fleet management system, dual validators for the ticketing system, passenger information system inside and outside, wheelchair ramp, automatic passenger counting system, video surveillance system inside and outside, driver-dispatcher voice communication system, vehicle parameter and driving mode monitoring system.

The purchased trolleybuses will reduce pollution and noise, increase passenger comfort and provide easy access for people with reduced mobility, are environmentally friendly, capacity is 100 passengers respectively 150 passengers.

To reduce operating costs, the most efficient means of transport are trams and trolleybuses because they run on electricity and the energy produced is 100% from hydropower.

In the Bucharest-Ilfov Region there are 200 public transport lines in operation, 135 of which are urban lines and 65 are regional bus lines. The total number of tram routes is 22 and trolleybus routes are 16. The total number of bus routes is 162 of which 72 are urban day lines, 65 regional lines and 25 night lines.

The length of public transport routes is 2420 km (double track), divided as follows: 273 km trams, 152 km trolleybuses and buses 1995 km of which 801 km regional lines.

In 2021, the total vehicle fleet of 1,728 of which 281 trams, 176 trolleybuses and 1,271 buses was distributed on 187 routes as follows: 24 tram lines, 146 bus lines of which 43 regional lines and 17 trolleybus lines. The total number of vehicles is 2159 of which 1527 buses, 227 trolleybuses and 405 trams. 227 trolleybuses, 1000 buses and 300 trams have exceeded their normal service life. [3 STB activity reports 2021].

All means of transport are equipped with automatic fare collection systems and information boards inside.

The fare offer is advantageous because there is an integrated transport system. Thus, there are surface-only trips (bus, trolleybus and tram, the type being one trip, two trips or ten trips of 90 minutes each and offering the possibility of transferring from one line to another and from one means of transport to another), another is integrated (metro and surface means of transport, one trip, two or ten trips of 120 minutes each) and surface transport passes (there are several categories: 24 hours, 72 hours, 7 days, 1 month, 6 months and 12 months), as well as 50% reduced passes for pupils and students. There are also integrated (surface-train) passes for 24 hours, 72 hours, 7 days, 1 month, 6 months and 12 months and integrated surface-train metro passes for Gara de Nord and Otopeni Airport valid for 1 month, 6 months and 12 months. And the last type of offer is the tourist travel card for 24 hours or 72 hours as well as passes for 1 month, 6 months and 12 months. [2Bucharest City Hall] [2].

At present, at least 20 major intermodal nodes can be identified in Bucharest. In these nodes there should be a better connection between the means of transport serving them (stations as close and easily accessible as possible), but also better information for passengers about all possible connections and their schedules, not just the connections from the current station.

These intermodal nodes are:

- Bucur Obor - metro, trams, trolleybuses, buses,
- Clăbucet - metro, trams, trolleybuses, buses,
- Dristor - metro, trams, buses,
- Basarab station - metro, trams, trolleybuses, buses, CFR,
- Gare de Nord - metro, trams, trolleybuses, buses, CFR,
- Lujerului - metro, trams, trolleybuses, buses,
- Charles de Gaules Square - metro, buses,
- Crângași Street - metro, trams, buses,
- Drumul Taberei Street - trams, trolleybuses, buses, metro,
- Eroii Revoluției Square - metro, trams, buses,
- Iancului Street - metro, trams, buses,
- Presei Libere Square - trams, buses,
- P-ța Romană - metro, trolleybuses, buses,
- P-ța Sudului - metro, trams, trolleybuses, buses,
- Titan Street - metro, trams, trolleybuses, buses,
- Unirii Street - metro, trams, trolleybuses, buses,
- Victoriei Street - metro, trams, buses,
- Eroilor Bridge - metro, trolleybuses, buses,
- Grozăvești Bridge - metro, trams, buses,
- Răzoare - trams, trolleybuses, buses, metro,
- Universitate - metro, trolleybuses, buses.

Lack of parking at the entrance to the city leads to traffic congestion. Park & Ride parking offers citizens the possibility to park their car safely and continue their journey by public transport to their destination. Access from the car park to public transport should be easy and have access to information on connections to different points of interest in the city.

Such parking lots with access to public transport can be arranged in the following locations: Băneasa Airport, Anghel Saligny, Bucurestii Noi / Pajura, CFR Progresul, Colentina / Helitube, Alexandria Depot, Granitul / Antilopa, Metro Nicolae Teclu / IMGB, Petricani / Glucoza Factory, Preciziei.

A civilised and attractive public transport system requires passengers to be very well informed about vehicle timetables, routes and transfer possibilities.

Maps showing the public transport network are missing from most stations and vehicles. Area maps describing all transport links should be displayed at major stations. The vehicle schedule is not displayed, so the passenger cannot know the frequency of the line, nor the first and last passes of vehicles through the station. It is necessary to mention the times of the journeys through the station on all days, unless the intervals are sufficiently short, in which case the first 3 and last 3 journeys through the station and the frequency per hour interval shall be mentioned. It is recommended to implement electronic devices in the main stations to announce the time remaining until the arrival of the next vehicle, together with the development of a smartphone/tablet app to provide real-time information.The information can be made available in stages starting with tram and trolleybus lines and continuing with major bus lines. As a priority, it is recommended that the full schedules (all departures) for all lines be posted on the RATB website and drivers be encouraged to follow them. The passenger information system on the metro is effective.

3. Conclusions

The tram network is comprehensive but does not provide service at full capacity due to lack of priority in traffic, resulting in low speeds, lack of passenger comfort and reduced frequencies on some lines. The tram system does not directly reach downtown destinations and does not provide cross-town service. In order for the tram system to operate under optimum operating conditions, it should have its own lanes on as long a section of the network as possible, be given priority at intersections (according to evaluations carried out in European research projects, it was found that giving priority to trams at intersections helps to improve the flow of all traffic, including cars), have a modern dispatching system and be equipped with modern means of transport.

Although the current bus and trolleybus systems provide extensive coverage of the city, there is no good integration with other modes of transport, but rather an overlap with them.

Some of the city's main squares, such as Unirii, Victoriei, Universității and Romană are particularly complex in terms of mobility and urban conditions, combining surface and underground public transport services and mixed urban functions.

The current residential on-street parking system in Bucharest cannot provide residents in densely built-up neighbourhoods with reserved parking spaces close to their homes. Given the large number of urban development planning proposals and regulations, mobility planning should be linked and coherent with urban development planning (and vice versa), so as to respond to accessibility, housing quality and environmental requirements. Public

transport system operating technologies fail to provide basic passenger information and safety features such as: on-board video surveillance, real-time passenger information systems, integrated dispatching system for all operators, schedule compliance - all of which should lead to increased trust and attractiveness of the public transport system with an impact in reducing individual car transport. The increase in the number of private cars, the lack of parking spaces both in residential areas and in the central area have led to a sharp deterioration of the pedestrian infrastructure, green spaces and the quality of public spaces in general.

Cycling is a means of transport that should be encouraged for short journeys of up to 5 km, and for longer distances it should be combined with public transport, with parking facilities at stations, transfer points and terminals.

It is recommended that the public transport network should benefit from several transport corridors with increased capacity, integrated with metro lines, which should be adapted to the volume and structure of transport demand in the areas concerned. Along these transport corridors, transfer points can also be established which, depending on the situation on the ground, provide an attractive link to some of the new, less accessible residential areas.

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