 https://doi.org/10.34135/sjpppa.230203

Aleksandar KOVAČEVIĆ[1]

THE ROLE OF INFORMATION – COMMUNICATION TECHNOLOGY IN TRANSPORT REFORMS: A CASE STUDY OF BELGRADE

Abstract
The ubiquity of the Information – Communication Technology – ICT has sparked significant interest in smart city initiatives. Smart transportation systems are integral to this concept. Our research explores its potential impact on transportation enhancements, notably in Belgrade. The central research question revolves around whether employing ICT in transportation can effectively address Belgrade's transportation challenges. Our study focuses on relevant scientific literature in areas like local democracy, public policy, and public administration about smart cities. Taking a multidisciplinary approach, we draw on insights from various disciplines, employing fundamental scientific methods including literature reviews, case studies, and comparative analyses. Our research begins with a descriptive analysis of prominent global smart city projects, particularly emphasizing transportation improvements. We explore intelligent transportation systems and their implementations in cities like Copenhagen, Vienna, and Barcelona. The data we gather forms the basis for crafting an intelligent transportation policy and instigating reforms in Belgrade, charting past and future transportation changes..

Key words: Smart cities, Intelligent Transport System, Local regulations, Information – Communication Technology, Belgrade

1 INTRODUCTION

The Fourth Industrial Revolution brings about considerable changes in many aspects of our lives. Although this revolution took place in the technological realm, we can attest to major changes in the social realm. As a result, social

1 Faculty of Political Science, University of Belgrade, Jove Ilića 165, 11042 Belgrade, Serbia, email: veran.stancetic@fpn.bg.ac.rs, ORCID iD: 0000-0002-5574-0132.

science research, particularly political science research, is quite fascinating in this topic. The major goal of this study is to combine both the technological and social realms by managing Intelligent transport systems in smart cities. In this article, we look at the smart city projects in Europe, particularly in Copenhagen, Vienna, and Barcelona, focusing on the development of intelligent transport systems in these cities. These examples might form the basis of a case study of the smart tool's deployment in Belgrade's transport management. So, the study topic is: whether employing ICT in transportation can effectively address Belgrade's transportation challenges. We begin with descriptive studies of smart city initiatives and smart transport and then move on to comparative analyses of best practices in transport reform in Copenhagen, Vienna, and Barcelona. Learning from the best practices of these cities might help us determine the direction of Belgrade's transport reforms. We also examine Belgrade's current position, municipal regulations, and the significance of citizen engagement in this sector.

2 SMART CITIES AND INTELLIGENT TRANSPORTATION SYSTEM

In modern local government, a democratic, decentralized, autonomous decision–making process and the concept of subsidiarity are essential. Democratization is an inescapable trend in modern society, and decentralized administration is more responsive to local life and people's needs (Komšić, 2019, p. 148). The subsidiary principle is defined by the European Charter of Local Self–Government as the preservation of public responsibility by those authorities closest to the citizen. Allocating responsibility to another authority should take into account the scope and nature of the assignment, as well as the needs for efficiency and economy (European Charter of Local Self–Government, 1985, Art. 4). Subsidiarity is defined by three principles: democratic involvement of people and consumers of public services; functionality and adaptability; inventiveness and rationality in spending public monies; and citizens' democratic potential (Đorđević, 2017, p. 14). Furthermore, subsidiarity is incorporated within EU legislation and entails that "in areas which do not fall within its exclusive competence, the Community shall take action, by the principle of subsidiarity, only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States and can therefore, because of the scale or effects of the proposed action, be better achieved by the Community" (Treaty of European Union, 1992, Art. 3b).

These principles are essential for grasping the concept of smart cities because smart cities demand democratic organization, smart and modern management, and leadership that inspires citizens and other stakeholders

to participate in the development of local public policies and quality public services (Đorđević, 2019, p. 361). It is hard to find a comprehensive definition of smart city. A smart city could be an established geographic area where advanced technologies like ICT, logistics, energy production, etc., collaborate to enhance citizens' well–being, inclusion, environmental quality, and smart development. This area is governed by a defined group of authorities responsible for setting rules and policies for city management and growth (Dameri, 2013, p. 2549). The essential elements of the smart city are a smart economy, smart people, smart governance, smart mobility, smart environment, and smart living (Giffinger, 2007, p. 114). To fully understand the involvement of citizens in decision–making, we need to first explain coproduction. Coproduction, in which the consumer of public services also participates in their provision, should be characterized as the citizen's contribution to the development of good public services. Consumers are not professional service providers, and their engagement is motivated by the desire to enhance service quality (Vamstad, 2012, p. 1175). The development of ICT encourages the coproduction process. We can now employ many smart tools to engage citizens in this process. As a result, all of the benefits of digitalization must be used to construct effective and efficient infrastructure. This infrastructure consists of various smart sensors, digital platforms and apps, e–government, and so on. Companies and people are included in the ecosystem of these digital platforms (Palleti, 2016, p. 148), which is implicit in the idea of co-production.

The reshaping of modern cities requires the human dimension of urban planning. The acclaimed Danish architect Jan Gehl advocates for eye–level cities. Twelve quality requirements may be combined into three: protection, comfort, and enjoyment. It is critical to establish risk protection before beginning any city planning. The next phase is to guarantee that public places are used properly for walking, standing, sitting, looking, talking, listening, and self–expression. Last but not least, good architecture and design must be prioritized over all other requirements (Gehl, 2010, pp. 238 – 239). A process of Dubaization that insists on the development of the largest and tallest skyscrapers is the opposite side of the human dimension (Alraouf, 2006, p. 25). Because this process upsets the human dimension, it is critical to encourage urban planners and architects to create lively, safe, environmentally friendly, and healthy cities (Gehl, 2010, p. 6) that promote good governance, the use of smart tools, and green mobility as vital characteristics of modern cities. Social scientist especially from the field of political sciences insists on the human dimension and citizen’s participation in urban planning. We call that process urban politics that might be seen “as concerned with politics in urbanized communities. Politics is a widespread activity that occurs in all arenas where human beings are engaged in the production and reproduction of their lives. It involves conflict and cooperation,

leading to the raising and resolution of issues through collective decision–making" (Stocker, 1998, p. 119). The new dimension of urban politics is the smart city initiative, with a special emphasis on the human dimension in urban planning.

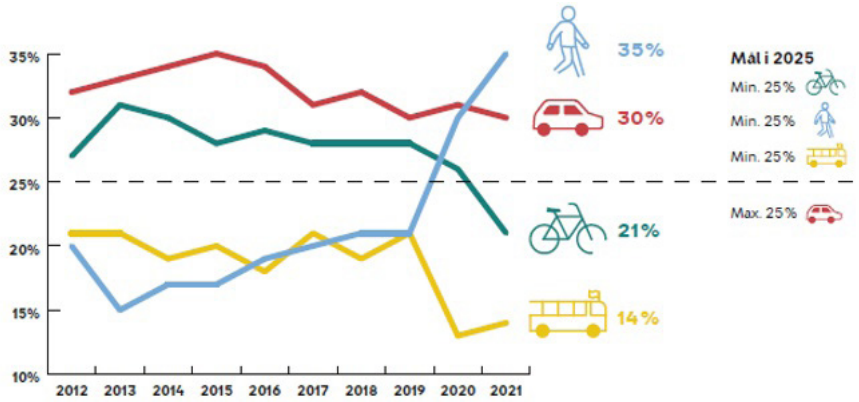
The development of an intelligent transport system is the most essential issue in this study. We begin with a definition of smart mobility as a vision of mobility that prioritizes the well–being of citizens, involves all stakeholders, and seeks to create a more sustainable urban transportation system. This vision aims to enhance overall urban efficiency and, most importantly, the quality of life for residents, often through the integration of cutting–edge technologies and extensive data analysis (Cavar Semanjski, 2023, p. 22). On the one hand, there is the techno–centric component of mobility with a focus on the technology part of mobility, and on the other hand, there is the consumer–centric aspect with a focus on the role of people in the building of smart and urban environments (Papa and Lauwers, 2015, pp. 543 – 546). Intelligent transport systems are built on four pillars: shared mobility, automated mobility, electric mobility, and integrated mobility (Finger and Audouin, 2019, pp. 3 – 5). Shared mobility is an innovative transportation approach that combines ride–sharing, bike–sharing, ride–on–demand, and other services (Cohen and Shaheen, 2018, p. 9). The customer utilizes self–driving vehicles that are more efficient, economical, and environmentally friendly in automated mobility (Fagnant and Kockelman, 2019, pp. 169 – 172). Electric mobility encourages electric or hybrid cars to reduce the use of fossil fuels and the greenhouse effect (Biresselioglua, Kaplanb, and Yilmaza, 2018, p. 2). The final pillar is integrated mobility, which is described as mobility as a service as a digital distribution model that combines various transportation choices, allowing users to plan, choose the best option, and make bookings and payments through a mobile app (Finger and Audouin, 2019, p. 5).

Intelligent transport systems are closely linked to the development of sustainable urban mobility, which is one of Europe's most significant policies. We must distinguish between traditional planning and sustainable urban mobility planning, which underlines the human component and the participation of many stakeholders in this process. As a result, the Sustainable Urban Mobility Plan is a strategic document that member states are encouraged to implement (Rupprecht Consult, 2019, p. 9). SUMP is a type of local public policy that focuses on mobility and transportation. Furthermore, according to the concept of subsidiarity, this is a fundamental right of local self – government and under this principle, "national or international government bodies (e.g., the EU) may only set basic standards" (Kovačević, 2023, p. 33). SUMP implementation necessitates ongoing supervision and evaluation, which may lead us back to the starting point when we examine the established policy. As a result, during the coproduction process, we assess the attitudes of all stakeholders before deciding to begin the next policy cycle.

3 COMPARATIVE ANALYSIS OF COPENHAGEN, VIENNA AND BARCELONA

From a comparative standpoint, transport reform is one of the most fascinating issues. We utilize examples of best practices from three European cities for this study. We are concentrating on two crucial issues: these cities' transport models and ICT's role in transport reform. Although these cities represent three distinct European traditions, we must examine the best results and implement them in the case study of Belgrade. Before we begin the examination, we need to discuss the many indications that placed these cities on the smart city map. We utilize two distinct indexes to describe the positions of these cities. Firstly, the Smart City Index for 2023 covers five categories: health and safety, mobility, activities, opportunities, and governance. These are separated into two groups: structures and technology. Copenhagen ranked fourth in this index. We will identify the category of mobility for this study. The primary cause of concern for Copenhagen residents is traffic congestion, nevertheless, they are satisfied with public transportation. Modern technology, such as online scheduling and ticket sales, improves public transportation. Car–sharing applications, bike hire, parking space apps, and traffic congestion information on mobile phones, on the other hand, are significant but not vital to responders (IMD World Competitiveness Center, 2023, p. 73). Vienna was ranked 28th in the world.

Figure 1. The share of different transport modes and aims for 2025 in Copenhagen



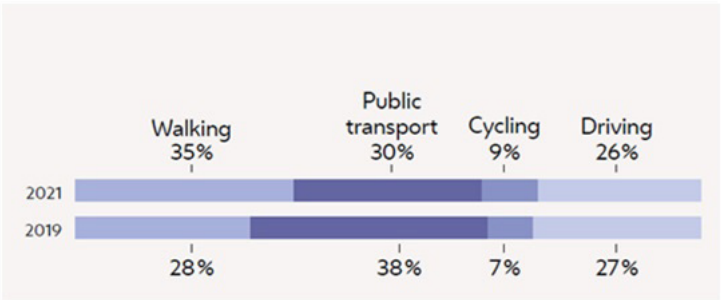
Source: Københavns Kommune, 2022, p. 6.

The main source of concern for Vienna residents is also traffic congestion; nonetheless, they are happier with transport systems than Copenhagen residents. Online scheduling and ticket sales, for example, improve public transit. According to 56.5% of respondents, the city provides traffic congestion

information via mobile phones. Car–sharing apps, bike hire, and parking space apps are important but not critical to respondents (IMD World Competitiveness Center, 2023, p. 168). Barcelona came in 75th place in the world. The primary cause of concern for Barcelona residents is traffic congestion, but they are generally pleased with the public transportation system. Bike hiring, online scheduling and ticket sales, and traffic congestion information via mobile phones are all crucial to mobility. Respondents consider car–sharing and parking space applications to be important but not critical (IMD World Competitiveness Center, 2023, p. 46).

The next important problem is transportation modes. We can differentiate between motorized and non–motorized means of transportation. Non–motorized means of transportation are by definition environmentally friendly; however, we may also include public transportation in this category. The Commission of European Communities issued the "Green Paper: Towards a New Culture for Urban Mobility" paper in 2007, which encourages walking, cycling, and public transportation while arguing for a reduction of private automobile usage in traffic (Green Paper: Towards a New Culture for Urban Mobility, 2007, p. 6).

Figure 2. Distribution of the different transport modes in Vienna



Source: Bauer, Fendt, Lukacsy and Trautinger, 2022, p. 15.

Green mobility indicates the presence of cars with minimal levels of air pollution, such as natural gas vehicles, electric vehicles, hydrogen vehicles, and solar vehicles, in addition to walking, cycling, and public transportation. So, we discussed sustainable development in transport (Li, 2016, pp. 762 – 763). With a total share of 70%, Copenhagen maintains a consistent percentage of environmentally friendly means of transport. The city's goal is to raise the number of environmentally friendly means of transport to at least 75% while decreasing the total share of private cars to no more than 25%. The City of Vienna also has a consistent percentage of environmentally friendly modes of transport (74%). According to the European Commission's recommendations, the city ought to develop plans that support raising the total proportion of walking, cycling, and

utilizing public transportation by at least 80%, while reducing the use of private cars by a maximum of 20% (The City of Vienna, 2015, p. 4). Barcelona has a stable share of public transport (37.33%) and walking (34.35%), but a low share of cycling (2.28%). The usage of private cars is huge at 26.04%. The proposed scenario for 2024 is 35.27% walking, 41.25% public transport, 5% cycling, and 18.48% private vehicles (Ajuntament de Barcelona, 2022, p. 139). Barcelona's goal is to boost the use of environmentally friendly means of transport while decreasing the use of private vehicles.

The next important topic is the use of ICT tools in transportation and transportation management. As a result, we must incorporate the automated transport management system, which is one of the instruments in smart cities. The Cooperative intelligent transport systems (C – ITS) are the name given to this system. This system is Mainly focused on active road safety and traffic efficiency applications, aiding drivers in vehicle awareness, sharing road hazard alerts, and offering real–time traffic updates for speed control and navigation. C – ITS applications depend on constant vehicle–to–vehicle and infrastructure connectivity with frequent data exchange (Festag, 2014, p. 166). Intelligent Transport Systems are one of the essential EU reforms anticipated in the Directive 2010/10 of the European Parliament and Council on the framework for the deployment of Intelligent Transport Systems in the field of road transport and interfaces with other modes of transport (Directive, 2010/40, 2010, Art. 3). This Directive anticipates that standardization will be carried out by national or international organizations such as the European Telecommunications Standards Institute (ETSI). In this area, ETSI has produced a slew of distinct standards. It is important to note that ETSI has been carrying out this process since 2008 (ETSI, 2023).

Copenhagen participated in the EU project C – Mobile. This project envisages the development of the infrastructure that supports different technologies such as mobile internet, Wi–Fi (802.11p standard) that enables the citizens to use the advantages of this system (Ferrandez, Dajsuren, Karkhanis, Fünfrocken, and Pillado, 2018, p. 1). C – ITS logic incorporates user feedback as well as political feedback to guarantee that users' requirements are addressed. We have four packages that are divided into the following categories: urban efficiency, infrastructure–to–vehicle safety, traffic efficiency, and vehicle–to–vehicle safety (European Commission, 2017, pp. 1 – 3). The benefits of this system may be described by a cost–benefit analysis in which we have non–recurring expenses (infrastructure development) and recurrent costs (operational maintenance). We might also distinguish between two types of benefits: directly monetized (cost savings for road authority) and societal benefits (security, mobility, environment, and economics). Security is significant in the second and fourth packages, mobility and the environment in the first and third, and

economic benefit is essential in all packages (Mitsakis and Kotsi, 2017, pp. 7 – 8). During this project, Copenhagen implemented Cooperative Traffic Lights for Vulnerable Road Users (CTLV), Green Light Optimal Speed Advice (GLOSA), Road Works Warning (RWW), Road Hazard Warning (RHW), Green Priority (GP), and Warning Systems for Pedestrians (WSP). Copenhagen attempted to merge these smart technologies through one application called GreenCatch, which is accessible for Android and iOS users. The different delays caused by the problems with system functioning and, the corona pandemic limited this application. Although the Green Priority should be simple to implement, the authorities put Road Side Units (RSU) at intersections but not– Board Units (OBU) in vehicles, causing the system to malfunction (Araghi et al., 2021, pp. 43 – 45). Regardless, cost–benefit assessments revealed that benefits outweighed costs by 3.39 times, indicating that these reforms must be implemented (Mitsakis and Kotsi, 2018, p. 49).

Local authorities intended to replace obsolete traffic lights at 380 intersections. The project begins with the installation of ten smart traffic lights, which save travel time by two minutes during rush hour (Davies, 2016). It is also interesting to note that authorities have planned for Copenhagen to become a carbon–neutral capital by 2025 (see The City of Copenhagen, 2013, p. 13). The city's next challenge is a lack of parking. As a result, authorities decided to start overhauling this system by using smart parking options. In 2018, the city launched a smartphone application. Citizens may utilize this application to easily find parking spaces and pay for parking online (Copenhagen Solution Lab, 2018). In addition, the city created a smart parking system for the international airport. This parking lot features almost 11.000 parking spaces and several smart technologies, such as plate recognition, online payment, parking lot navigation, vehicle detection sensors, a pay station, and a mobile application (Copenhagen Airport, 2023).

Vienna and its Intelligent Transport solutions are the second city featured in the analysis. In 2006, the Austrian federal states of Vienna, Lower Austria, and Burgenland established the Competence Centre for Intelligent Transport Systems. This center is made up of the following specialized departments: research and development, Organisation, Technology, and Passenger Information. The primary goal of this center is to make transportation more efficient, safer, flexible, and environmentally friendly. The center's activities include traffic management support, traffic information collection, traffic data processing, and traffic service operation. The center created the AnachB smartphone application, which evaluates routes and travel times objectively for transportation, cycling, walking, driving, and combinations thereof across Austria using real–time data. AnachB also provides current traffic conditions, traffic web cameras, construction site information, diversions, and traffic news

(ITS Vienna Region, 2023). Because Vienna is world–renowned for its excellent public transport network, the government demanded changes to improve this service for citizens. So, in 2012, they began with multimodality in transport reforms with the Smile project and app. This app is part of the mobility as a service sector and allows users to plan routes and reserve various forms of transportation, including public transportation, regional rail, car–sharing, bike–sharing, and taxis, based on their needs. The application was finally shut down in 2014 (Audouin and Finger, 2019, p. 10). In 2017, the city established the WienMobile app. This application collects multimodal data and allows the integrated payment mechanism to function. The Austrian capital has become the benchmark for the implementation of system mobility as a service. This program differs from the previous one in that it provides access to various modes of transportation, various tickets, and service packages (Wiener Linien, 2023). At the EU level, Vienna joined the C – Roads initiative. The city roadways from the highway interchange to the city center were included in the pilot, with a total length of 17 km and 70 traffic lights. The pilot region needs to be outfitted with C – ITS infrastructure, which involves obtaining the appropriate equipment and replacing existing traffic lights; installing RSU (24 already installed); installing OBU (2 tramways already equipped); and so on (Pinkelnig and Gruber, 2022, pp. 8 – 9). Vienna also improved its parking facilities to reduce traffic congestion and pollution. The city makes use of advantageous technology based on the Internet of Things that may be used to determine if a parking space is empty or occupied. It is equipped with ten sensors that provide data to the platform (Smart Parking System, 2023). With almost 22,000 parking spots, Vienna Airport offers a smart parking system. Plate identification, online payment, parking lot navigation, vehicle detection sensors, a pay station, and a mobile application are all part of this system (Vienna Airport, 2023).

Barcelona is the next city that participate in the C – Mobility project. RWW, RHW, Emergency Vehicle Warning (EVW), Signal Violation Warning (SVW), Warning System for VRUs, GLOSA, Flexible Infrastructure (FI), In–Vehicle Signage (IVS), Probe Vehicle Data (PVD), and Motorcycle Approaching Indicator (MAI) are among the ten C – ITS services implemented by the city. These services include an area of 1050 square kilometers and are delivered via a single Android application to the main modes of mobility, including vehicles, motorcycles, cyclists, and pedestrians. Because the system was put in place during the epidemic, there were certain issues with its deployment (Araghi et al., 2021, p. 11). Regardless, the system provides substantial data that enhances the city's transit quality. It is vital to educate residents on the benefits of this system. The assessment findings for systems such as GLOSA and RHW, among others, are quite encouraging. GLOSA had a significant influence on the number of stops, with a 25% difference between baseline and treatment. Furthermore,

GLOSA results in 18% less energy consumed during acceleration and 21% less energy wasted during braking. Drivers can go through the intersection faster. GLOSA affects braking actions, with maximum deceleration values in the treatment being somewhat lower than in the baseline. There are also lower average speed numbers 100 and 150 meters before the stop line, which may imply earlier braking. The RHW service, on the other hand, has a good effect on the severity of braking. This indicates that the pace of treatment events is 2% slower than the speed of baseline events. This service is available throughout the city, on the ring road of the motorway, and other main routes in Barcelona (Araghi et al, 2021, pp. 13 – 28).

Barcelona built an application that used GPS sensors to track the movements of public transportation. These sensors are linked to a smart traffic light, which prioritizes public transit and emergency services. Smart traffic lights reduce traffic in real–time. The central device controls traffic lights by analyzing data from traffic magnetometer sensors with wireless capability. This approach is intended to reduce traffic congestion and pollution (Bibri and Krogstie, 2020, pp. 15 – 16). It is worth mentioning the Sentilo as vital to understanding the practical use of ICT in Barcelona. Sentilo is a component of the infrastructure that separates apps built to utilize information generated by the city and the layer of sensors installed across the city to collect and distribute this information. This initiative was launched by Barcelona in 2012. This is a cross–platform initiative that aims to share information between heterogeneous systems and integrate existing applications effortlessly (Sentilo, 2023). Intelligent transport systems are linked to three distinct apps: TMB Virtual, which utilizes mobile phone cameras to guide residents to the most appropriate public transport; Trànsit, which uses real–time traffic conditions to guide cars; and fassisApparkB, which assists drivers in finding open parking place, are among these applications (Bibri and Krogstie, 2020, p. 18). Barcelona implemented a smart parking solution. The city employs a basic sensor system to assist cars in finding parking spaces. Sensors are installed beneath parking spaces and have only one function: to determine if the space is empty or occupied. These sensors suggest the strong technical assistance of hubs that handle sensor data. Second, data must be sent from the hub to the drivers' devices to enable them to be appropriately guided. The city created the Smou app, which has more than 100,000 registered users. In addition, Barcelona provided the option to pay for a permit online (Stofan, 2023).

4 IMPLEMENTATION OF SMART TOOLS IN BELGRADE'S TRANSPORT REFORMS

This section of the research focuses on the incorporation of smart tools into Belgrade's transport changes. Following the logic of the research, which is presented from a comparative perspective, we begin with an analysis of the Belgrade transport model. Belgrade has a constant percentage of public transport at 48.6% while walking accounts for 24.1% and cycling accounts for 1%. Private cars account for 25.2% of all transportation. The situation is further complicated by the fact that motorized vehicles account for 74.9% of overall transportation. Although transportation models reveal that residents prefer public transportation, the large number of private cars on the roads may be explained by the fact that private cars are often single–occupant (18.7%) (Jović, Đorić, Čelar, Ivanović, Petrović, Kajalić, Stanković, Ranković Plazinić and Milanović, 2015, pp. 30 – 31). This situation indicates that Belgrade's streets are full of automobiles emitting excessive levels of pollution. Belgrade has a solid, although not environmentally friendly, transport system. Belgrade includes two eco–bus lines, the Vrabac electric vehicle in the city core, twelve tramway lines, and seven trolleybus lines. The rest of public transportation is provided by none-–eco–friendly buses (Gradsko saobraćajno preduzeće, 2023). Belgrade established a sustainable urban mobility strategy at the end of 2020, based on the following pillars: a constant share of walking of 25%; an increase in the number of bicycles of 4%; a high proportion of public transport of at least 48%; and a decrease in the share of private cars of at least 20% (Plan održive urbane mobilnosti, 2020, p. 137). SUMP also advocates for the use of smart gadgets in transport reform. As a result, the authorities developed a multimodality policy that would include several forms of transportation in the future. Belgrade signed a contract with Siemens in 2019 for flexible transport management at 322 intersections. The technique entails adjusting the length of red and green lights based on traffic density. This reduces traffic congestion by 10 to 15%. This approach also promotes tramways and public transport in general (Beo Info, 2019). The primary benefits of this system are quicker travel, fewer stops, and energy efficiency because the new system uses a smaller amount of energy. The Transport Department, in collaboration with commercial partners, creates a centralized unit to control traffic in the city. This system should operate traffic lights from a single location at the project's 322 intersection (Yunex Traffic, 2022). The Coronavirus pandemic delayed the project's implementation, and the first smart traffic lights were placed in 2020. In May 2023, the City Traffic Department continued this project by installing smart traffic lights at the intersection of Prince Milos and Nemanja streets (Beo info, 2023).

The Strategy of providing priority to public transportation at intersections with

smart traffic signals is another significant change in Belgrade. This approach may be classified into two types: active priority and passive priority. Active priority could be either unconditional or conditional, whereas passive priority tries to build signal plans that promote transportation along the corridor using smart traffic lights. The passive strategy is less flexible when it comes to increasing vehicle flows. Active prioritization strategies, on the other hand, are more flexible. Unconditional active strategy favors public transport at intersections, whereas conditional active strategy prioritizes public transport only if certain requirements and rules are completely satisfied, such as public transport delays about the timetable (Mošić, Vidović and Joksimović, 2022, pp. 49 – 50). The city authorities, in collaboration with private partners, are implementing an active conditional priority strategy in Belgrade's central center, on King Aleksandar Boulevard between Roosevelt and Resava Street. This system prioritizes tramways, and all trams on the three lines that run along this street have OBUs that, when paired with GPS, provide information about vehicle location.

Table 1. Results of the traffic studies

			private car		tramway	
		Length of the corridor (m)	Average journey (s)	Average speed (m/s)	Average journey (s)	Average speed (m/s)
Direction 1	Before	903	254	3.56	592	1.53
	After	903	248	3.64	345	2.62
Direction 2	Before	936	200	4.68	304	3.08
	After	936	192	4.88	270	3.47

Source: Mošić, Vidović and Joksimović, 2022, p. 52.

The technology tracks the vehicle as it approaches the intersection and sends information to the control unit through GPRS. The control unit changes the traffic signals to prioritize tramways while taking into account the impact on other vehicles. There are plenty of possibilities for prioritizing tramways, including extending the green traffic signal, reducing other active states, and including a specific phase for serving tramways. The traffic light management algorithm selects a prioritizing model based on the present scenario to maintain a balance between the time wasted by public transit and other traffic participants (Mošić, Vidović and Joksimović, 2022, pp. 50 – 51). The findings of traffic studies are shown in the table below. The average time of private traffic journeys is the same, although there are significant differences in public transportation's tramway subsystem. The overall time of the journey decreased by 42% while traveling from Rooswelt to Resava Street, but only 11% when traveling oppositely.

Following the presentation of the current transport reform initiative, we must make some recommendations to the Belgrade authorities. These recommendations are based on comparisons of Copenhagen, Vienna, and Barcelona. For this research, we shall offer two crucial proposals concerning transport modes and the use of ICT in transport improvements. In the beginning, Belgrade needs to develop a green transport package that includes sustainable urban development as well as environmentally friendly means of transport to minimize traffic congestion and air pollution. Also, Belgrade has to fulfill SUMP and enhance the proportion of its overall share of walking, cycling, and public transportation. The second suggestion is based on the use of various ICT tools in transportation. Belgrade's crossroads need to be modernized with smart traffic lights. As a result, Belgrade should join the European initiative and participate in various projects. Authorities need to create urban settings more intelligently to meet the human dimension of urban planning. This comprises the development of ICT services such as GLOSA, GP, OBU, RSU, RWW, RHW, GPS, GPRS, traffic cameras, and so on to enhance city traffic. As a result, the most important proposal for Belgrade is to establish the whole system and educate citizens on how to utilize it. We think that these technologies will increase citizens' safety, which is an essential goal in and of itself. Transportation changes must address the problem of safety. The municipality has to ensure the safety of the most vulnerable participants in transportation, such as pedestrians and bikers. We can increase safety by introducing smart transportation management systems that prioritize walking and cycling while also separating pedestrian and bicycle pathways from the road to reduce traffic accidents. The city should spend efforts that enlighten and warn citizens about the repercussions of violating traffic regulations. Citizens need to be comfortable on public transportation in two ways: safe vehicles, which are modernized eco–friendly vehicles, and user safety, which refers to discouraging criminal activity in vehicles through the adoption of panic buttons for drivers and passengers, as well as cameras.

The Intelligent Transport System is on the agenda for Belgrade and the Republic of Serbia. Although Belgrade initiated reforms, the current solutions must be improved. Parking signalization may be seen on city streets, but we cannot say that Belgrade has adopted smart parking. The public corporation "Parking Service" created an app that allowed citizens to find parking spots, pay with a deposit, credit card, or SMS, and obtain information about daily parking cards, vehicle removal, fines for unlawful parking, and so on (Parking Servis, 2023). Even though the app is established, customers have reported problems with the payment mechanism and a lack of recognition of different parking zones. In May 2023, Belgrade launched a public transport reform with a new payment system. The new transportation system began with the single termination of the contract with the private company when the city completely

took over the transportation charging system. The previous mobile app became unusable as a result. Meanwhile, a new app has been made available with more functions than the previous one, including the ability to pay for transportation. Additionally, mobile companies have made it possible to use their apps to pay for public transport usage in Belgrade. Though the initiative has received praise from officials, there is rising unhappiness among citizens, mainly because of the delays in public transportation. In the coming period, we may debate the new solutions and their implementation, as well as the system's benefits and drawbacks. We trust that the recommendation in SUMP will be guided by transport reform.

5 CONCLUSION

Modern cities require systematic improvements and the use of intelligent gadgets to offer a pleasant life for their citizens. As a result, a shift from traditional to sustainable urban planning that considers economic, environmental, and social factors is required. The use of smart tools in transport management and the development of intelligent transport systems are two critical features of smart cities. Local self–government is responsible for executing local policies that incorporate these new instruments. We can observe the implementation of the subsidiarity concept in transport management, both in the comparative cities and in Belgrade, where these sectors are under the sole supervision of local professionals. On the other hand, as shown in EU–level cooperation initiatives, this field needs collaboration with partner organizations to exchange experiences.

Comparing cities might offer useful practical examples for developing the Belgrade case study. These cities have nearly identical transportation difficulties, and to address them, they adjust their policies to the present state of affairs. We cannot expect Belgrade to become the bike capital that Copenhagen is, but promoting green mobility through infrastructure development could be the right response. Vienna is a world–renowned city for its public transport organization, and Belgrade may follow in its footsteps by encouraging the use of public transportation over private automobiles. Barcelona might be an example of rapid learning in the use of smart tools since research has shown that cities that opt to implement smart technology and educate their inhabitants have a high chance of success. Integrated intersection management from a single control center in Belgrade, with active conditional priority for tramways, is a very good approach that will reduce traffic congestion shortly. As a result, using smart transport solutions might be a long–term solution to many mobility difficulties in Belgrade. Authorities must engage in citizen education and include individuals in transportation planning to achieve greater success in this

area. It is necessary to modernize the public vehicle fleet with the addition of eco buses, increase the frequency of buses on busy lines, particularly during rush hours, develop multimodality, and favor new forms of transportation such as car–sharing and bike–sharing through mobility as a service system, which is one of the most important objectives of local transportation policies.

REFERENCES

1. AJUNTAMENT DE BARCELONA. (2022). Pla de Mobilitat Urbana 2024. Barcelona: Ajuntament de Barcelona.
2. ALRAOUF, A. A. (2006). The Emergence of New Urban Brand in the Middle East: Dubaization/Dubaification. In: Journal of Cultural Exchange (Kultur Austausch). 111/06 (Issue III), Page(s). 25 – 31.
3. ARAGHI, Y. et al. (2021). D6.4: Report on impact of C – ITS on surface transport system. C – Mobile.
4. AUDOUIN, M. and MATTHIAS, F. (2019). Empower or Thwart? Insights from Vienna and Helsinki regarding the role of public authorities in the development of MaaS schemes. In: Transport Research Procedia. 41, Page(s). 6 – 16, DOI: 10.1016/j.trpro.2019.09.003.
5. BAUER, R., FENDT, C., LUKACSY, M. and TRAUTINGER, F. (2022). Vienna in Figures 2022. Vienna: Statistics Vienna.
6. BEO INFO. (2019). Potpisan ugovor sa Siemensom o adaptilnom upravljanja saobraćajem. In: Beo info. [online]. Available at: URL https://rb.gy/f5mok [Accessed 5 October. 2023].
7. BEO INFO. (2023). Izgradnja sisteme za adaptilno upravljanje svetlosnom saobraćajnom signalizacijom. In: Beo info. [online]. Available at: URL https://rb.gy/6gtxu [Accessed 5 October. 2023].
8. BIBRI, S. E. and KROGSTIE, J. (2020). The emerging data–driven Smart City and its innovative applied solutions for sustainability: the cases of London and Barcelona. In: Energy Inform. 3, Page(s) 1 – 42, DOI:10.1186/s42162-020-00108-6.
9. BIRESSELIOGLU, M. E., KAPLAN, M. D, and YILMAZ, B. K. (2018). Electric mobility in Europe: A comprehensive review of motivators and barriers in decision-making processes. In: Transportation Research Part A: Policy and Practice. 109, Page(s). 1 – 13, DOI:10.1016/j.tra.2018.01.017.
10. CAVAR SEMANJSKI, I. (2023). Smart Urban Mobility: Transport Planning in the Age of Big Data and Digital Twins. Amsterdam – Oxford – Cambridge: Elsevier.
11. COHEN, A., and SHAHEEN. S. (2018). Planning for shared mobility. Chicago: American Planning Association.
12. COPENHAGEN AIRPORT. (2023). Parkering fra kun 499. – pr. uge*. In: Copenhagen Airport. [online]. Available at: URL https://rb.gy/kw54s [Accessed 7 October. 2023].

13. COPENHAGEN SOLUTION LAB. (2018). The Road to Smart Parking. In: Copenhagen Solution Lab. [online]. Available at: URL https://rb.gy/84r6r [Accessed 16 June. 2023].
14. DAMERI, R. (2013). Searching for Smart City definition: a comprehensive proposal. In: International Journal of Computer Sciences & Technology. 11 (5), Page(s). 2544 – 2551, DOI:10.24297/ijct.v11i5.1142.
15. DAVIES, A. (2016). Copenhagen's New Traffic Lights Recognize and Favor Cyclists. In: Wired. [online]. Available at: URL https://rb.gy/mpjb [Accessed 15 June. 2023].
16. DIRECTIVE 2010/40. (2010). Directive of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport, OJ L 207/1, 7.7.2010, p. 1 – 13.
17. ĐORĐEVIĆ, S. (2019). Smart policies and innovative services. In: The e – future of Cities. Between temptation of exponential growth of technology growth and concept of human cities. The book of proceedings. Belgrade: Faculty of Geography and Academy of Engineering Sciences of Serbia, Page(s) 361 – 374.
18. ĐORĐEVIĆ, Snežana. 2017. Primena principa supsidijarnosti u Srbiji. Beograd: FPN, Čigoja.
19. ETSI. (2023). Standards. In: ETSI. [online] Available at URL https://rb.gy/iiam1 [Accessed: 15 June. 2023.
20. EUROPEAN CHARTER OF LOCAL SELF–GOVERNMENT. (1985). Council of Europe, European Treaty Series no. 122, Strasbourg.
21. EUROPEAN COMMISSION. (2017). Grant Agreement number: 723311 (2017), Accelerating C – ITS Mobility Innovation and Deployment in Europe. European Commission.
22. FAGNANT, D. J. and KOCKELMAN, K. (2015). Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations. In: Transportation Research Part A: Policy and Practice. 77, Page(s) 167 – 181. DOI:10.1016/j.tra.2015.04.003.
23. FERRANDEZ, R., DAJSUREN Y., KARKHANIS, P., FÜNFROCKEN, M. and PILLADO. M. (2018). Modeling the C – ITS architectures: C – MobILE case study. In: 25th ITS World Congress. Copenhagen.
24. FESTAG, A. (2014). Cooperative intelligent transport systems standards in Europe. In: IEEE Communications magazine. 52 (12), Page(s) 166 – 172. DOI:10.1109/MCOM.2014.6 979970.
25. FINGER, M. and AUDOUIN, M. (2019). Introduction. In: Finger, M., and Audouin, M. eds., The governance of smart transportation system. Cham: Springer, Page(s) 1 – 10.
26. GEHL, J. (2010). Cities for People. Washington: Island Press.
27. GIFFINGER, R. et al. (2007). Smart cities – Ranking of European medium–sized cities. Vienna: Vienna University of Technology, Centre of Regional Sciences.

28. GRADSKO SAOBRAĆAJNO PREDUZEĆE BEOGRAD. (2023). Dnevne linije. In: Gradsko saobraćajno preduzeće. [online]. Available at: URL https://rb.gy/qxir7 [Accessed 18 June. 2023].
29. GREEN PAPER. TOWARDS A NEW CULTURE FOR URBAN MOBILITY. (2007). Brussels, Commission of European Communities.
30. IMD WORLD COMPETITIVENESS CENTER. (2023). IMD Smart City Index Report 2023. Lausanne – Singapore: IMD World Competitiveness Center.
31. ITS VIENNA REGION. (2023). Who we are? In: ITS Vienna Region Competence Centre for ITS of Vienna, Lower Austria and Burgenland. [online]. Available at: URL https://rb.gy/5v4fm [Accessed: 16 June. 2023].
32. JOVIĆ, J., ĐORIĆ, V., ČELAR, N., IVANOVIĆ, I., PETROVIĆ, D., KAJALIĆ, J., STANKOVIĆ, S., RANKOVIĆ PLAZINIĆ, B., i MILANOVIĆ, D. eds. (2015). Ažuriranje transportnog modela Beograda sa saobraćajnim istraživanjima karakteristika kretanja. Beograd: Saobraćajni fakultet i CEP.
33. KØBENHAVNS KOMMUNE. (2022). Mobilitetsredegørelse 2022. København: Teknik – Og Miljøforvaltningen.
34. KOMŠIĆ, J. (2019). Demokratija i dobra (samo)uprava. Beograd: Dan Graf.
35. KOVAČEVIĆ, A. (2023). The role of bike sharing in transport reform: learning from comparative experiences to develop a case study for Belgrade. In: Slovak Journal of Public Policy and Public Administration. Vol. 10. No. 1., Page(s) 29 – 46. DOI: 10.34135/sjpppa. 230102.
36. LI, H. (2016). Study on green transportation system of international metropolises. In: Procedia engineering. 137, Page(s). 762 – 771, DOI:10.1016/j.proeng.2016.01.314.
37. MITSAKIS, E. and KOTSI, A. (2017). Costs and benefits of bundled C – ITS services. The C – MobILE approach. In: Smart Cities and Mobility as a Service International Conference. Patras, Page(s) 1 – 8.
38. MITSAKIS, E. and KOTSI, A. (2018). D2.1 Ex – ante Cost–Benefit Analysis. C – Mobile.
39. MOŠIĆ, M., VIDOVIĆ N. i JOKSIMOVIĆ, I. (2022). Uticaj uvođenja prioriteta javnog prevoza na uslove u saobraćajnom toku. In: TESI at the crossroads. Proceedings. XIII International Conference on Traffic Engineering. Beograd: Saobraćajni fakultet, Page(s): 47 – 55. DOI:10.37528/FTTE/9788673954585/TESi.2022.02.
40. PALETTI, A. (2016). Co – production Through ICT in the Public Sector: When Citizens Reframe the Production of Public Services. In: Caporarello, L., Cesaroni, F., Giesecke, R. and Missikoff, M. eds. Digitally Supported Innovation. Lecture Notes in Information Systems and Organisation, vol 18. Cham: Springer, Page(s) 141 – 152.
41. PAPA, E. and LAUWERS. D. (2015). Smart mobility: Opportunity and threat to innovate places and cities. In: Real CORP 2015. Plan Together – right now – overall, From Vision to Reality for Vibrant Cities and Regions. Proceedings of 20th International Conference of Urban Planning and Regional Development in the Information Society, Vienna: CORP, Page(s) 543 – 550.

42. PARKING SERVIS. (2023). Aplikacija za plaćanje parkiranja. In: Parking Services. [online]. Available at: URL https://rb.gy/e84bt [Accessed 18 June. 2023].
43. PINKELNIG, A. and DAMARIS A. G. (2022). Annual pilot overview report 2021. C – Roads.
44. PLAN ODRŽIVE URBANE MOBILNOSTI. (2020). Skupština grada Beograda 34 – 833/20 – C.
45. RUPPERT CONSULT. (2019). Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan, Second Edition. Cologne: Ruppert Consult.
46. SENTILO. (2023). What is? In: Sentilo. [online]. Available at: URL https://rb.gy/6t9kx [Accessed 28 June. 2023].
47. SMART PARKING SYSTEM. (2023). New installation of NB – IoT sensors in Vienna. In: SPS. [online]. Available at: URL https://rb.gy/7y85x [Accessed 16 June. 2023].
48. STOFAN, D. (2023). 6 Smart Cities that get traffic control right. In: Good Vision. [online]. Available at: URL https://rb.gy/7a8df [Accessed 27 June. 2023].
49. STOKER, G. (1998). Theory and Urban Politics. In: International Political Science Review. 19 (2), Page(s) 119 – 129.
50. THE CITY OF COPENHAGEN. (2013). Action Plan for Green Mobility. Copenhagen: Technical and Environmental Administration.
51. THE CITY OF VIENNA. (2015). Urban Mobility Plan Vienna. Vienna: Urban Development Vienna.
52. TREATY OF EUROPEAN UNION. (1992). OJ C 191, 29.7.1992.
53. VAMSTAD, J. (2012). Co–production and Service Quality: The Case of Cooperative Childcare in Sweden. In: International Journal of Voluntary and Non–profit Organizations. 23(4), Page(s) 1173 – 1188, DOI:10.1007/s11266-012-9312-y.
54. VIENNA AIRPORT. (2023). Anreise & Parken. In: Vienna Airport. [online]. Available at: URL https://rb.gy/io8io [Accessed 16 June. 2023].
55. WIENER LINIEN. (2023). WienMobile app: Information. In: Wiener Linien. [online]. Available at: URL https://rb.gy/zbxmhu [Accessed 16 June. 2023].
56. YUNEX TRAFFIC. (2022). Around the World with Yunex Traffic: Serbia. In: Yunex Traffic. [online]. Available at: URL https://rb.gy/74fof [Accessed 18 June. 2023].