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THE DEVELOPMENT OF SMART TRANSPORT IN BELGRADE - WHAT CAN BE LEARNED FROM THE GOOD PRACTICE OF COPENHAGEN, VIENNA AND LJUBLJANA

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Abstract

Big cities confront several transportation concerns, including traffic congestion, air pollution, public transportation availability, and infrastructural issues. City governments must provide residents with the best solution to these problems. The goal of this study is to examine the development of smart transportation in smart cities. Smart transportation is the most significant functional feature of any smart city, as it provides high-quality, environmentally friendly transportation serving a specific population. It encompasses a variety of forms of transportation, including walking, biking, carsharing, and public transportation. This research focuses on the question of whether various modes of smart transportation can resolve Belgrade's persistent transportation problem. Firstly, we define smart cities, smart transportation, smart mobility, and sustainable urban mobility. The evolution of smart transport requires changes in spatial planning, which include monitoring people's mobility (sensors), and their (non-)retention in squares and other public places, and developing these locations to meet residents' demands. Secondly, we consult data on smart cities like Copenhagen, Vienna, and Ljubljana in order to develop the optimal scenario for our case study of Belgrade as a smart city in the transportation field.

Key words: smart cities, smart transportation, smart mobility; smart tools, air pollution

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РАЗВОЈ ПАМЕТНОГ ПРЕВОЗА У БЕОГРАДУ – ШТА МОЖЕМО НАУЧИТИ ИЗ ДОБРЕ ПРАКСЕ КОПЕНХАГЕНА, БЕЧА И ЉУБЉАНЕ

Апстракт

Велики градови се суочавају са бројним изазовима у превозу, међу којима су саобраћајне гужве, загађеност ваздуха, доступност јавног превоза и инфраструктурни проблеми. Градске власти треба да пронађу најбоље начине за превазилажење ових изазова. Овај рад се фокусира на развој паметног превоза у паметним градовима. Паметан превоз је најважнији функционални аспект концепта паметних градова, будући да представља квалитетан и еколошких прихватљив облик превоза. Он укључује различите облике превоза као што су пешачење, бициклизам, дељење возила и јавни превоз. Ово истраживање вођено је питањем да ли различити облици паметног превоза могу решити вишегодишњи проблем са превозом у Београду. Почињемо са дефиницијама концепата паметних градова, паметног превоза, паметне мобилности и одрживе урбане мобилности. Развој паметног превоза подразумева промене у просторном планирању које се ослањају на сазнања стечена праћењем кретања људи (путем сензора), њиховог (не) задржавања на трговима и другим јавним просторима, и укључују пројектовање јавних простора према захтевима грађана. Након тога, консултујемо податке о паметним градовима попут Копенхагена, Беча и Љубљане како би креирали најбољи сценарио за студију случаја града Београда као паметног града у области транспорта.

Кључне речи: паметни градови, паметан превоз, паметна мобилност, паметни алати, загађење ваздуха

INTRODUCTION

The notion of smart cities and its application in modern society are discussed in this paper. In our opinion, the most crucial functional feature of smart cities is a high-quality, accessible, and environmentally friendly transportation system serving a specific population. That is what we refer to as a 'smart transportation system'. In this research, we use some aspects of smart transportation systems, such as the existing transportation model and the role of ICT in transportation reforms, with examples of some implemented solutions. We pay special attention to transportation reform projects that emphasise the use of smart solutions and eco-friendly modes of transport. We also discuss the P+R system as one component of a smart parking solution. As a result, we explore the smart transportation system, and its implementation in several countries and cities as part of our comparative approach. We chose Copenhagen, Vienna, and Ljubljana as examples of successful transportation reforms. To construct a smart transportation system, we need to utilise a variety of digital tools and smart sensors. To bring the idea of a smart city to life, we must embrace all of the benefits of the Fourth Industrial Revolution. The main research question is whether various modes of smart transportation can resolve Belgrade's persistent transportation problem. To begin answering this research question, we con-

sider the idea of smart cities and the manner in which this idea is being implemented in various cities.

THE CONCEPT OF SMART CITIES

Cities as local governments gained prominence during times of crisis (beginning in the 1970s), when it became obvious that rising social issues needed to be handled locally. As a consequence, cities have become important developers of new policies and venues for the creation of new entrepreneurial institutions, tools, and work techniques (Đorđević, 2012, p. 173). However, a comprehensive description of the notion of the smart city is difficult to come by. As a result, a multidisciplinary approach is necessary. Academics have attempted to describe the smart city, but local governments have tried to put the idea into practise by constructing various prototypes or smart projects (Dameri & Rosenthal-Sabroux, 2014, p. 10). The difficulty in defining smart cities stems mostly from two factors. First, the difficulty stems from the meaning we assign to the word 'smart', which gives rise to phrases such as 'Intelligent City', 'Knowledge City', 'Wired City', and 'Digital City'. Secondly, the difficulty stems from a lack of understanding of the word 'smart'. (Cocchia, 2014, p. 18). Giffinger et al. (2007) identify six key characteristics of smart cities, including smart economy, smart people, smart transportation, smart environment, and smart living (Giffinger et al., 2007, p. 11). Dameri (2013) defines the smart city as:

> a well-defined geographical area, in which high technologies such as ICT, logistic, energy production, and so on, cooperate to create benefits for citizens in terms of well-being, inclusion and participation, environmental quality, intelligent development.
>
> (Dameri, 2013, p. 2549)

Đorđević (2019) identifies three key characteristics of smart cities: democratic organisation, smart and modern management, and leadership that engages people and other stakeholders in the development of public policies and high-quality public services (Đorđević, 2019, p. 362). It can be noticed, then, that one of the most important aspects of the notion of the smart city is the widespread use of various smart tools.

The Fourth Industrial Revolution is defined by the use of the mobile Internet, a variety of low-cost sensors, artificial intelligence, and chine learning (Schwab, 2016, p. 11-12). Schwab (2016) goes on to emphasise the emergence of many megatrends, the most important of which is the Internet of Things (IoT). IoT is defined by Haller et al. (2009) as:

> a world where physical objects are seamlessly integrated into the information network, and where the physical objects can become active participants in business processes.
>
> (Haller et al., 2009, p. 15)

People have gotten somewhat addicted to using smart gadgets in regular communication, as their whole lives have migrated to the Internet. Many of the issues encountered by cities, as shown in Figure 1, cannot be addressed without the deployment of technology breakthroughs. Moreover, digitalisation has substantial consequences for city operations.

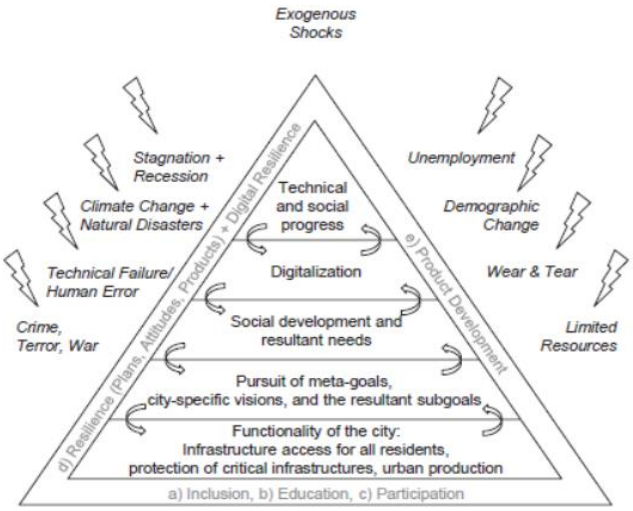

Figure 1. Challenges facing cities.
Source: (Etezadzadeh, 2016, p. 43)

How does digitalisation affect cities? First and foremost, cities need infrastructure that is both efficient and effective. Cities may therefore become more open, safe, and functional (Etezadzadeh, 2016, pp. 43-45). So, it is important to monitor who has access to this information in order to keep it safe.

SMART MOBILITY, SMART URBAN MOBILITY AND SUSTAINABLE URBAN MOBILITY

As previously mentioned, Giffinger et al. highlight the six most significant qualities of smart cities. Smart mobility has been facilitated by the development of infrastructure and the use of contemporary technologies in modern cities. This concept's key features are local and (inter-)national accessibility, the availability of ICT infrastructure, and sustainable, creative and safe transportation methods (Giffinger et al., 2007, p. 12). Smart mobility entails the construction of the necessary infrastructure to support various digital tools, followed by a radical change in the existing transportation system and the development of 'green' means of transport. Various authors claim that a smart transportation system lies within the following

four pillars. The first pillar is shared mobility, which is divided into at least four categories: carsharing, carpooling, e-hailing, and demand-responsive transportation. Automated mobility, as the second pillar, includes the process of equipping cars with various sensors (Lane Assist, Automated Cruise Control (ACC), Blind Spot Sensor, and so on) that can perceive the car's surroundings and respond in real time to prevent traffic collisions. Electric transportation, as the next pillar, entails the advancement of electric and hybrid cars (Audouin & Finger, 2019a, p. 4). Integrated mobility, as the last pillar, entails merging two or more separate public or private transportation services for travel purposes. As a result, the idea of Mobility as a Service (MaaS) has emerged, and it is described as:

> a digitally supported distribution model bundling several transport options together, and enabling the user to plan their trips, select the transport option that best suits their need, and finally book and pay for it via an app.
>
> (Audouin & Finger, 2019a, p. 5)

While smart mobility merits a multidisciplinary approach, there are comparatively few academic discussions or more extensive literature on this subject. This notion was a "buzz phrase in the planning and transport fields in the last decade", according to Papa and Lauwers (2015, pp. 543-546), who divided it into two phases: techno-centric and consumer-centric aspects of smart mobility. Smart urban mobility might be defined as "connectivity in towns and cities that is affordable, effective, attractive, and sustainable" (Lyons, 2018, p. 9).

The notion of 'smart mobility' is inextricably tied to the idea of sustainable urban mobility. The European Commission advises member states to adopt and implement the Sustainable Urban Mobility Plan (SUMP), as a strategic document aimed at satisfying people's and businesses' mobility demands in cities and their surroundings, with the aim of achieving a higher quality of life. Sustainable urban mobility is a proactive and comprehensive approach to addressing the many difficulties that arise in daily traffic. It aims to improve people's lives by making them more mobile. It entails the development of various forms of transportation in functioning urban areas with high workforce mobility (Rupprecht Consult, 2019, p. 9). This plan requires a very careful review of existing solutions, which completes the whole process of making public policies.

THE CONCEPT OF SMART TRANSPORTATION – LESSONS FROM COPENHAGEN, VIENNA AND LJUBLJANA

We examine alternative approaches to transportation reform from a comparative viewpoint. Copenhagen, Vienna, and Ljubljana are used in this study. We compare these three cities to Belgrade for numerous reasons.

Firstly, these cities are establishing a model by implementing smart solutions in transport reforms. Secondly, these cities are the capitals of and largest cities in their respective countries. Thirdly, with the exception of Ljubljana, these cities cover territories of approximately the same size, and their populations are nearly identical. In addition, Vienna and Belgrade are part of the group of Danube River cities and towns. Having been part of Yugoslavia, Ljubljana and Belgrade developed in the same manner for more than seventy years. Vienna has a long history of well-organised public transportation, and it might serve as a model for Belgrade's transportation reforms. Copenhagen is the most bike-friendly city in the world, and it is also trying to reduce air pollution. While Belgrade has a lot of problems with air pollution, especially in the city centre, the lessons from Copenhagen's transportation changes could serve as examples of best practises. Due to their similarities, these cities could serve as examples for transportation reform in Belgrade. In this study, we focused on three areas: 1) the transportation models; 2) the role of ICT in transportation reform; and 3) projects in transportation reform.

Before we begin our research, we must first note the global statuses of these cities. Copenhagen ranked 7th on the Smart City Index for 2021 (IMD World Competitiveness Center, 2021, p. 9). Copenhagen is ranked 6th on the Smart Mobility Synthetic Indicator, with a rating of 3.12 (Garau et al., 2016, p. 45). Vienna ranked 11th on the Smart City Index for 2021 (IMD World Competitiveness Center, 2021, p. 9). The Global Liveability Index for 2019 pronounced Vienna as the most liveable city on the planet (The Economist Intelligence Unit, 2019, p. 4). We can confidently state that Ljubljana is the smartest city in the area of the Western Balkans. Ljubljana was the European Green Capital in 2016. Furthermore, Ljubljana ranked 14th on the list of bike-friendly cities in 2019, with a total score of 57.1% (The Copenhagenizeindex, 2019).

Transport Models in Copenhagen, Vienna And Ljubljana

To begin with, we should explore the modes of transportation used in these cities. The differences across transportation models are shown in Figure 2[1]. According to our research, increasing the percentage of people using eco-friendly modes of transportation, including bicycling, walking,

[1] Figure 2 shows a comparison of the observed cities' transportation models. According to the figures for Copenhagen for 2019, the overall share of public transportation is 21%, the share of walking is 21%, and the share of cycling is 28%, while the total percentage of cars in all transportation is 30%. (The City of Copenhagen, 2020, p. 3). Official statistics for 2019 show that public transportation accounts for 38% of total transportation in Vienna, walking accounts for 30%, and cycling accounts for 7%, while private cars account for 25% (Bauer, 2020, p. 15). According to data from 2013, cars accounted for 41.5% of all transportation in Ljubljana, bicycles 11.1%, public transportation 12.6%, and walking 34.80 percent (Milovanovič, 2017, p. 15).

and modern public transportation, is a top priority for cities. Denmark's capital aims to be carbon neutral by 2025. Copenhagen's authorities have created a green transportation package that includes urban development and green transportation adapted to smooth traffic flow. They want to ensure that at least one-third of all transportation is done by bicycle, one-third by public transportation, and one-third by vehicle (The City of Copenhagen, 2013, p. 9).

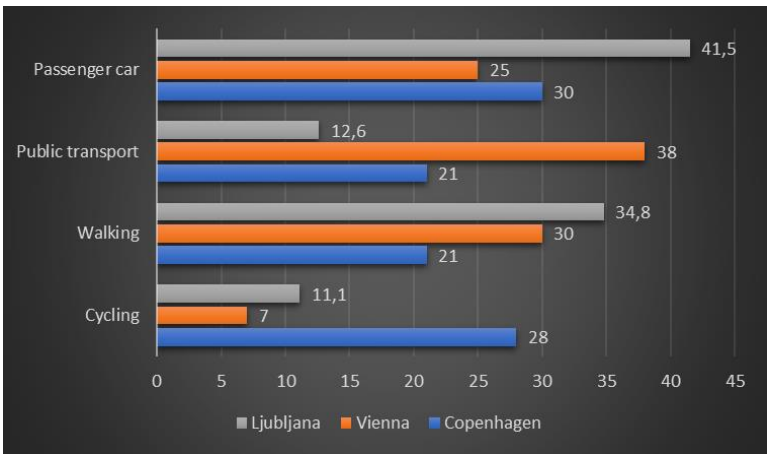

Figure 2. Transport model of Copenhagen, Vienna and Ljubljana

Vienna enacted a 2025 Urban Development Plan in 2014. This plan envisions Vienna as a liveable, socially equitable, gender-equitable, educational, cosmopolitan, wealthy, integrated, participative, and environmentally sustainable city. Thus, the primary objective should be the growth of public transportation, walking, and cycling, rather than an increase in the number of private vehicles (The City of Vienna, 2014, p. 24). Vienna approved a sustainable urban mobility strategy in 2015, and it includes a fair, healthy, compact, eco-friendly, robust and efficient mode of transport (The City of Vienna, 2015, pp. 19–24). In 2019, the City of Vienna approved the Smart City Wien Framework Strategy 2019-2050. As a result, they hope that 85% of all transportation will be eco-friendly by 2030 (The City of Vienna, 2019, p. 68).

The City of Ljubljana adopted the Urban Mobility Strategy in 2017, with the goal of increasing the proportion of environmentally friendly modes of transportation. Since 2003, the number of private vehicles has decreased significantly. This is a positive achievement, but it is insufficient in helping to achieve the carbon-neutral objective set by Copenhagen. The number of pedestrians has almost doubled, but the drop in the use of public transportation and a minor rise in cycling are concerning facts. To meet their target, which allows vehicles a maximum 33% share in all transpor-

tation and environmentally friendly modes of transportation a 67% share, Ljubljana has developed a strategy based on increasing the share of pedestrian, bicycle and public transport, and on decreasing the use of private cars in transportation (Milovanovič, 2017, pp. 19–21).

The Role of ICT in Transport Reform

The importance of ICT in the transportation reforms in these cities is the second major topic of this paper. ICT play a critical role in the Copenhagen transportation overhaul. Copenhagen has created a central unit that monitors 360 traffic lights, and prioritises buses and bikes, enabling them to move freely (The City of Copenhagen, 2013, p. 19). Copenhagen participated in EU C-Mobile application initiative to regulate traffic flow. This software tells users how fast they need to ride their bike or drive to get through the green light at the next traffic light. The software is completely hands-free, and gives information in the form of visual or audible signals. This project entails creating a C-ITS (Cooperative Intelligent Transportation System) infrastructure that supports a variety of technologies, including mobile internet and wireless internet access in cars (802.11p standard), and allows a large number of people to take advantage of these services (Ferrandez, 2018, p. 1).

Vienna has used ICT to modernise its transportation system, and has built the first intelligent traffic light in Meidling, near the school, so as to improve transportation safety, particularly for pedestrians. This traffic light uses a camera with software equipped to identify the pedestrian's desire to cross the street, and sends a signal to the traffic light to change the light to green (Wien zu fuss, 2019). In addition, the city intends to replace 200 push-button traffic lights, particularly in school zones (Liceras, 2019). Since 2016, Slovenia has been a member of the large European project C-road. The primary goal of this project is to gather real-time traffic data. The pilot location is on the portion of Highway A1 between Postojna and Divaca. Nine roadside ITS stations (RSUs), and an additional mobile roadside ITS maintenance vehicle were placed along the motorway. The motorway company installed the RSUs linked to the central ITS station (C–ITS back office) at the DARS Maintenance and Control Centre Kozina (Štern, 2021). They created the mobile application Traffic Plus, which uses the 3G/4G cellular network to facilitate data interchange between connected vehicles and the Cloud. Users may now receive and send traffic information and signalling using this programme, which has been modified to serve as an On-Board Unit (OBU) (Štern, 2021).

Different Transport Modes and Projects in Transport Reform

The third crucial factor is the development of various modes of transportation and initiatives in transportation reform. Copenhagen – A Cyclist City is a comprehensive policy prepared by the city authorities, meant

to be implemented between 2011 and 2025. The Bycyklen, which was the first large-scale bike-sharing system in Europe, serves as the basis for this plan. This system was first implemented in 1995, with the introduction of 1,000 specially constructed bicycles and eight bike racks, and it has now grown to include over 2,000 bicycles and 110 bike racks. It is part of the coin–deposit system (Shaheen et al., 2010, p. 160). During 2013, this system encountered a lot of problems. In October 2014, the city launched a new CityBike programme based on the IoT, which included the use of electric-assisted cycles with inbuilt GPS trackers and tablet computers on the bicycles' handlebars (Behrendt, 2016, p. 159). The main goal of this policy is to build a bike superhighway called a 'cycle highway', where commuters' needs are the most important (Sekretariatet for Supercykelstier, 2020).

Copenhagen provides a variety of options for reducing the use of private cars in transport. It is important to note that Uber, the world's best-known ride-sharing service, does not operate in Copenhagen. Copenhagen developed the P+R system, which enables car owners to park on the outskirts of the city and travel by public transportation. Copenhagen participates in the EU-funded carsharing programme through the smartphone application Share Now. In 2019, the Share Now application was formed by the merging of Car2Go and DriveNow. Over 500 vehicles from various manufacturers, including Mercedes-Benz, BMW, Mini, Fiat 500, Smart, and electric vehicles, are available via Share Now. Value-seeking, convenience, lifestyle, and sustainability are four motivating patterns identified by Schaefers (2013, pp. 73–75). Danish researchers noted considerable support for the utilitarian goal of being more flexible without a vehicle, which is the driving force behind carsharing. On the other hand, environmental considerations are often emphasised as a benefit, but not as the primary motivation (Garret et al., 2020, p. 16).

Vienna's public transportation system is one of the best in the world. As a result, the city of Vienna spends heavily on the modernisation of transportation. The city has begun work on the implementation of ideas involving mobility as a service (MaaS). The SMILE project (which stands for "Simply MobiLE") was launched in 2012 by the Austrian Federal Railway Company (BB) and Wiener Stadtwerke. Due to the cessation of public support and the competing interests of the corporation that led this application, this project concluded by the end of 2014 (Audouin & Finger, 2019b, p. 9–10). In 2015, Wiener Stadtwerke established Upstream, a start-up subsidiary that debuted the WienMobil app in 2017. It provides customers real-time integrated schedule information as well as information on potential delays, allowing them to travel by public transportation without difficulty (Li, 2019, pp. 238–239). The carsharing system Car2Go has been operating in Vienna since December 2011, offering consumers over 1,000 different types of Mercedes, BMW, Mini, and Smart cars to choose from. This system allows one to choose and book a vehicle using a smartphone app, and

pay for each minute of driving at a reasonable rate (Hudak, 2016, p. 4). In addition, Uber operated in Vienna for a time. Uber ceased operations in the summer of 2019 due to a lawsuit accusing them of offering transportation services without the required licences (Wolf, 2019).

The incorporation of bicycles into Vienna's public transportation system was first proposed in the early 1990s. However, there was not enough political will or financial assistance in the 1990s to carry out this project. In 2002, the private ViennaBike organisation launched a bicycle-sharing programme, but it did not survive long due to considerable losses. The CityBike system launched in May 2003, with 50 stations. In 2015, there were 121 stations and more than 1,500 bicycles available, and Gewista records more than a million rides every year (Laa & Emberger, 2020, p. 150). In Vienna, an effort was made to build a free-floating bike-sharing system (FFBS), but the system ran into various issues such as poor parking, low-quality bikes, vandalism, and the exploitation of parking places for privately owned bicycles (Laa & Emberger, 2020, p. 151). Finally, the city of Vienna strengthened its bicycle sharing regulations in 2018. According to these rules, each bicycle must be authorised and registered by the city, whereupon it is given a unique identity number. Shared electric scooters are another transportation innovation in Vienna. In 2018, the first shared e-scooters debuted in Vienna. Currently, there are six distinct e-scooter service providers. These operators use scooters licenced by the city, and given a unique licence plate (Radics, 2020, p. 2).

The bicycle sharing system is Ljubljana's most important contribution to the development of eco-friendly transport. The BicikeLJ system is the outcome of a public-private cooperation between the city of Ljubljana and Europlakat. It began operating in May 2011, with 30 stations and 300 bicycles. There are now 73 stations and 730 bicycles in the BicikeLJ, with plans to expand the network (Mestna Občina Ljubljana, 2021). The BicikeLJ allows Ljubljana's residents and visitors to hire bicycles at self-service terminals located throughout the city centre and in P+R facilities (Bauchinger et al., 2021, p. 12). In collaboration with Zagreb and Bratislava, Ljubljana joined the EU-funded URBAN-E project. This initiative seeks to promote e-mobility, multimodal transportation, and green transportation in metropolitan areas, with a focus on reducing CO_2 emissions (URBAN-e, Outline of the Action, 2017). As part of this project, the first public mini-hub for charging electric cars was built in March 2019 (Mestna Občina Ljubljana, 2019).

Ljubljana is currently implementing a project of 12 EURBAN electric cars as an eco-friendly mode of transport, which was first tested on public transport in 2016. This initiative began on the city's rural eastern outskirts, and then extended to include the adjacent rural roads. During low service timeslots, customers were picked up and brought to normal bus stops. The services are charged in the same manner as ordinary public

transportation, and are the same price as a single bus journey. The small number of passengers was a concern with this approach (Bauchinger et al., 2021, p. 12). For tourist trips, Ljubljana debuted the Urban Electric Train in 2016. Also, small electric cars, known as 'Cavaliers', were introduced to carry people in the pedestrian zone (Betterlifestyle Team, 2016). Avant2go, Slovenia's first MaaS carsharing system, was established in 2016 by the cities of Ljubljana, Maribor, Kranj, and Murska Subota, in collaboration with Slovenian IT specialists and automotive firms. This system consists entirely of electric cars from a variety of manufacturers. Avant2Go's services are straightforward and transparent: users use a smartphone app to find an available car, reserve it, activate it, and return it to a parking area designated for these vehicles (Kogoj, 2018, p. 37). The lack of parking spaces was solved by converting some streets into one-way parking lots, which allowed people to park on the road. The city also implemented a system of preferential cards for residents, which has reduced the pressure on parking spaces caused by visitors. Ljubljana has launched an initiative to develop a P+R at the urban periphery, where drivers may leave their cars and use public transportation to reach their desired locations in the city (Milovanovič, 2017, pp. 40–41). The city created the Urbana Card, a contactless smart card that can be used to pay for public transportation, parking and several municipal services (Single City Card Urbana, 2021).

SMART TRANSPORT SOLUTIONS IN BELGRADE

Finally, we can discuss how smart transportation solutions can be implemented in Belgrade. In December 2020, Belgrade adopted the Sustainable Urban Mobility Plan (SUMP). Belgrade's data varies from that of the other cities in the sample because 49.93% of the city's transportation model is comprised of public transportation, 24.32% is comprised of passenger cars, 24.25% is comprised of pedestrians, and only 0.75% of the model is comprised of bicycles (Transport model of Belgrade, 2015). As a result, the development of Belgrade's plan as a bicycle city is now unattainable, since it requires a change in the habits of Belgrade's residents. However, in recent years, Belgrade's streets have seen an increase in the number of bicycles, particularly in the city's recreational areas. Thus, Belgrade's growth plan envisions bicycles and walking having a 30% overall share in the city's transport model, and the building of 100 kilometres of new cycling pathways (Sustainable Urban Mobility Plan, 2020, p. 57). Three scenarios are envisaged in this plan. The city has chosen the third scenario, which entails a complete reorganisation of the transportation system, with an emphasis on increasing the share of bicycles and walking, maintaining a stable share of public transportation, and decreasing the share of private motorised vehicles in total transportation (Sustainable Ur-

ban Mobility Plan, 2020, pp. 131–133). The SUMP envisions Belgrade as a city that is adaptive, sustainable, high-quality, logical, efficient, and tolerant. The campaign to implement this plan, called 'Belgrade on the move', rests on increasing walking (25%) and cycling (4%), maintaining a high proportion of public transport (48%), and reducing private cars in transport (20%) (Sustainable Urban Mobility Plan, 2020, pp. 137-138). Belgrade highlights the role of eco-friendly modes such as car and bike sharing, and electric cars, and, in the future, it will work to integrate these modes to decrease air pollution, which is at an all-time high. What is the best scenario for Belgrade?

The following Table provides proposals for all three of the mentioned areas. The city of Belgrade is in the early stages of introducing smart solutions. One of the innovations is the implementation of a P+R system, in which users with personalised Bus Plus cards who also own cars may use the system by registering on the parking service website. Other users may use SMS to pay for this service (Park and ride in Belgrade, 2021). This system is comparable to those used in other cities, although it has a few drawbacks. The first disadvantage is that customers who do not have a customised Bus Plus card will be unable to combine public transportation and parking. A similar card, which is currently in use in Ljubljana, may be a viable alternative. The fact that these services are restricted to a single area – the city's cultural and commercial centre, which is located near the city centre, is another negative aspect. Furthermore, despite the fact that these facilities are well linked to other parts of Belgrade, there are no alternative eco-friendly modes available. As a consequence, Belgrade should follow the example of the observed cities in formulating a solution to this problem. Since 2019, seven electric cars have been integrated into public transportation in Belgrade's core pedestrian zone, only one of which is suited for handicapped people. This mode of transportation is comparable to Ljubljana's Cavalier system. Belgrade has launched a park and bike system, which enables users to rent a bicycle for the same fee charged for parking (Park and cycling in Belgrade, 2021). The biggest benefit of the system is the convenient location of these facilities, but its downside is that it is not part of the bike-sharing system. Finally, Car: Go (a Serbian counterpart of Uber) is an active ride-sharing application in Belgrade that was designed as a smart transportation system in smart cities. Belgrade has traffic management systems that integrate a variety of sensors to manage traffic congestion. These systems should be similar to Copenhagen's, with a central control unit that handles traffic lights and prioritises eco-friendly modes of transportation. At the end of last year, Belgrade began the creation of a bike-sharing system. The plan is to build 150 public bicycle racks and 100 km of bicycle paths (Danas Online, 2021). As a result, we can advise municipal officials to draw on the rich expertise of other communities in order to execute the most cost-effective solution for their inhabit-

ants' requirements. Many of Belgrade's transportation problems might be solved by consulting this expertise.

Table 1. Recommendation for transport reform in Belgrade

Transport models	▪ construct a green transportation package that comprises sustainable urban development and eco-friendly forms of transport adapted to reduce traffic flow and air pollution; ▪ increase the percentage of walking, cycling, and public transportation in the overall transportation system.
The role of ICT	▪ development and enhancement of mobile applications that provide real-time transport information to citizens; ▪ intelligent transportation management systems that promote environmentally sustainable means of transport; ▪ smart bus stops for public transport.
Different transport modes and projects	▪ establishment of a bike-sharing programme; ▪ deployment of mobility as a service; ▪ public authorities providing incentives to encourage the use of electric vehicles in transport; ▪ expansion of park-and-ride and park-and-bike networks; ▪ the development of a Belgrade city card that may be used for public transport, parking, admission to museums and theatres, etc.

CONCLUSION

Smart city initiatives are spreading rapidly all over the globe. The creation of smart transportation systems using ICT is one of the most important advancements. Cities are opting to implement green solutions in transportation reform in the face of severe climate change, induced by the greenhouse effect. As a result, the cities investigated in this research aim to enhance their use of eco-friendly modes of transportation. They boast major achievements in this process, dependent on the prior status of transportation, infrastructure, and people's habits and social backgrounds. As a result, all attributes should be considered while developing smart solutions. Copenhagen and Vienna, for example, have a long history of using cycling as a form of transportation. Ljubljana, on the other hand, has a strong preference for cycling and smart carsharing. These cities are attempting to limit the use of private cars in their transportation systems. Belgrade is in the early stages of developing smart solutions.

The SUMP is a new document that covers important topics. Belgrade's advantage is its high proportion of public transportation in overall transportation. Belgrade must preserve its market share and improve its transportation system by adopting cars that run on ecologically acceptable fuels. Belgrade's drawback is its low percentage of bicycles. Therefore, we cannot predict whether it will become a bicycle-friendly city in the future.

However, great progress may be made in this arena by implementing bike-sharing systems and cycling infrastructure, such as bicycle routes and intelligent traffic signals that promote non-motorised modes of transportation. If Belgrade follows through on its plan, the overall percentage of bicycles in transportation might rise beyond the target of 4%. Belgrade has to come up with innovative concepts like carsharing, making electric car charging more convenient, and modifying the laws for vehicles in urban and green areas. If the offered remedies are implemented, Belgrade has the possibility of becoming the green capital. This means that building a new city today is impossible without digital tools and smart solutions.

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РАЗВОЈ ПАМЕТНОГ ПРЕВОЗА У БЕОГРАДУ – ШТА МОЖЕМО НАУЧИТИ ИЗ ДОБРЕ ПРАКСЕ КОПЕНХАГЕНА, БЕЧА И ЉУБЉАНЕ

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Резиме

Велики градови се суочавају са бројним изазовима у превозу, међу којима су саобраћајне гужве, загађеност ваздуха, доступног јавног превоза и инфраструктурни проблеми. Градске власти настоје да пронађу најефикаснија решења за ове проблеме, те да уведу паметне облике превоза. У паметне облике превоза убрајамо еколошки прихватљиве облике превоза: пешачење, бициклизам, дељење возила и реформисани јавни превоз. На самом почетку је потребно да дефинишемо концепт паметних градова. Паметни градови су јасно дефинисане географске области које се одликују демократском организацијом, модерним менаџментом који користи дигиталне алате у управљању и грађанима који учествују у креирању локалних јавних политика. Један од најважнијих аспеката паметних градова је паметна мобилност. Паметна мобилност почива на четири стуба: дељена мобилност, аутоматизована мобилност, електрична мобилност и интегрисана мобилност. Европска комисија препоручује државама чланицама усвајање Плана одрживе урбане мобилности којим се захтева увођење зелене агенде у систем транспорта, уз обавезно укључивање грађана и других заинтересованих актера. У анализу су укључени пионири у развоју концепта паметне мобилности као што су градови Копенхаген, Беч и Љубљана. Компаративна анализа укључује три важна аспекта: транспортни модел посматра-

них градова, улогу информационо-комуникационих технологија у реформи превоза, и различите облике превоза и пројекте у реформи превоза. Компаративна анализа транспортних модела показује усмереност анализираних градова ка увођењу еколошки прихватљивих облика превоза. Градови уводе паметне системе надзора и контроле над саобраћајем у циљу смањења саобраћајних незгода и гужви, и повећања безбедности на путевима. За потребе остваривања ових циљева развијају се различите мобилне апликације које повезују кориснике и паметне сензоре. Градови развијају еколошки прихватљиве облике превоза и приступају различитим пројектима у реформи превоза. Копенхаген је усмерен ка развоју бициклизма, те настоји да развија посебне путеве на којима бициклисти имају првенство пролаза. У циљу смањења употребе приватних аутомобила у превозу, Копенхаген развија и системе за дељење возила који укључују углавном електрична возила. Са друге стране, Беч посебно инсистира на функционалном јавном превозу, уз неизоставно дељење возила, и на систему градских бицикала и електричних скутера. Љубљана такође развија систем дељења бицикала, али и систем посебних електричних возила која превозе путнике од руралних делова града до регуларних аутобуских стајалишта. Такође, у Љубљани је имплементиран посебан систем дељења возила који је дело стручњака из Словеније.

Град Београд је на самом почетку имплементације паметног превоза, те је потребно доста времена не би ли се извукле лекције из богате европске праксе. Београд је крајем 2020. године донео План одрживе урбане мобилности, којим је дефинисан правац развоја града у наредном периоду. Транспортни модел Београда одликује се великом заступљеношћу јавног превоза, те развој паметног превоза треба усмерити у том правцу. Београд се не може похвалити великим бројем бицикала у превозу, пре свега због конфигурације терена и навика грађана, те се бициклизам не може развити у оном облику у ком се развија у другим градовима. Београд треба да настоји да смањи употребу приватних возила у превозу уз промовисање еколошки прихватљивих облика превоза.