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THE ROLE OF BIKE SHARING IN TRANSPORT REFORM: LEARNING FROM COMPARATIVE EXPERIENCES TO DEVELOP A CASE STUDY FOR BELGRADE

Abstract
Many issues confront modern cities that can only be addressed locally. Cities are developing strategies that combine new solutions and mobility to properly execute the concept of Smart Cities. One conceivable answer is a bike-sharing system. This study incorporates the comparative experiences of Copenhagen, Vienna, and Ljubljana to provide a case study on the implementation of a system in the city of Belgrade. As a result, the research question is: would the deployment of a bike-sharing system in Belgrade solve the city's various transportation problems? This article opens with an overview of Smart Cities and Smart Mobility, as well as a look at the history of bike-sharing systems. The paper then goes on to analyze the strategies and solutions utilized in other cities before finally outlining Belgrade's reactions and reactions in this process.

Key words: Smart City; Smart Mobility; Bike-sharing System; Comparative Approach; Belgrade's Case Study

1 INTRODUCTION

The modernization of cities entails the introduction of many services that will make citizens' lives less difficult. Cities have recently opted to pursue the smart city idea. The development of bike-sharing systems is one of these services that is more commonly connected with the smart city idea. This paper starts with a research question: would the deployment of a bike-sharing system in Belgrade solve the city's various transportation problems? In this article, the bike-sharing concept will be analyzed, beginning with a brief overview of the relevance of bike-sharing and its relationship to smart cities and urban mobility. The idea of bike-sharing in cities is included in an analysis of local public policy. In the

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context of bike-sharing, urban politics is very fascinating. Therefore, this study will employ all scientific methods as well as the comparative method. Data will be gathered through the analysis of the written contents of key policy papers and case studies.

This study starts with a brief overview of the smart city and urban mobility concepts, followed by a brief history of bike-sharing. The primary goal is to link this issue to shared mobility, which is a crucible for urban mobility and the intelligent transport system. Also, it will examine diverse experiences from Copenhagen, Vienna, and Ljubljana to create a case study for Belgrade's bike-sharing system deployment.

1 A BRIEF HISTORY OF BIKE-SHARING

City officials acknowledged the value of public bicycles as early as the mid-1960s. The creation of "White Bicycles" in Amsterdam, the Netherlands, in 1968, marked the beginning of public bicycle use. These bikes were specially colored to stand out from regular bikes. The problem with the first generation of bike-sharing was misuse, in which people abused the system by throwing bikes into canals or using them for personal gain. The second generation of bike sharing began in small Danish cities in 1991. Because these programs were tiny, the first large-scale bike-sharing system was established in Copenhagen in 1995. These bikes are diligently developed, and they may be picked up and returned at certain places for an affordable price. The third generation of bike-sharing systems is smart bikes, which users may pick up and use throughout the city by taking advantage of smart technology. Initially, the system consists of electronically secured racks or bike locks, a communication system, and on-board computers. The first examples of the third generation were Bikeabout at Portsoy University in England in 1996, Vélo à la Carte from Rennes, France, in 1998, and Munich's Call a Bike in 2000. JCDecaux introduced the first and largest third-generation bike-sharing service in Lyon in 2005. Two years later, Paris launched its bike-sharing plan, and so on. Until the end of 2009, there were more than 120 third-generation bike-sharing systems (DeMaio, 2009, pp. 42-43).

We are currently in the fourth generation of bike-sharing. This system, known as a free-floating or dockless bike-sharing system, is relatively new and allows bikes to be locked to any standard bicycle rack, removing the need for expensive stations. This technology minimizes bike theft and misuse while also allowing for smart management (Pal and Zhang, 2017, p. 93). Bikes can be located, hired, locked, or unlocked via a smartphone app. The dockless approach provides a more flexible bike-sharing plan. These solutions are more efficient, accessible, and cost-effective, as well as sustainable and environmentally friendly[2]

2 Each generation of bike-sharing has achieved technological advances: the first without a locking

(Boor, 2019, p. 2). The introduction of modern technologies in bike sharing has shifted development away from Europe. The founding of Ofo in China in 2014 represented the beginning of this system. Mobile is one of the many operators who follow Ofo. Now, Ofo and Mobike are the major operators and the only ones that operate on a large scale globally (Boor, 2019, p. 11).

According to research, bike-sharing systems are available in 1.590 cities in 92 countries on every continent except Antarctica, indicating that they are expanding worldwide. Figure 1

Figure 1. Active bike-sharing systems in August 2022 by type

Type	# of systems
Dock-based	**1134**
Free-floating	**393**
Dockless hubs/bays	**226**
N/A	**63**
Hybrid (Dock and free-floating)	**62**
Hybrid (Dock and hubs)	**18**
Secure to street furniture	**13**
Hybrid (Dock and park-beside-dock)	**5**
Grand total	**1914**

Source: The Meddin Bike-sharing World Map team, 2022, p. 7.

depicts 1.914 schemes with 8.967.112 bikes, including 194.351 e-bikes (The Meddin Bike-sharing World Map team, 2022, p. 4). We may deduce from the overall share of different generations of bike sharing that the fourth generation has not yet been fully implemented. Local governments opt to create bicycle stations while establishing the bike-sharing system, most often for system safety and potential abuses that happened during the system's development.

2 THE CONCEPT OF SMART CITIES AND SMART MOBILITY AND ITS IMPLICATIONS ON BIKE-SHARING

The concept of smart cities and smart mobility, as well as its implications for bike-sharing systems, is the next major topic. These ideas are fundamental to the discipline of urban politics, which is a pervasive activity that takes place in all venues where people are involved in the creation and reproduction of their existence. It entails conflict and collaboration, which lead to the emergence and resolution of challenges through collective decision-making (Stocker, 1998, 119). Smart cities, on the other hand, need democratic organization, smart and modern management, and leadership that allow citizens and other stakeholders to engage

mechanism, the second with a coin-deposit system, and the third with a card assessment system. The last generation began with the introduction of smart looks (Boor, 2019, p. 10).

in decision-making and the production of public services and commodities (Djordjevic, 2019, p. 361). A smart city may be explained as a well-defined geographical area in which modern innovations collaborate to benefit their citizens in terms of well-being, inclusion, participation, environmental quality, and intelligent development (Dameri, 2013, p. 2549). A smart economy, smart government, smart mobility, a smart environment, smart living, and smart people are all required for this city (Giffinger et al., 2007, p. 114). According to Urban Politics, the most essential feature of any smart city is the self-awareness of the individuals participating in decision-making, who are the partners of democratic government in discovering the best responses to citizens' demands (Kovacevic, 2023).

It is vital to focus on smart mobility and smart transportation systems before implementing a bike-sharing system. Smart mobility refers to a citizen-centered mobility vision embraced by all stakeholders for the development of a sustainable urban mobility system that enhances overall urban performance and the quality of life for its citizens via the use of big data and innovative technologies (Cavar Semanjski, 2023, p. 22). It belongs to shared mobility, which is, according to Finger and Audouin (2019, pp. 3-5), one of the four pillars of a smart transportation system. Shared mobility could be identified as an innovative transport reform that allows customers to have short-term access to a mode of transport. This system can provide three scenarios: roundtrip, one-way station-based, and one-way free-floating services[3]. Car sharing, bike sharing, and other low-speed forms of transportation are included in this system Transportation, land use, urban design, economic development, conservation, and climate action are all influenced by shared mobility. Bike-sharing is regarded as an innovative service in the field of shared mobility (Cohen and Shaheen, 2018, p. 9).

The rise in popularity of bike-sharing systems is closely linked to the development of green modes of transportation. Chris Bradshaw, a Canadian politician, and businessman, offered a green transport hierarchy that prioritises walking, cycling, and public transport while discouraging the use of private vehicles (Li, 2016, p. 762). Cycling is one of the most environmentally friendly modes of transport; hence, this reform involves promoting cycling and investing in the necessary infrastructure. The examples from throughout the world illustrate that it makes little difference whether cities are in the mountains, very cold, or very warm. The only thing that matters is that they have a "strong and dedicated bicycle

3 In the first scenario, different modes of transport are returned to their origins, while in the second scenario, they are returned to distinct, specified station locations. In the third scenario, the possibility of returning to any location within a geographical region exists (Cohen and Shaheen, 2018, p. 9). The first scenario seems to be associated with the first generation of bike-sharing. In contrast, the second scenario is likely to be associated with the second and third generations of bike-sharing. In this case, we have two options for unlocking bikes: coin deposit and card. The final scenario is related to the fourth generation of bike-sharing programs.

culture" (Gehl, 2010, p. 182). The most important aspect of a cycling strategy is traffic safety. So, the first step is to build a cohesive cycling network secured by curbstones and parked vehicles. The second phase is to improve cyclist's perceived and actual safety at city intersections, which may be accomplished by the use of colored cycling lanes, cycle symbols, specific light signals, and ongoing education about the significance of bicycle safety on the roadways (Gehl, 2010, pp. 185-186).

Cycling plans are unique local public policies that are closely linked to Sustainable Urban Mobility. SUMPs are important local strategies in transportation planning in modern cities. This plan reflects an important transition from traditional planning, which included only traffic experts and architects, to sustainable planning, which involves citizens and other stakeholders (Ruppert Consults, 2019, p. 9). The adoption and implementation of this Plan are exclusively the responsibility of the local government. Under the principle of subsidiarity, national or international government bodies (e.g., the EU) may only set basic standards.

3 CYCLE STRATEGIES AND BIKE-SHARING SYSTEMS IN EUROPE

The many projects for bike-sharing systems in various cities throughout the world are discussed in this chapter. To increase this type of mobility, different concepts from various cities will be discussed. Copenhagen will be the first city considered in the comparative analysis. Copenhagen is the best-known city in the world for establishing a cycling strategy. To fully understand this phrase, we must first explain some crucial facts regarding Copenhagen's cycling history. The city's first cycling track was constructed at the end of the 19th century to tackle the friction between bicycles and horse-drawn carriages. Since this time, the city has made significant investments in the growth of cycling, which became more obvious during the 1960s. The city now boasts a well-developed network of bike paths. In addition, traffic lights for bikes have been placed, giving them priority over motor vehicles. Also, certain inner-city roadways have speed restrictions (30km/h or 50km/h) that allow for eye contact between cars and bikes, increasing their safety (Freudendal-Pedersen, 2015, p. 601). The city has developed several cycling initiatives. In its 2002 cycling strategy, the city not only influenced cycling infrastructure and safety through an extensive network of cycle lanes, cycle traffic lights, and cycle parking spaces, but it also raised questions about how cyclists felt safe and how cycling contributed to a vibrant urban atmosphere and urban spaces. It could also be said that Copenhagen's usage of cycling is defined more in terms of everyday life on the move than in terms of possible risks for cyclists because of the spread of motorized vehicles (Jensen, 2013, pp. 252-253).

At the beginning of the 2010s, the city administration created Copenhagen: A Cyclist City, a comprehensive strategy that runs from 2011 to 2025. The fact that around 150.000 Copenhagen residents ride their bikes to work or school each day facilitated the creation of this strategy (City of Copenhagen, 2011, p. 9). The bicycle share of trips to work and education inside municipal boundaries increased from 41% in 2016 to 49% in 2018. Copenhagen is currently only one percentage point away from meeting its goal of having a 50% bicycle share by 2025 (City of Copenhagen, 2019, p. 6). Since this time, the overall number of cycle trips to work and education has decreased significantly. According to the most recent data, the city is 15% away from achieving the objective of 50% cycle travel to work and education. Cycling's appeal has decreased as a consequence of the increased attraction of motorized modes of transportation as well as the adoption of other modes of transportation such as car sharing or electric vehicles. Regarding the bicycle share of overall transportation, the city decides to set lower targets and settles on a share of 25%. It is positive that there has been a rise in walking, which is also a green mode of transportation. A steady proportion of 21% of cycling demonstrates that Copenhagen remains a model of effective cycling development practice (Københavns Kommune, 2022, pp. 6-7).

The creation of bicycle superhighways is another significant initiative in Copenhagen. A cycling superhighway is a cycle route where the requirements of commuters are given top priority. The Capitol Region's bike superhighways are a cohesive network of cycle lanes that provide a safe, smooth ride with fewer stops and better safety, providing an alternative to driving on routes greater than 5 km (Sekretariatet for Supercykelstier, 2020). A cycle superhighway must have the following features: (1) accessibility: a good connection of residential, business, and educational areas, as well as public transit, to improve the chances of those who combine cycling with other modes of transportation; (2) directness: the quickest way between work and home for commuters; (3) comfort: making cycling a pleasant experience; and (4) safety: increasing safety and ensuring good conditions to reduce the risk of bicycle accidents (Sekretariatet for Supercykelstier, 2019, p. 12). There are three possible scenarios for this strategy. The present cycle path is referred to as the base scenario. Scenario 1 is now in development, while Scenario 2 is expected to be completed by 2030, and Scenario 3 is planned to be completed by 2045. The planned infrastructure for such scenarios will enhance the current bicycle network. A completely new infrastructure is also suggested, such as a new bicycle connection (bridge) across Copenhagen Harbour (Hallberg, Rasmussen, and Rich, 2021, p. 402). Cycling as an everyday routine and the hazards associated with cycling are two sides of the same coin. The local administration must find a way to bring these two sides together. Nowadays, we can discuss the implementation of services such as Cooperative Traffic Lights for Vulnerable Road Users (CTLV), Green Light Optimised Speed Advisory

(GLOSA), and Green Priority (GP) in Copenhagen, which is designed to prioritize cycling. Although there are certain issues with this system, we can conclude that Copenhagen has taken an enormous step forward in improving cycling safety (Araghi et al., 2021, pp. 43–45).

In January 1995, Copenhagen established the first large-scale bike-sharing system in Europe, called Bycyklen. This initiative included 1,000 specially designed bicycles that were placed all around the city at the designated city bike rack (eight at the beginning). The Bycyklen has continued to operate with more than 2,000 bicycles and 110 city bike racks. This system belongs to the second generation of bike-sharing known as the coin-deposit system. The main components of this system are (1) different bicycles, usually by color and unique design; (2) a designated docking station in which bikes can be locked, borrowed, and returned; and (3) a small deposit to unlock the bikes (Shaheen, Guzman, and Zhang, 2010, p. 160). This system had significant issues in 2013. The city launched a new CityBike program in October 2014, developed using the Internet of Things and including electric-assist bikes that have embedded a GPS tracker and tablet computer on the handlebar (Behrendt, 2016, p. 159). The new system was part of the fourth generation of bike sharing. Because the original owner and founder of Bycyklen went bankrupt in 2017, the City and Commuter Bike Foundation became the owner of this system 2017. During the preceding period, the company worked hard to build a lucrative and financially viable business, and the system has been profitable since Foundation took over. Operating grants have expired, and there is no way to renew the agreement with municipalities or continue as an advertising-financing system; thus, the board of the bike-sharing system decided to declare bankruptcy in December 2022 (Bycyklen, 2023).

Vienna is the next city examined in this study. We need to look at many strategic documents to comprehend how cycling is used in transport improvements. Analyzing the development of bike infrastructure is crucial to comprehending how cycling has changed in Vienna. In the 1970s, there were just 11 kilometers of cycle paths in Vienna. Following this time, the city's cycle routes started to be built. Cycling started to appear in transportation master plans in the 1980s, initially as a form of recreation and then as a mode of transport. These results in a major lengthening of the cycle paths, which measured around 1.350 km in 2016 (Knoflacher, Frey, and Leth, 2018, p. 5). Vienna's cycling network is growing all the time. Nowadays, there are 1,654 kilometers of various cycling routes, including multipurpose lanes, cycleways, cycle lanes, cycle pathways, integrated pedestrian and cycle paths, and traffic-calmed zones. Additionally, a lot of one-way streets allow cyclists to go in both directions (City of Vienna, 2023a). With a total share of 74% in 2021, Vienna will have a constant number of environmentally friendly means of transport. Bicycles account for 9% of the overall transportation share (Bauer, Fendt, Lukacsy, and Trautinger, 2022, p. 15).

The important document is the eight-pillared Vienna cycling manifesto: (1) encouraging peaceful coexistence characterized by fair road sharing and peaceful interpersonal interactions with a focus on improving Vienna's traffic culture; (2) more and better infrastructure that creates future-oriented public spaces and favors active mobility; (3) speed reduction for greater safety to support cycling and improve the lives of citizens; (4) effective protection against theft; (5) using bicycles as a connecting element for effectively integrating various modes of transport and developing intermodal routes; (6) reaching out to new target groups; (7) developing bicycle-friendly cities; and (8) positioning Vienna as a pioneer for the advantages of sustainable mobility and cycling promotion among its workforce (Gerlich, Lorenc, and Prukner, 2013, pp. 8-9). Another important strategic document in Vienna is the Sustainable Urban Mobility Plan (SUMP). SUMP specifies the following six goals: (1) fair: street space is allocated to different users and modes of transportation fairly; (2) healthy: increase in the share of active mobility, such as walking and cycling; (3) compact: reduction in the distances traveled between work, home, and leisure activities; (4) eco-friendly mobility: a change in the transport model with an emphasis on the increase in walking and cycling; (5) robustness: less air pollution; (6) efficiency: using new technology and resources as efficiently as possible (City Council of Vienna, 2015, pp. 19–25). The "Smart City Vienna Framework Strategy," adopted in 2022, emphasizes the importance of cycling. The strategy encourages environmentally friendly modes of transport to account for 85% of overall travel by 2030. This includes promoting active mobility, constructing infrastructure, and making suggestions to federal authorities to change legislation, develop policy instruments, and support various active mobility initiatives (Deistler et al., 2022, pp. 55–59).

The idea of incorporating bicycles into the Austrian capital's transport system dates back to the early 1990s. However, there was no political will or financial support for the project's realization. In 2002, the private association "ViennaBike" launched a bike-sharing system. There were around 230 stations in the city center where users could unlock one of the 1,500 bicycles for a deposit of 2 €. This system belongs to the coin-deposit system, which is the second generation of bike sharing. Despite the local authorities support for this project, the association chose to end the contract at the beginning of 2003 due to severe losses, such as bicycle theft. In 2003, a station-based bike-sharing system was launched in Vienna. Since then, the bike-sharing system has grown steadily. The system begins with 50 stations located within the city center. In 2015, there were 121 stations and over 1500 bicycles after the third spreading. Every year, Gewista, which was chosen in a bidding process for this system, records over a million rides. The website contained information about the station. Registration required a bank account card, credit card, cell phone, or specific Citybike card (Laa and Emberger, 2020, p. 149). Since 2022, Winner Linien's new WienMobile

bike-sharing system, operated by Nextbike, has started to operate. This system has about 200 stations and 3,000 bicycles available every day of the week in all 23 districts of Vienna. There is also the option of 50 digital stations that can be set up temporarily, for example, for events. The WienMobil bike has seven gears and an integrated electronic frame lock. The bike may be found using GPS and borrowed and returned at pre-determined physical and digital stations (City of Vienna, 2023b). To take advantage of the city bicycles, users need to complete these steps: download the app and register; scan the QR code to unlock the bike; drive off; park; and pay. When the user completes the drive, the loan immediately ends when the frame lock is locked and is billed straight through the app (Wiener Linien, 2023). This system is part of the new Smart City strategy and belongs to the fourth generation of bike sharing. Through the companies Ofo and Greenride-Bike, there have been some attempts to develop a free-floating system for sharing bicycles. Donkey Republic, a corporation that symbolizes a hybrid of systems, also functioned in Vienna for a time. Greenride-Bike is a Viennese company, while Ofo is a Chinese company that began operations in Vienna in 2017. Due to a policy change that restricted the number of bikes accessible and made these businesses' operations unprofitable, they were pushed out of operation. The authorities, on the other hand, saw unauthorized parking and abandoned bicycles, the removal of which was the city's obligation, as troublesome. Donkey Republic is a Danish company that used public bike stations, which caused an issue for the city even though this was allowed by law. Even though this company viewed bicycle accreditation as an important matter, it continued to operate in Vienna (Laa and Emberger, 2020, pp. 150–152). However, looking at their website now, we can deduce that the Austrian capital is not on the list of places where this system functions.

Ljubljana is the next city in our study. The city has accomplished the most in terms of transport reform in the area of the former Yugoslavia, and as such, it may serve as a model of outstanding practice. To comprehend Ljubljana's progress in this area, strategic documents concerning the implementation of smart solutions are examined, with a focus on environmentally friendly means of transport. As a result, the Integrated Transport Strategy from 2017 is examined below. The biggest issue in Ljubljana is the large proportion of environmentally unsuitable modes of transportation, which comprised 41.5% of private car use in transportation in 2013. Although this is a considerable decline from 58% in 2003, it is still necessary to work on decreasing this amount. As a result, Ljubljana's goal is to increase the number of environmentally friendly modes of transport to 67% by 2027, with bicycles accounting for 16% of the total (Milovanovič et al., 2017, p. 19). These objectives are reasonable and adhere to the strategy documents adopted by the other two cities. The Sustainable Urban Mobility Plan is built on four pillars: (1) increased walking; (2) increased cycling; (3) increased use of public

transportation; and (4) reduced use of private cars in transportation (Milovanovič et al., 2017, p. 21). Strategies for improving cycling will be provided for this study. The plan's operational goal is to raise the number of cyclists by 10%. To accomplish this goal, the city needs to build new infrastructure. The five critical aspects of the cycling network's continuity, directness, attractiveness, safety, and comfort maintain the quality of cycling infrastructure. To improve traffic and living conditions, Ljubljana wants to increase the use of bicycles and minimize the use of private vehicles in daily traffic. The city needs to build a high-quality network of bike paths. The authorities recognized that the bicycle infrastructure in some areas is inadequate or even dangerous. Another difficulty for the city is the potential for regional connectivity between cities. Ljubljana should invest in this project and support the combination of cycling and public transportation for mobility. The popularity of cycling and the entire share of cycling in transport are the next challenges. The city stated that the usage of private cars has increased in recent years; therefore, it is vital to encourage individuals, particularly employees and young people, to use bikes. This issue could be overcome by creating a high-quality bicycle infrastructure and changing citizens' habits. SUMP proposed four strategic goals: (1) a higher proportion of cyclists in traffic and a higher share of routes taken by bicycle; (2) improved cyclist accessibility; (3) a higher share of cyclists from neighboring municipalities in the Ljubljana Urban Region; and (4) the provision of cyclist-supporting infrastructure (Milovanovič et al., 2017, pp. 26–29).

Ljubljana has made significant efforts to become a successful cycling city. Infrastructure investment has resulted in considerable improvements. Ljubljana has around 306 kilometers of cycle routes, which include cycle lanes on the road or pavement, separate cycle lanes, and paths shared by pedestrians and cyclists. On 123 one-way streets, cyclists are guided for about 28 kilometers in the opposite direction of motor traffic. More than 20 streets, spanning around 8 kilometers, have shared carriageways for vehicles and cyclists. On twelve streets, approximately 10 kilometers of cycling lanes are marked without a center line. In 2021, more than 240 new bike racks with a capacity of 600 bicycles were built, and three P+R terminals were outfitted with bike lockers, safe bicycle storage containers, and BicikeLJ urban bike rental stations (Koželj, Božič, Kontić Bezjak, and Sopotnik, 2022, p. 10). This infrastructure was built using funds from the Slovenian government, the city, and the EU through joint initiatives. This year will also see the development of new infrastructure as well as the reconstruction of existing infrastructure. Additional work on connecting multiple towns with bicycle lanes is also planned. The city intends to make further changes, such as better traffic signage for cyclists by marking new cycle areas and expanding or replacing ground markings in current cycling areas. In addition to installing additional bike racks throughout the city, the city built Ljubljana's first secure

public bicycle storage facility for approximately 100 bicycles in the garage at Kongresni trg, as well as four smaller secure mobile bicycle storage facilities at various locations. The city intends to launch an electric bike rental system, beginning with 17 locations spread over the city. Another notable occasion will be the establishment of the first cycle-only street, probably along the Ljubljanica River (Koželj, Božič, Kontić Bezjak, and Sopotnik, 2022, p. 26). Under the theme "Cycling the Change," the city hosted Velo-city 2022 in June 2022, a flagship event of the European Cyclists' Federation, and presented its recent success in improving cycling to a global audience of over 1,400 advocates, policymakers, city officials, industry leaders, researchers, and journalists. Ljubljana received the titles of European Green Capital in 2016, European Mobility Week in 2003 and 2013, and European Best Green Capital in 2021, besides organizing this event (Reibold, 2022).

In 2011, the first bike-sharing system, BicikeLJ, was established in Ljubljana. This system is the result of a public-private partnership between the city of Ljubljana and Europlakat, a subsidiary of the world-renowned French advertising conglomerate JC Decaux. At first, there were 300 bikes at 30 stations. The popularity of bike-sharing has grown, as has the quantity of bikes available. There were 580 bicycles at 58 stations in 2017, and almost 5 million bicycles were borrowed between 2011 and 2018 (Bauchinger, Reichenberg, Goodwin-Hawkins, Kobal, Hrabar, and Oedl-Wiesed, 2021, p. 12). There were about 8.78 million bikes rented by the end of 2021, 235.344 registered users, 63.823 active users, 80 stations, 820 bicycles, 1.602 bicycle stands, and 8 rentals of each bicycle every day (Koželj, Božič, Kontić Bezjak, and Sopotnik, 2022, p. 34). This system is almost entirely free to use, with two types of subscriptions: yearly for 3 € during all seasons, with an unlimited number of times and a restriction of 60 minutes each time, and weekly for 1 € during all seasons, with a limit of 60 minutes each time. An additional 60 minutes will cost 1 €, a second extra hour will cost 2 €, and the remainder will cost 4 € each (BicikeLJ, 2023). Because this system encourages short journeys, 99.9% of journeys are less than an hour long, with the average journey being 18 minutes (Koželj, Božič, Kontić Bezjak, and Sopotnik, 2022, p. 36). As a result, this system places as minimal a financial burden on its consumers as possible. The bike-sharing system with the use of some kind of smart lock system could be classified as the last generation of bike-sharing. Also, the benefits of information technology, such as the usage of a smartphone app for identifying bicycles, are utilized in this system, which unquestionably follows recent trends in bike-sharing.

4 CYCLE STRATEGY AND BIKE-SHARING IN BELGRADE

This chapter will look at the possibilities of incorporating cycling into

Belgrade's transportation system. Except in recreational areas, there is a tiny bicycle tradition in Belgrade. The terrain configuration in Belgrade is an essential concern, with several slopes and a lack of plains on which to ride a bicycle. If the city, on the one hand, and people, on the other, work together to improve their daily routines, this problem may be handled by using new electric bicycles that can tackle the climbs that exist in Belgrade. On the other hand, we need to develop bike paths before we can consider implementing a bike-sharing system. To fully understand Belgrade's position, we need to look at the transportation model and SUMP. Belgrade maintains a stable proportion of public transportation at 48.6%, with walking accounting for 24.1% and cycling accounting for 1%. Private automobiles account for 25.2% of total transportation. The fact that motorized vehicles account for 74.9% of total transportation complicates matters even further. Although transportation models show that inhabitants prefer public transportation, the high number of private automobiles on the roads may be explained by the fact that single-occupant private cars are common (18.7%) (Jović et al, 2015, pp. 30-31). As can be noticed, the proportion of bicycles is quite low, lending credence to the preceding statements. We cannot expect Belgrade to fully restructure its transportation strategy to promote the growth of bicycle traffic, but the city needs to strive for a greater proportion of bicycles in everyday traffic. Therefore, we shall offer the fundamental starting points of SUMP.

Belgrade adopted SUMP at the end of 2020, which is based on several pillars: (1) favoring walking while maintaining or increasing the share of walking to 25%; (2) favoring cycling and increasing the share of bicycles to 4%; (3) maintaining a high share of public transportation in traffic at a minimum of 48%; and (4) reducing the use of private vehicles to 20% (Plan održive urbane mobilnosti, 2020, pp. 137-138). SUMP anticipated: (1) development of the bicycle network (paths, lanes, parking lots); (2) improvement of existing cycling infrastructure; (3) implementation of the public bicycle system (Bike-sharing); (4) bicycle transportation in public transportation; and (5) promotion of cycling tourism, Eurovelo route implementation, and bed and bike. The installation of bike paths on selected streets, including Ustanicka, Surcinska, Mirijevski Boulevard, and Visnjicka, is a fast solution (Plan održive urbane mobilnosti, 2020, p. 140). The dynamics of bicycle infrastructure construction are expected to occur in three phases, with the following time frames: Phase I will run from 2021 through 2023. Phase II will extend from 2024 to 2028, while Phase III will span from 2029 to 2031. The building of 504.8 km of bicycle pathways is planned for these phases, with a project costing more than 30 million € (Plan održive urbane mobilnosti, 2020, pp. 155-156). The construction of bicycle paths is not going forward as planned, and journalists referring to a State Auditing Institution report point out that only 101 km of bicycle paths had been built in Belgrade by the end of 2021, accounting for only 36 km of the planned 259 km if we look at the period from

2016 to 2021 (Petaković, 2023).

The creation of a public bicycle system is the city's next project. Although the process has been postponed on numerous occasions, it can be said that its implementation started with the adoption of the SUMP. The city decided to find a private partner for this system. Before launching the call for public-private partnership, the city secured all relevant authorizations and documents and adopted the Decision to Establish a Public Bike System in Belgrade and the Bicycle Rental Station Installation Plan. The decision specifies that public bicycles may be put on public traffic zones (sidewalks, paths for pedestrians, and squares); public green spaces; and public usage places accessible to a large number of people. Stations to set up the public bicycle system include areas for parking, elements for unlocking and locking, an information panel, and devices and installations with IT solutions that enable communication with users, specifically bicycle borrowing and return, payment, and registration. A public bicycle is a vehicle having at least two wheels in the sense of road safety standards, with characteristics governed by general product safety requirements. It is specifically constructed and equipped for rental and usage in citizen transport, and it may be driven by the driver's power. A public bicycle can also be a pedal vehicle with an electric motor that has a top speed of no more than 25 km/h (Odluka o postavljanju sistema javnih bicikala na teritoriji grada Beograda, 2021, Art. 2-4). The Bicycle Rental Station Installation Plan considers the installation of 150 bicycle rental stations outfitted with the equipment specified in the previously mentioned decision. It intends to set up bike rental facilities in nine municipalities around the city (Plan mesta za postavljanje stanica za iznajmljivanje bicikala na teritoriji grada Beograda, 2021, Art. 2). The majority of the stations are planned to be located in New Belgrade, which is a reasonable solution given that this municipality is entirely located on a plain with wide boulevards and large spaces between blocks of buildings, making this type of transportation easier and more feasible.

For the establishment of a public bicycle system in Belgrade, at the end of 2021, the Secretariat for Transport of the City of Belgrade released a public call for a public-private partnership that includes concession components. The projected value of the concession is close to 5 million euros, with a concession period of 15 years. The contract calls for the construction of 150 stations containing 1,000 bicycles. The technical qualities of the stations and bicycles comply with the mentioned requirements. The private partner is responsible for developing a software solution, a website, and a mobile application. The concession specifies the timetable for establishing the public bicycle system. The private partner is required to begin delivering services within 30 days of signing the Public Contract, as well as develop the system's full capacity within 460 days. The concession requires that bicycles be borrowed and paid for via a smartphone app and that the pricing list be provided by the private partner and accepted by the public

one. Furthermore, no public partner funding is anticipated for the duration of the project (Secretariat for Transport of the City of Belgrade, 2021). Based on what has been exposed, we may assume that the concession states that the Belgrade bicycle-sharing system belongs to the latest generation. There are two offers: Smove SAS from France and a partnership headed by Helbiz from Belgrade, along with Helbiz from Italy, submitted for the public call. The committee chose Helbiz's offer with a concession fee of 11,750 million dinars as the most beneficial offer after thoroughly evaluating the alternatives (Odluka o izboru najpovoljnije ponude, 2022). Even though the most suitable bid was chosen 16 months ago, the Belgrade City Assembly did not accept the final drawing of the "Public contract for the management of the public bicycle system". The previous year was an election year; therefore, it might be one of the reasons for the delay in making this decision. More than a year has passed since the inauguration of the new Belgrade administration, and it is confusing why the assembly hasn't yet approved this concession, even though municipal authorities pledged that the system would be implemented by the end of 2022. Until the contract concludes, the private partner cannot carry out the concessionary activities, and Belgrade citizens cannot enjoy the benefits of using public bicycles.

CONCLUSION

All cities that begin the implementation of the smart city idea insist on the implementation of the Sustainable Urban Mobility Plan and, in general, a change in citizens" traffic habits. This study found that introducing a bicycle-sharing system, as well as increasing the percentage of bikes in total transportation, is one of the viable solutions with social, economic, ecological, and health advantages. Because of their positive and negative experiences with the adoption of this system, Copenhagen, Vienna, and Ljubljana are ideal examples for the city of Belgrade. Belgrade is still in the early stages of developing these policies since the SUMP will not be implemented until the end of 2020 and the integration of the city's public bicycle infrastructure has not yet begun.

SUMP is well-designed; nevertheless, its entire implementation must be improved. This approach demands greater flexibility on the part of local authorities. To begin the deployment of this system, the local authorities need to first sign the Public Contract with the selected private partner. Furthermore, they should continue to develop the network of bicycle pathways by, first and foremost, implementing SUMP's quick solutions. The city of Belgrade, as well as its citizens, should not be deterred by the terrain's layout because challenges may be addressed with the combination of excellent bicycles and quality cycling infrastructure. Belgrade, like Copenhagen, should allow bicycles to be transferred

via public transportation, and like Copenhagen and Vienna, it should build smart solutions and bicycle paths. Because Ljubljana is a model of excellent practice in many areas, Belgrade, like Ljubljana, should apply all constructive answers via the rapid growth of this system while still allowing for steady progress and extension. Based on what has been discussed, there can be no objections to Belgrade's strategic intentions; nonetheless, the main issue is a lack of political will to execute acceptable answers rapidly. Furthermore, one of the issues is financial because the development of cycling infrastructure in all phases necessitates a substantial sum of money, which, owing to the global financial crisis, postponed countless promising projects in the previous year. In conclusion, the introduction of a bike-sharing program will improve the transportation system while tackling several issues that are related to the existing situation.

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