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Bike-Sharing System in the Czech Republic and Foreign

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Abstract

This paper discusses the bike-sharing system in the Czech Republic and selected neighboring states. The current problem of deteriorating air quality is driving cities to implement an efficient, more environmentally friendly approach. One of them is introducing a system of shared resources - shared bikes, scooters, cars, and others. Our goal is to address the issue of shared bikes, which are already widely used worldwide. However, it is necessary to point out that it is essential to have the bikes appropriately distributed in the stations, and their collection during the night at frequented stations must be ensured. The paper aimed is to analyze bike-sharing systems in the Czech Republic and foreign countries in Middle Europe, primarily in the Slovak Republic. The bike-sharing system in the Czech Republic and Slovak republic was analyzed mainly. The Poland bike-sharing system was added. The analysis of the bike-sharing providers was based on the available data. Based on the results, we can conclude that two (three) primary providers are in the selected states. These providers have different ways of bike storage. The vast difference is the number of bikes in the chosen town with the same population.

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1. Introduction

The United Nations drew attention to humanity's economic, social, and environmental problems. As a result, the Sustainable Development Goals (SDGs) were established, where 17 goals were set to address current issues and to be

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resolved by 2030. (United Nations, 2023) The goal is the involvement of companies, organizations, and individuals to support solutions to the problem of sustainable development. One of the goals is to create inclusive, safe, resilient, and sustainable cities and towns. This goal includes sustainable transport systems, including improving road safety. This goal also mentions reducing the adverse environmental impacts on cities and their inhabitants, with a focus on air quality. Emphasizing the environmental aspect of individual modes of transport should be an essential aspect of the transport policy of an advanced society. (Dvorak et al., 2020) Another plan aims to build resilient infrastructure, promoting inclusive and sustainable industrialization and innovation. The aim is to develop high-quality, reliable, sustainable, and resilient infrastructure to be modernized and equipped by industrial enterprises by 2030 to be sustainable, use resources more efficiently, and be environmentally friendly. (United Nations, 2023; Larina et al., 2021) There it is necessary to mention the significance of the functioning of the critical infrastructure system. As mentioned, the infrastructure must be resilient. However, it can be disrupted by negative influences and threats from the external and internal environment. Such failures are then reflected in negative impacts on other critical infrastructure elements or directly on the protected interests of society, i.e., the security of the state, the economy, and the population's basic needs. (Rehak and Novotny, 2016) Splichalova et al. (2020) mentioned an example of infrastructure disruption and its impact on transport in the case study.

Transport is an important area that directly affects the country's economy. (Poliak et al., 2021) And rapid development in transport causes adverse effects on the environment. Transport accounts for almost a quarter of Europe's greenhouse gas emissions and is the main cause of city air pollution. (European Strategy for low-emission mobility, 2016) In 2020, the European Environment Agency published a publication (Europe Towards Zero Pollution) stating that transport is responsible for 45% of Europe's nitrogen oxide (NO₂) emissions and a significant proportion of total emissions of other key pollutants. It also states that suspended particulate matter (PM), nitrogen dioxide (NO₂), and ground-level ozone (O₃) are the pollutants that cause the most significant damage to human health and the environment in Europe. The primary sources of these pollutants are road transport, household heating, agriculture, and industry. (European Environmental Agency, 2020)

Several government officials (in countries, regions, and municipalities) are trying to solve this problem by implementing new policies to limit the massive development of automobile transport. (Bruun and Vanderschuren, 2017) Transport significantly affects cities' sustainability and quality of life. (Foltynova et al., 2020) The 2019 European Union (EU) regulation set stricter CO₂ emission targets for all vehicles in the EU, defined as a percentage reduction from the starting points for 2021. A 15% reduction in cars is required from 2025, and a 37.5% reduction from 2030. In 2014, the EU Commission issued an implementing regulation setting out procedures for the approval and certification of innovative technologies to reduce CO₂ emissions from light commercial vehicles. (European Commission, 2019)

In the transition to a sustainable urban future, reducing the use of cars and thus traffic congestion and emissions caused by transport on the environment and public health is essential. (Acheampong et al., 2021) Bike sharing is a form of sharing economy aiming to increase utilization. (Ikonen, Heljanko and Harjunkosi, 2022) Faulin et al. (2019) add that many modern cities face increasing operational complexity worldwide. As the population grows, new transportation systems are being considered, from bicycles to subways and car-sharing services. Transport planning should focus on supporting public transport to ensure sustainability. (Desta and Toth, 2021) There are several ways to move towards sustainable urban transport. As Kubalak et al. (2021) mentioned in their publication, a possible way is to start using other modes of transportation, such as walking or cycling. Introducing a system of shared bicycles in the framework of sustainable urban transport represents one of the essential factors that would reduce the number of vehicles in the road network. The shared bike system started to be a phenomenon in large metropolises until this trend gradually reached the world. The shared bike system is more ecological and has less impact on the environment. However, we can talk about shared bikes and electric scooters within the shared mobility system. Whether it is a system of shared bikes or electric scooters, it is necessary to point out that the means of shared mobility are not always used evenly, and there is no accumulation in selected places. Chemla et al. (2013) add that it is necessary to redistribute bikes so that morning peak demand responds to given requirements. Therefore, the city must have ready models to collect shared mobility resources.

The paper aims to present a comparative analysis of bike-sharing systems in the Czech Republic and foreign countries in Middle Europe.

2. Methodology

The paper is divided into several parts. Firstly, we prepared a literature review to place the topic in the context and define the research gap. Secondly, we introduced the bike-sharing system in the Czech Republic. There was introduced two providers of bike-sharing systems. The main part, results, presents the bike-sharing system in foreign. There was selected Middle Europe.

3. Results

This part of the paper presents the bike-sharing system in the Czech Republic and foreign. The aim of the paper is to compare several bike-sharing systems in selected countries in Middle Europe.

3.1. Czech Republic

There are two bike-sharing providers in the Czech Republic. These providers have different operating principles. This is the company Nextbike Czech and Rekola.

The company Nextbike Czech started offering shared bike service for the first time in 2019. They operate in 25 cities, providing 5,000 city bikes and 500 e-bikes. The shared bike station system uses public racks in cities built in a given city and serves general purposes. If Nextbike deems it appropriate to create a new rack, all costs of such construction and approval must be undertaken by the city. The bike borrows, and return system only occurs at designated stations in the Nextbike application. If the bike is not returned to the station correctly, the user is fined. About 90 percent of borrowing is realized within 15 minutes. Two and a half million rentals took place in the Czech Republic, with more than 3.2 million km driven, in 2022. For the same distance traveled behind the wheel, 504 tons of CO₂ were saved. In the Czech Republic, over 300,000 users already have the app on their phones (Nextbike Czech, 2023a).

Table 1. Nextbike Czech.

City	Population	City Area	Bike Quantity	Station Quantity	Population per 1 Bike	Bike Quantity per 1,000 Inhabitants	Station Quantity per km ²
Beroun	90,701	31	112	17	810	1.2	0.5
Brno	379,526	230	400	200	948	1.1	0.8
Dvůr Králové	15,710	36	50	16	314	3.2	0.4
Frýdek Místek	56,066	52	160	100	350	2.9	1.9
Havířov	69,084	32	200	50	345	2.9	1.6
Hlučín	16,562	21	40	6	339	2.9	0.3
Hradec Králové	90,596	106	100	40	906	1.1	0.4
Jihlava	50,108	88	112	50	447	2.2	0.6
Kladno	66,903	37	120	50	558	1.8	1.4
Krnov	22,665	44	100	25	227	4.4	0.6
Kuřim	10,847	17	30	17	362	2.8	1
Mladá Boleslav	41,868	29	150	50	279	3.6	1.7
Mnichovo Hradiště	8,711	34	43	16	203	4.9	0.5
Olomouc	99,496	103	300	100	332	3	1
Opava	54,840	91	100	30	548	1.8	0.3
Ostrava	279,791	214	1100	350	254	3.9	1.6
Pardubice	88,520	83	100	40	885	1.1	0.5

Písek	29,814	63	100	80	298	3.4	1.3
Praha	1,275,406	496	1000	400	1,275	0.8	0.8
Prostějov	43,055	39	120	42	359	2.8	1.1
Říčany	16,182	26	40	24	405	2.5	0.9
Rychnovsko	10,717	35	40	14	268	3.8	0.4
Uherské Hradiště	24,430	21	75	40	326	3.1	1.9
Vrchlabí	11,968	28	40	12	299	3.3	0.4
Zlín	72,973	103	145	70	503	2	0.7

Table 1 shows the basic information about the cities where Nextbike Czech provides bike-sharing services. The information about the bike quantity and station quantity is available on the website (Nextbike Czech, 2023b). As can be seen, the most significant number of bikes per 1,000 inhabitants is in Mnichovo Hradiště (4.9). On the other hand, the lowest number of bikes per 1,000 inhabitants is in the capital city Prague (0.8), and others are in the towns Brno (the second largest city in the Czech Republic), Pardubice and Hradec Kralove (1.1). Next, we can compare the number of inhabitants per bike. The least population per bike is in the city of Mnichovo Hradiště (203). On the other hand, the most population per bike is in the capital city Prague (1,275). From this result, we can state that the free bike opportunity is higher in smaller towns than in the biggest cities.

The company Rekola started offering shared bike service for the first time in 2013. They currently operate in only four Czech cities and one city in Slovakia, providing 2,000 bikes. Previously, this provider covered 13 cities in the Czech Republic. It was canceled due to low interest or was replaced by the provider Nextbike Czech. Contrary to Nextbike Czech, Rekola does not use public racks in cities. Users can borrow a bike wherever they find it free, and they can also return it anywhere. There are no designated stations where the bicycle must be replaced. The only condition is compliance with the zones established within each city, the so-called pink zones. (Rekola, 2023)

Both bike-sharing providers have mobile apps through which users can rent a bike. The rental price is different, depending on the use length and the organization offering the bikes.

Table 2. Rekola.

City	Population	City Area	Bike Quantity	Population per 1 Bike	Bike Quantity per 1,000 Inhabitants
Brno	379,526	230	150	2530	0.4
České Budějovice	93,984	56	220	427	2.3
Olomouc	99,496	103	110	905	1.1
Praha	1,275,406	496	1000	1275	0.8

Table 2 shows the basic information about the cities where Rekola provides bike-sharing services. As can be seen, the provider's bike-sharing Rekola is only in four Czech towns. The most significant number of bikes per 1,000 inhabitants is in České Budějovice (2.3). On the other hand, the city of Brno has the lowest number of bikes per 1,000 inhabitants (0.4). Next, we can compare the number of inhabitants per bike. The least population per bike is in the city of České Budějovice again (427).

On the other hand, the most population per bike is in the city of Brno (2,530). This result confirms that the free bike opportunity is higher in smaller towns than in the biggest cities. There could not be analyzed the station quantity per km² because of the zones for the pink zones.

3.2. Foreign countries

The following state, which we select for the comparative analysis, is the Slovak Republic. There are primary bike-sharing providers are ANTIK Bike, BikeKIA, and Arboria Bike. The bike-sharing system is in several cities in the

Slovak Republic. There are mentioned the number of the bike in the Slovak Republic by the provider's ANTIK bike (see Table 3).

Table 3. ANTIK bike.

City	Population	City Area	Bike Quantity	Population per 1 Bike	Bike Quantity per 1,000 Inhabitants
Bratislava	424,428	368	17	24,966	0.04
Považská Bistrica	40,139	91	40	1,003	1
Kysucké Nové Město	14,660	26	5	1,932	0.3
Krásno nad Kysucou	6,816	28	6	1,136	0.9
Poprad	51,922	63	18	2,885	0.3
Přešov	89,872	70	5	17,974	0.06
Svidník	11,246	20	5	2,249	0.4
Košice	239,171	245	152	1,573	0.6
Moldavan ad Bodvou	9,899	20	7	1,414	0.7
Trebišov	24,547	70	12	2,045	0.5
Humenné	33,860	29	5	6,772	0.1
Snina	20,103	59	3	4,021	0.1

Table 3 shows the basic information about the cities where ANTIK bike provides bike-sharing services. As can be seen, the provider's bike-sharing ANTIK bike is in 12 towns. The most significant number of bikes per 1,000 inhabitants is in Považská Bistrica (1). On the other hand, the city of Bratislava (0.01).

The next provider's bike-sharing system is Bike KIA. This provider's bikes are only in the city of Žilina. There are 21 stations and nine virtual stations. There is no available number of bikes. It should be noted here that the shared bike system does not work in the winter season. The bikes are used from spring to autumn. It is an exceptional case that is not applied in the Czech Republic.

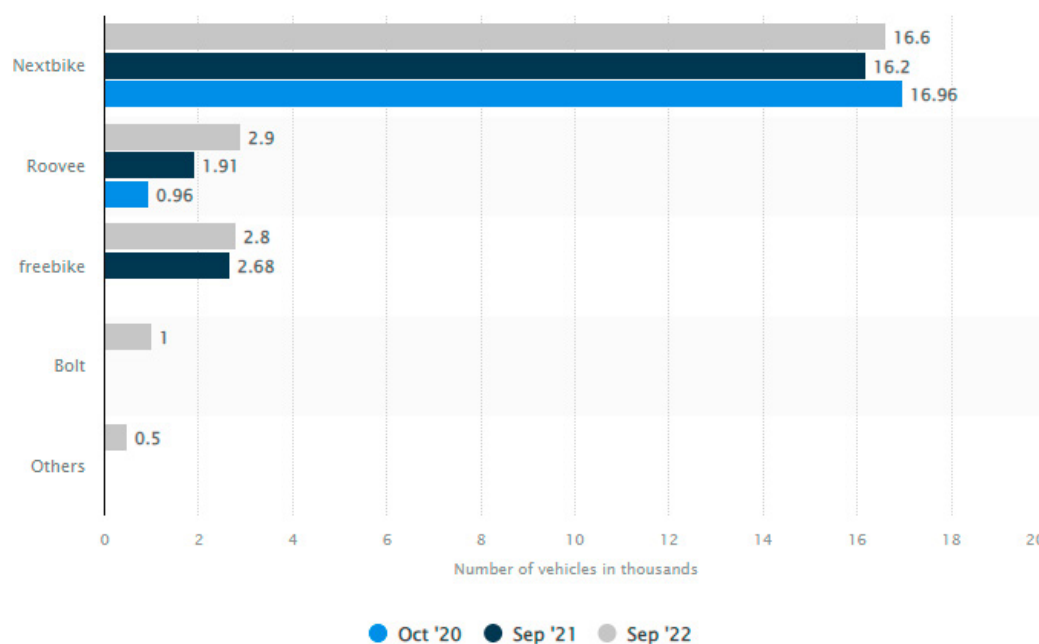


Fig. 1. Bike-sharing providers in Poland (Statista, 2023a)

The third mentioned provider of the bike-sharing system is the Arboria bike. This provider's bikes are only in the city of Tmava. There is available 118 bikes. There are only electric bikes in Tmava. It is a system of shared bikes using stations.

Poland is the next state in Middle Europe where we could compare the situation with the bike-sharing system—several bike-sharing providers, such as Nextbike Poland, Roovee, Freebike, and Bolt. The following figure shows the bike-sharing service providers in Poland between October 2020 and September 2022 (see Fig. 1).

Figure 2 shows the bike-sharing providers in Poland. As can be seen, the most significant provider of bike sharing is Nextbike Poland. These providers have the most bike – sixteen thousand. The second most considerable provider is Roovee.

Poland had more than nine thousand bikes in the 2nd quarter of 2022. Most bikes are in Warsaw (5.2 thousand), Wroclaw (2.3 thousand), and Poznan (1.8 thousand). (Statista, 2023b)

The bike-sharing system of providers Nextbike Poland is the same as in the Czech Republic. There are stations where you can borrow and then return the bike. It is necessary to mention that bike-sharing provides services in some regions (and cities). We can state that this service is offered only in the southern part of Poland (Warsaw, Lublin, Poznan, Skiweniewice, Lodz, and Piotrkow Trybunalski). In a city like Gdansk and Torun (in the north), bike sharing from this provider is unavailable.

The second significant bike-sharing provider is ROOVEE. The system is similar to Rekola in the Czech Republic. There are no stations for bikes; however, there are only zones where you can anywhere borrow and return the bike. There we can state that there are cities in the north, too; however, the city of Gdansk is not here.

4. Discussion and Conclusion

The existing literature analyzing bike-sharing systems has increased significantly in the past decade due to the extensive adoption of these systems worldwide. The works found in the literature on bike-sharing systems focus on one or more of the following topics: analysis of static and dynamic rebalancing, demand analysis of bikes, location of new stations, maintenance policies of bikes, etc. (Ramirez-Nafarrate, Moncayo-Martinez and Munguía-Williams, 2022)

The paper aimed to analyze bike-sharing systems in the Czech Republic and foreign countries in Middle Europe.

Table 4. Providers of bike-sharing system in the selected states.

State	Providers of bike-sharing system	Stations	Zones
Czech Republic	Nextbike	YES	NO
	Rekola	NO	YES
Slovak Republic	Bike KIA	YES	NO
	ANTIK bike	NO	YES
	Arboria bike	YES	NO
Poland	Nextbike	YES	NO
	Roovee	NO	YES
	Freebike	YES	NO

Table 4 presents the providers of the bike-sharing system in the selected states and the way of using stations or zones. The Czech Republic had a bike-sharing system with two primary providers (Nextbike Czech and Rekola). From this result, we can state that the free bike opportunity is higher in smaller cities than in the most significant towns by both providers. The next part of the results was to present the bike-sharing system in the selected foreign countries in Middle Europe (Poland and the Slovak Republic). There are the same providers of bike-sharing systems (one primary

provider, Nextbike, with the stations where we can borrow and return the bikes) and the ROOVEE, with the zones. We can conclude that these countries are the two primary providers of bike-sharing.

Table 5. Comparative analysis of the selected providers.

City	Providers	State	Population	City Area	Bike Quantity	Population per 1 Bike	Bike Quantity per 1,000 Inhabitants
Bratislava	ANTI-K bike	SK	424,428	368	17	24,966	0.04
Brno	REKOLA	CZ	379,526	230	150	2530	0.4
Přešov	ANTI-K bike	SK	89,872	70	5	17,974	0.06
Olomouc	REKOLA	CZ	99,496	103	110	905	1.1

Table 5 shows the comparative analysis of the selected Czech Republic and Slovak Republic bike-sharing providers. As can be seen, we compare two groups of towns with a similar population. For this comparative analysis was selected the bike-sharing providers with the zones system. The first was chosen as a town with a population of about 400,000 (Bratislava – SK, Brno – CZ). The second group was selected with about 100,000 inhabitants (Přešov – SK, Olomouc – CZ). The table shows the vast difference in the number of bikes in these towns in the above groups.

The goal of the bike-sharing system is to have as several stations available for inhabitants as possible, which will be available near the user's favorite places (doctors, transport links, authorities, etc.). However, the requirements for the location of the given station (accessibility by vehicle) must also be reflected. Based on the established criteria, it is possible to place bike stations appropriately. Our research aims to prepare a model for the deployment of bike-sharing stations. One of the critical issues for high-quality bike-sharing systems is rebalancing city-wide stations to maintain bike availability. Traditional strategies, such as repositioning bikes by trucks and volunteers based on historical riding records, usually operate in fixed paths and limited capacities, lacking the flexibility to cope with the highly dynamic and context-dependent riding demands, and typically suffer from high costs and long delays. (Zhang et al., 2021) Future research aims to prepare a model for the optimization of bike-sharing stations based on the selected criteria.

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