https://doi.org/10.53964/mem.2023011

https://www.innovationforever.com

Modern Economy and Management

ISSN 2790-3214 (Online)

Open Access

MiniReview

Overview of Sports Infrastructure in City of Bratislava: Challenges, Opportunities, and Research Agenda

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Received: June 30, 2023 **Revised:** September 8, 2023 **Accepted:** September 18, 2023 **Published:** November 23, 2023

Abstract

This article provides a summary of the sport infrastructure in the context of sustainability in the city of Bratislava, the capital of Slovakia. Sport infrastructure served as a vital aspect of urban development, playing a significant role in promoting the wellbeing of the population, enhancing social cohesion, and advancing economic growth. The article underscores the challenges the city is facing as well as its recent efforts to improve its sport infrastructure. The lack of suitable locations in the city is one of the greatest obstacles to the development of Bratislava's sport infrastructure. Although there are many sports facilities in the city, the majority of them are out-of-date and unable to accommodate the rising demand for sports participation. Besides, the city's sport infrastructure is largely concentrated in a few areas, making it challenging for citizens to participate in sports in other parts of the city. Bratislava had also made investments in creating parks and bike paths within the city to encourage active lifestyle and advance sustainable transportation. A recently re-elected major would be able to continue working towards sustainability goals as started in his previous election term. Additionally, maintaining support and investment in sports infrastructure would have a long-term advantages for both the sports community, the general public and sport tourists. The expansion and improvement of Bratislava's sport infrastructure could lead to a more engaged and active population, increased social cohesion, and improved public health if thoughtfully planned and carried out in a sustainable manner.

Keywords: Bratislava, sport, infrastructure, city

Citation: Jorgič B. Overview of Sports Infrastructure in City of Bratislava: Challenges, Opportunities, and Research Agenda. *Mod Econ Manag*, 2023; 2: 11. DOI: 10.53964/mem.2023011.

1 INTRODUCTION

1.1 Sports in a City and Its Benefits for Residents

Sports and regular physical activity are important aspects that promote public health. Physical activity, according to research, helps prevent the development of lifestyle diseases such as diabetes, cardiovascular disease (hypertension), and helps improve the condition of people with diabetes, metabolic state, sleep quality. Moreover, it serves as a potent antidote against anxiety, stress, and depression, yielding a multitude of physiological benefits[1]. Engaging in such activities is associated with a longer and better quality of life, increasing amount of energy and improving mood and

well-being. Furthermore, sports and physical activity helps children to develop respect for their body, contributes the development of their body and mind, enhances self-esteem, social, cognitive development, and academic achievement. Extensive research has demonstrated that lack of physical activity is a major contributor to mortality, disability, and a diminished quality of life in developed nations[2]. For these reasons, it is critical that cities create high-quality, efficient infrastructure that helps both residents and the community. Through providing residents with activities like recreational and sporting, cities can substantially reduce healthcare costs associated with lifestyle-related diseases and improve overall life expectancy[1].

Embracing an active lifestyle is vital, and the statistics reflect this. In 2014, it was observed that 35% of men in the EU engaged in 150 minutes or more of non-work-related sport or physical activities per week, compared to 26% of women[3]. However, in Slovakia, nearly 49% of the population refrained from any form of physical activities. When compared with the top one-third of European Union countries, which boast an average of 25% inactive citizens, its evident that there is room for improvement in Slovakia, particularly in its capital, Bratislava. We could presume that this data applies to a considerable extent to Bratislava residents, albeit the added issue was that they do not currently record this data at the city level. As a result, conducting personal statistical surveys to ensure targeted interventions was essential. Furthermore, the life expectancy of Bratislava residents was lower than that of Vienna, pointing out that sports and physical activities have potential influence on this statistic, despite this not the only factor that affected it. The average life expectancy in Bratislava (2018) was 75.8 for men and 81.8 for women, while it was 77.8 for men and 82.7 for women in Vienna (2020)[4]. A significant percentage (62%) of those who participated in sports also do so at home, which seted us apart from Western European nations where the majority of people regularly engage in sports outside of their home[5]. Possibly due to the condition and accessibility of the city's sporting infrastructure. Improving the quality and accessibility of urban sports facilities could serve as a catalyst for increased physical activity among the city's residents. One prime example is cycling, a mode of transportation that is not only cost-effective but also promotes health and environmental benefits. With global concerned over climate change, pollution, traffic congestion, and obesity, cities worldwide are now prioritizing cycling-friendly policies.

In the case of Preveza, a small tourist-oriented city in Northwestern Greece, where cycling is more prevalent compared to other Greek cities, there are initiatives in place to foster cycling. Through a structured survey, local residents assessed the suitability of cycling in the city, the existing infrastructure, the need for proper education, and the behavior of cyclists and drivers. Over half of the residents opt for bicycling as their primary mode of transportation, emphasizing their affordability within the city. Many residents expressed the belief that the government should promote bicycle usage by providing financial support for bicycle acquisition. About two-thirds of the residents found that the city's cycle facilities are adequate, although they raised concerns about safety of young cyclists who did not adhere to traffic rules. Adult cyclists, on the other hand, generally followed traffic regulations but reported a lack of respect from drivers on the road[6].

The insights from Preveza's cycling study offer valuable lessons that could benefit cities with similar characteristics. With transportation emissions contributing to approximately one-third of global CO2 emissions, initiatives to encourage non-motorized transportation are vital[7]. Short car trips, which accounts for around 30% of European car journeys, shorter than three kilometers, were a major contributor to emissions[8]. Hence, cities worldwide are developing laws and infrastructure to promote "active transportation", with walking and cycling at the forefront[9]. The promotion of active travel received significant attention in many places across the world. Several reports from the government and other authorities argued that people should walk or cycle for short distances. In order to promote cycling as an alternative mode of city transportation, bicycle sharing programs became popular throughout Europe, Asia, and America[10].

Sports infrastructure is a critical component of a sustainable and smart city. It encompasses facilities, equipment, and amenities that promote active lifestyles, foster athletic development, and attract sports tourism. High-quality sports infrastructure not only encourages physical activity but also mitigates the need for private cars, reducing the city's carbon footprint and alleviating traffic congestion, air pollution, and noise pollution. A well-conceived sports infrastructure plan can also stimulate social cohesion by bringing people from diverse backgrounds together through sports and physical activities. Moreover, it serves as a catalyst for economic growth, job creation, and environmental sustainability[11].

A well-designed sports infrastructure can attract sports tourism and create new job opportunities in the sports industry. This also promotes local businesses and economic growth and help protect natural resources. For example, using sustainable materials and practices in building sports facilities can help reduce waste and the use of non-renewable resources. Sports infrastructure that is designed with sustainability in mind can help create a healthier, more active, and more resilient community while also contributing to the long-term sustainability of the city.

In the context of smart cities, sports continue to evolve to cater diverse audiences, aligning with entertainment and

public health objectives. By integrating sports venues and public spaces into smart city ecosystem, cities leverage sports as a tool for urban development. The emphasis is on creating a smarter way of life for residents, fostering a culture of physical activity, and building a sense of community through shared public spaces[12].

2 RESULTS

2.1 Bratislava and an Overview of Sports Infrastructure

Bratislava, the largest city in Slovakia, is the administrative, economic, political, educational and cultural center of the state and the region. The population of Bratislava has experienced consistent growth over the past years. With a population of 723,714 as of December 31, 2021, Bratislava region accounted for 13.3% of the total population of Slovakia[13]. The city has experienced both domestic and international migration, this upward trend can be attributed to factors such as urbanization, employment opportunities, and the city's attractiveness as a cultural and educational hub. Climatically, the region belongs to a moderately warm area in Central Europe. The water network belongs to the river Dunaj (Danube) basin, the second largest river in the Europe, flowing through the Bratislava city and which forms part of the natural border with Austria and Hungary.

While Bratislava boasted a considerable sports infrastructure, there is room for improvement in certain areas. Approximately 46.6% of Bratislava residents expressed satisfaction with the city's sports facilities, a figure trailing behind the 12 EU capital cities with the highest satisfaction ratings, averaging at 66%[4]. To foster public engagement and optimize citizen satisfaction with the quality, selection, and accessibility of the city's sports infrastructure, strategies to raise awareness of existing public sports facilities must be devised. Additional funding and elevated maintenance standards are also essential to ensure the long-term viability of these facilities (Table 1).

2.2 Accessibility and Affordability of Sports Infrastructure

There were several perspectives from which to examine the availability of sporting facilities. The degree of availability was up to 750 meters, approximately 100%, if we include sports fields in their fullest meaning, which includes playgrounds in kindergartens, hiking trails, untreated water bodies, and private exercise facilities.

The accessibility and distance of a sporting facility were important considerations when assessing the quality. However, if we focused on public sports venues that provide infrastructure the availability of sporting facilities, according to research, reached 92% at a distance of 750 meters, but at distances of up to 500 meters, the number dropped to 76%. In Bratislava, there are 91 primary schools, 91 elementary schools, and 97 high schools[14]. Most often, these facilities had a sports-operated indoor or outdoor area. The level of accessibility of sport infrastructure would be greatly enhanced if these areas were also completely open to the general public. However, there is frequently no regular procedure for opening the sports field. A substantial portion of school campuses were closed to the general public. For comparison, in Czech Republic, up to 72.4% of the total number of school sports facilities in Prague were accessible to general public[15]. Many institutions were constrained by concerns about property damage caused by hooliganism or high operating costs. It was therefore necessary for the city itself and its districts to work with schools to make school grounds accessible, in order to build and renew sports infrastructure.

STaRZ is direct decision-making authority over the city's physical education and recreational facilities as well as pricing policy. If they were to change the price list solely based on the concept of affordability, they would obviously not be acting in a market-driven manner. Such a strategy would result in rising operating losses in the absence of municipal or other subsidies.

The main operations managed by STaRZ include Ondrej Nepela Ice Stadium, Pasienky Swimming Pool, Harmincova Ice Stadium, Lamač Summer Swimming Pool, Rosnička Summer Swimming Pool, Zlaté Piesky. These various operations had various energy and financial requirements, structure of costs. Therefore, STaRZ must set the operating model in a way that, it satisfied the needs of the city's population while, on the other hand, not creating a sizable loss[16].

2.3 Digital Perspective of Sport Infrastructure

Bratislava is not only developing a diverse sport infrastructure, but it is also embracing digitalization and technology to improve the sport tourist experience. In the digital age, where travelers want both tangible experiences and seamless, tech-enabled journeys, sport tourism is evolving. With its unique fusion of sports, culture, and technology, Bratislava is well-positioned to meet this changing need.

Through the automation and digitization of infrastructure functions driven by the advancement of information and communication technologies (ICT), smart cities created digital infrastructure based on traditional infrastructure. Modern ICTs and digital management were used in smart city concepts to fortify its infrastructure. Professional digital management was necessary for digital infrastructure. Many countries deployed ICT-based e-government to combine many services into a single comprehensive system that supports effective and efficient governance[17]. In terms of digital infrastructure and accessibility the city made significant progress in developing its digital infrastructure, ensuring high-speed internet access and mobile connectivity. This facilitated communication, online

https://doi.org/10.53964/mem.2023011

Table 1. Key Elements of the Sport Infrastructure

Name	Short Description	Date of Construction / Modernization	Functions	Availability / Accessibility	Challenges	Opportunities
Pasienky Stadium	Multi-purpose stadium (Capacity 11,500 seats)	Construction: 1939 Modernized in 2010	Football matches, athletic events	Easily accessible by public transport, parking available	Aging infrastructure	Renovation and modernization
Ondrej Nepela Arena	Ice hockey and figure skating (Capacity 10,000 seats)	Construction: 1940 Modernized in 2011	Ice hockey games, figure skating	Excellent public transport access	Seasonal events	Hosting international events
Tehelné Pole Stadium	Football stadium (Capacity 22,500 seats)	Construction: 1939 Rebuild in 2019	Football matches	Good public transport links, limited parking	Seasonal events	Hosting international events
Pasienky Swimming Pool	Public swimming facility	Construction: 1974 Modernized in 2007	Swimming, aqua fitness	Easily accessible, reasonably priced	Maintenance and upkeep issues	Adding additional facilities/ renovation and modernization
NTC Arena	Tennis complex (Capacity 4,500 seats)	Construction: 2003 Modernized in 2019	Tennis tournaments, events	Public transport nearby, well-maintained courts	Limited capacity for events	Attracting international tournaments
Bowlingové národné centrum (BNC)	Bowling center	Construction: 2010	Bowling	Convenient location, parking facilities available	Competition from other venues	Hosting bowling tournaments
Petržalská Swimming Pool	Public swimming facility	Construction: 2016	Swimming, aqua fitness	Public transport access, affordable pricing	High operational costs	Energy efficiency
X-Bionic Sphere	Multisport complex	Completed in 2016	Various sports, equestrian	Located on the outskirts, car-dependent	High operational costs	Expanding sports and wellness services

booking, and real-time updates for sport tourists. The city offerd mobile apps "Bratislava CARD City & Region" with features like GPS-guided tours, event listings, and navigation services, making it easier for sport tourists to explore both sporting and cultural attractions.

Modern technology, including high-definition screens, interactive seating plans, and contactless ticketing systems, was integrated into sporting venues, like the Ondrej Nepela Arena and Tehelne Pole football stadium, enhancing the spectator experience. Bratislava's sporting events, whether marathons, cycling races, or tennis tournaments, often provided online registration and ticket purchasing options, facilitating the process for both participants and observers. The city actively used digital channels, including social media and online advertising, to promote sporting events and engage with sport tourists before, during, and after their visits.

In line with international trends in sport tourism, Bratislava's sport infrastructure incorporated digitalization and technology. It presented the city as a forward-thinking vacation spot and improves convenience, accessibility, and engagement for sports tourists. The dedication of Bratislava to fusing its variety of sports with digitization and technology enhanced its appeal as a sport tourism location for tech-savvy tourists.

2.4 Sports Infrastructure Funding and Investments

Despite the evident benefits of investing in sports infrastructure, Bratislava's budget allocation for sports was relatively modest, accounting for only 0.97% of the city's overall budget from 2015 to 2022. In comparison, neighbouring cities such as Ostrava allocate 6.2%, Krakow 2.2%, Prague 1.7%, and Brno 4.8%. This figure was based on a meagre €6.69 per capita for this period, significantly lower than other cities such as Krakow - €40, Prague - €37, Vienna - €19.5. The method of investment was also an important consideration. The city must invest significantly more in the construction of the city's sports infrastructure, but the current investment to technological debt ratio was 6:1, which only worsened the condition of these facilities' equipment over time and made repairs much more expensive in the long run. According to a survey of the Finance Review over the years, the share of funding allocated to sport in 2015 was the lowest compared to other years, while in 2017 this figure was up to twice as high. Based on 2022 data, 1.10% was currently allocated to sports activities. This indicated a positive trend toward increased funding to address the lack of sport infrastructure[4].

STaRZ-managed city sports facilities are currently operational. However, insufficient investment in their modernization and reconstruction foreshadow problems in the near future. Individual plant remediation was, of course, a priority. Internal city audit also proposed solutions for optimizing energy intensity. Optimizing the energy management system might improve the condition of sports facilities while maintaining a consistent income. This included renovating lighting, reusing waste heat, and renovating cooling and heating systems to make sports grounds more energy and financially sustainable.

2.5 Parks and Recreational Areas

Bratislava offers a plethora of parks, squares, and recreational areas for residents to enjoy. Notable squares for recreation and social interaction included Hodžovo námestie, Župné námestie, Námestie Slobody, and Námestie SNP. The city also boasts an array of parks, including Sad Janka Kráľa, Horský park, Tyršovo nábrežie, and Pruger Wallnerova záhrada. Mountain range Malé Karpaty and forrests are also a highly treasured component of the city. These provide ample opportunities for residents to connect with nature, engage in outdoor activities, and maintain an active lifestyle, including Devínska Kobyla, Železná studnička, Biely Kríž[18].

2.6 Bike Paths and Cycling in Bratislava

Cycling in the city is an environmentally friendly alternative to driving a car. Its advantages include not only the environmental friendliness, but also low space requirements and improved living conditions for city dwellers. Public bikes had a positive impact on emissions reduction as a green mode of transportation[19]. To encourage bicycle usage, the city aimed to expand the cycling network, making daily commutes, recreation, and tourism more accessible. While cycling was already a popular mode of transportation in many European capitals, Bratislava's share of bicycle traffic is currently under 1%, compared to Vienna, pedestrian and cycling transport accounts for 30%. The city's traffic planning, which had been heavily focused on cars for many years, is to be held responsible for the low share of bicycle traffic[20].

The city's priority is to increase the share of cycling transport in its territory so that residents could use bicycles safely and comfortably for transportation and recreation on a daily basis. The core network of major urban cycling routes is made up of main routes that are divided into circuits and radials, which are supplemented in individual urban areas by secondary routes (Figure 1). Furthermore, companies and organizations might construct additional routes to connect to their objects.

Cycling to Work is a nationwide campaign whose major purpose is to assist the growth of non-motorized, particularly bicycle, urban transportation while also encouraging municipalities in Slovakia to establish better conditions for ecologically friendly forms of urban transportation. This included the objective to encourage companies to create adequate circumstances for workers who travelled by bike to work, as well as to encourage employees to utilize this mode of alternative transportation more frequently when commuting to work every day[22].

Bicycle sharing is on the rise too. Slovnaft first mobility project in Slovakia, launched in 2018 is a partner of Bratislava city bike-sharing. Svišť E-Scooters were introduced to the market in May 2023, while TIER and Bolt started in 2020 operating in Bratislava e-scooters and e-bikes market[23].

2.7 Playgrounds and Outdoor Fitness Equipment

The Cvičko program is a training program aimed at creating a network of new workout playgrounds. Six workout playgrounds were added in the Bratislava center in 2022, linked by a running circuit on the Danube embankment. The goal of this project is to increase public interest in sports and physical activity in general[24]. All training grounds had instructions on how to properly use the devices, and a bonus was a video tutorial, which was prepared by a professional trainer and instructs people on how to exercise effectively in terms of physical fitness. Aside from the Cvičko project, there is also an OCTAGO workout playground on 5 different locations. The OCTAGO project is primarily concerned with exercising with a body weight without the need to visit a fitness centre or use dumbbells, instead relying on the resistance of the body's own weight.

3 DISCUSSION

3.1 Bratislava as a Sport Tourism Destination

The sports cities are important resource of tourism activities. Usually took one of two forms: designating one zone of a city as a sports city or branding the whole city as a sports city[25]. Sport tourism is a growing industry worldwide[26]. Bratislava has a potential to become sport tourism destination due to its unique combination of diverse sporting infrastructure, scenic surroundings, and cultural heritage, history, and geographical advantages. There are prospects for additional growth, to address the requirements of athletes and sports enthusiasts, these activities include marketing and promotional initiatives, cooperation with event planners on the international stage with strategic planning and financial investment. Following described factors will contribute to Bratislava's appeal as a sport tourism destination.

3.2 Diverse Sporting Infrastructure

Bratislava possess a wide range of sporting facilities, including stadiums, arenas, swimming pools, tennis complexes, climbing walls, multi-purpose facilities and gyms. This diversity enabled the city to host various

https://doi.org/10.53964/mem.2023011

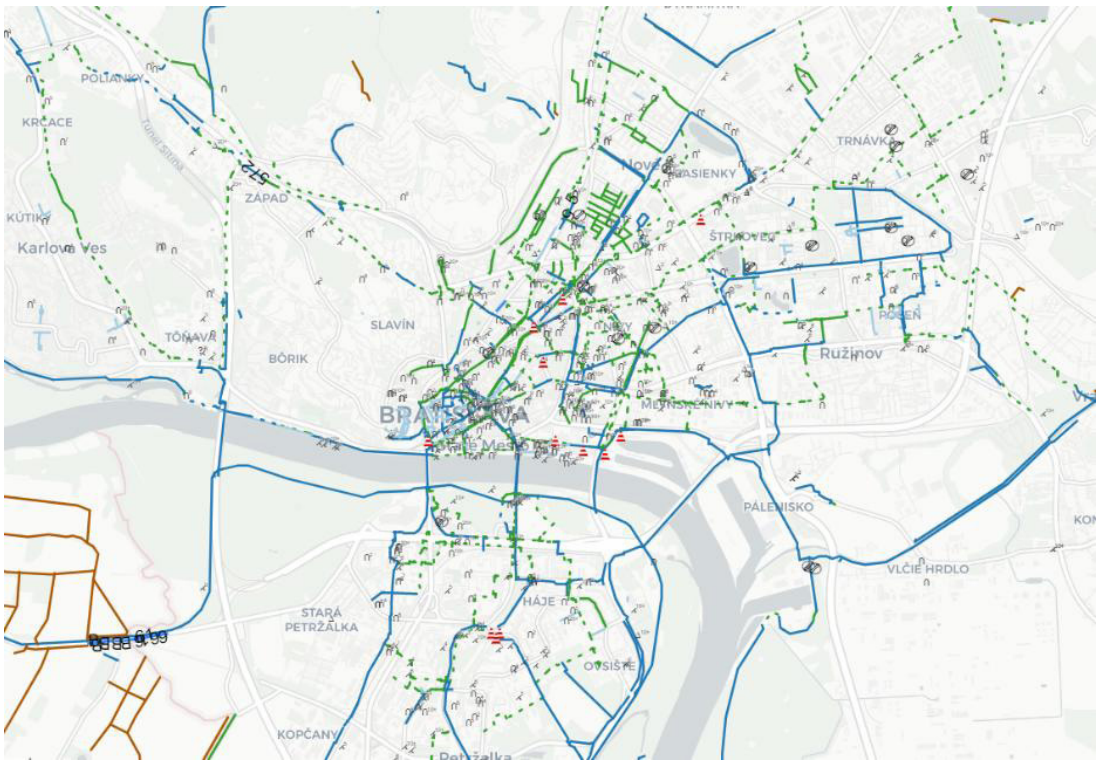

Figure 1. Cycling map of Bratislava. The map depicts existing cycling routes (solid lines) and recommended cycling routes (dashed lines). Separate cycling routes - marked in blue; Bicycle paths in traffic - marked in green[21].

sporting events and competitions. The Ondrej Nepela Arena and Tehelne Pole football stadium, stood out as appropriate sites for international football, ice hockey and figure skating events. Internationally, the most successful sport in Slovakia is ice hockey where currently, as of 2022, the country was ranked as the eighth best team in the world by the IIHF World Ranking. Various sports and sports teams have a long tradition in Bratislava, with many sport teams and individuals competing in the best Slovak and international leagues and competitions. Many significant sports events, such as World and European Championships, had been held in Bratislava. The Men's Ice Hockey World Championships were held in Bratislava in 2011 and 2019.

3.3 Natural Beauty and Outdoor Activities

Bratislava's scenic location along the Danube River, surrounded by forests and hills, made it an ideal destination for outdoor activities such as hiking, mountain biking, and trail running. The city's cycling infrastructure, combined with its natural surroundings attracts cyclists and adventure seekers. The Danube River offers opportunities for water sports such as rowing, kayaking, and paddleboarding. The riverbanks provided an excellent backdrop for waterfront activities.

3.4 Historical and Cultural Attractions

Tourists interested in sports history could explore the city's sporting landmarks, football stadiums, and other sport centers. Bratislava offers a blend of historical sites, cultural experiences, and culinary delights, enhancing the overall tourism experience. Among the most important sites are listed: Slovak National Gallery, Kunsthalle Bratislava, Multium Gallery, Slovak National Theater and other.

3.5 Event Hosting Capabilities

The city actively hosted and organized a range of sports events and festivals, attracting participants and spectators from Slovakia and nearby countries. These events might also contribute to the city's sport tourism interest. On annual basis Bratislava Marathon took place in March or April which attracts runners from around the world to explore the city's scenic routes. Bratislava Night Run, held every September, is a unique race that takes participants through the illuminated streets of Bratislava after dark. The Lovestream festival and Bratislava Jazz Days attracted world-class musicians to perform in Bratislava and other smaller festivals features a diverse lineup of artists.

3.6 Access and Infrastructure

Bratislava's central European location and accessibility via major transportation hubs, such as Vienna (flying distance 55km) and Budapest (flying distance 161km), made it convenient for international travelers. The city has own airport and offers a range of accommodation options and well-developed transportation infrastructure.

4 CONCLUSION

The city of Bratislava has a well-established sports infrastructure, but several challenges had to be addressed before its full potential could be realized. The city's

development of sports infrastructure was hampered by a lack of suitable locations for sports facilities and the outdated nature of many existing facilities. Furthermore, because sports infrastructure was concentrated in certain areas, citizens find it difficult to access and participate in sports in other parts of the city. As Bratislava sought to improve sports infrastructure, address accessibility challenges, and invest in sustainable practices, it not only enhanced the well-being of its residents but also positioned itself as an attractive sport tourism destination.

The existing infrastructure is not yet sufficiently developed and secured to attract a significant number of mobile users who would prefer to ride a bicycle instead of driving a car on a regular basis. This situation should be improved by enhancing cycling infrastructure. Bratislava stood at the threshold of a vibrant future, one where sports infrastructure, sustainability, and digitalization converge to create a more active, engaging, and sustainable. It has the potential to be as environmentally friendly as Amsterdam, Copenhagen, and Oslo[27].

By fostering a culture of physical activity, optimizing energy efficiency, and embracing digital advancements, Bratislava could transform into a city where residents and visitors alike can lead healthier, more active lives while exploring the rich tapestry of sporting, cultural, and natural treasures that this city has to offer. As Bratislava continues on its path towards sustainability and smart urban development, sports play a pivotal role in shaping a brighter future for the city and its people.

Acknowledgements
Not applicable.

Conflicts of Interest
The author declared no conflict of interest.

Author Contribution
Jorgič B wrote the article, read and approved its submission. The article includes partial analysis within his PhD research, which is focused on circular economy in Bratislava.

Abbreviation List
ICT, Information and communication technologies

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