



ANALYSIS OF CYCLING INFRASTRUCTURE - A CASE STUDY OF SPLIT

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Abstract

Many cities in the world have recognized cycling as one of the alternative ways of urban transport and are increasingly investing in the development of cycling and appropriate infrastructure, which helps to ensure the sustainable development of both the city and mobility in general. Cycling has numerous advantages compared to motorized transport because it contributes to a healthier lifestyle, reduces the use of personal vehicles and thus the traffic volumes, and affects the reduction of fuel consumption and air pollution. Adequate cycling infrastructure and its connections to other modes of transportation are necessary for cycling to be both safe and attractive to the general public. The city of Split started investing in bicycle lanes and promoting this mode of transportation only in the last fifteen years. This paper presents an analysis of the existing bicycle infrastructure in the city area in terms of construction and network connectivity, as well as the compliance of geometric elements with the current Rulebook on Bicycle Infrastructure. Furthermore, the method of organization and use of the public bicycle system is presented. This system which was introduced in July 2019 and was upgraded in the following years, significantly contributed to the development of bicycle traffic in Split. Following the analysis, some recommendations for enhancing the cycling infrastructure were made. In general, urban planning and design of city roads and public areas can have a substantial impact on the safety, comfort and connectivity of the cycling infrastructure, which will help promote and develop cycling and sustainable mobility.

Keywords: mobility, cycling infrastructure, analysis, city of Split

1 Introduction

The main goal of sustainable transport is to create a safe, efficient, and accessible transportation system that minimizes negative impacts on the environment and society while promoting economic development. Due to increasing concerns for the environment, existing traffic congestion and health issues related to sedentary lifestyles, cycling is increasingly being promoted as a healthy mode of transportation and an important part of sustainable urban mobility. Investments in cycling infrastructure and the creation of comfort environments for cyclists are crucial for promoting this mode of transportation and creating more environmentally friendly cities. Although private car is the dominant mode of transport in most cities, cycling has several advantages that can compete as an alternative to personal vehicles. The main advantages are: avoiding traffic congestion and parking issues, being more ecologically friendly by reducing greenhouse gas emissions and contributing to environmental protection, promoting physical activity and a healthy lifestyle, and being more cost-effective mode of transportation. It is clear that the development of cycling requires appropriate infrastructure and transportation policies by city authorities to encourage citizens to ride their bikes more often. This paper presents basic data on the cycling infrastructure in Split and measures that can contribute to the development of cycling.

2 Cycling in Europe and Republic of Croatia

Several European countries are well-known for highly developed bicycle traffic, with notable examples being the Netherlands (especially the cities of Amsterdam, Utrecht, and Groningen) and Denmark (Copenhagen and Aarhus), where there is a high proportion of bicycles in the modal split. Figure 1 shows the share of bicycle usage for daily trips in EU countries during the year 2014. It can be observed that the highest shares are in the Netherlands (36%) and Denmark (23%), while the average share for EU-28 countries was 8%. Croatia is below the European average with a bicycle share of 6% [1, 2].

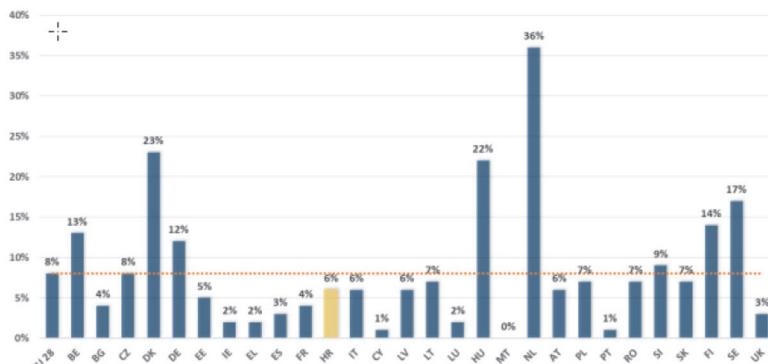


Figure 1 Share of bicycle use in the EU 28 countries for daily trips [1, 2]

According to data from Eurobarometer [3], the average percentage of people who ride bikes as their primary mode of transportation stayed at 8% in 2019 compared to 2014. Many European countries have created and implemented national cycling strategies and plans. Based on these plans, they continue to invest in the construction and improvement of cycling infrastructure as well as promote cycling, which has increased the use of bicycles, particularly for shorter distances (Fig. 2).

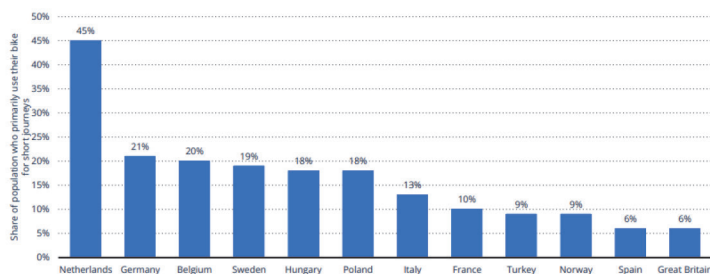


Figure 2 Share of bicycle use as their primary mode of transport for short journeys in EU in 2022, by selected countries [4]

The development of cycling in Croatia has not kept pace with other European countries but is experiencing continuous progress, driven by set goals related to sustainable mobility, awareness of the need for more environmentally friendly and healthier modes of transportation, cycling tourism as a segment of tourist offerings, etc. The Regulation on Cycling Infrastructure [5] was adopted in 2016, prescribing basic planning principles and elements for the design, construction, and maintenance of cycling infrastructure. The National Plan on the Development of Cycling Transport for the period from 2023 to 2027 was completed in July 2023 as the first strategic document setting the framework for defining measures, projects, and activities

to realize the full potential of cycling [1]. Table 1 displays the length of the bicycle network in the major county capitals and cities with 20,000 or more residents that was gathered as part of the National Plan preparation process. The requested data were not provided by the cities of Split, Dubrovnik, Šibenik, Kaštela, Zaprrešić, Sinj, Petrinja, and Virovitica [1].

Table 1 Length of bicycle infrastructure on the roads of county centers and cities with more than 20,000 inhabitants [1]

City	Bicycle lane [km]	Bicycle path [km]	City	Bicycle lane [km]	Bicycle path [km]
Zagreb	14,898	237,7	Bjelovar	0,2	28,8
Rijeka	0 0 0 2,2 0,28	0	Vinkovci	2,2	5,608
Osijek	0	54,7	Koprivnica	68,61	6,39
Zadar	0	15	Čakovec	35	110
Velika Gorica	2,2	43,5	Solin	0	0
Pula	0,28	6,5	Đakovo	6,3	16,55
Slavonski Brod	10	52	Vukovar	1,4	14,6
Karlovac	1,5	36	Požega	0	9
Varaždin	21	24	Kutina	0	9,3
Sisak	8,55	3,57	Krapina	0	0
Samobor	0	3,5			
			TOTAL	172	677

According to data from [1], approximately 849 km of cycling paths have been built in the area of 21 cities, a public bicycle system has been introduced in 15 cities (71%), while only three cities (14%) have cycling education facilities. Integrating cycling into spatial planning and urban revitalization efforts is essential to encourage more people to use bicycles as a mode of transportation.

3 Case study of Split

3.1 Existing state of cycling infrastructure

The city of Split only began investing in cycling paths and promoting cycling as a mode of transportation in the last fifteen years. Before that, there was only a path primarily for recreational purposes, as it extends through the Marjan Forest Park where motor vehicle traffic is generally prohibited (except for occasional lines of public city buses). The first cycling path within the city network was built in 2010, approximately 800 meters in length, during the reconstruction of Hrvatske Mornarice Street. Five years later, in September 2015, this path was completed by connecting it to the existing route around Marjan and constructing new sections on the West Coast and in Domovinskog rata Street (a total of 11 km in length). The disadvantage of this route is that it has no continuity in some sections due to spatial limitations, which forces cyclists to share the road with motor vehicles. These locations are marked with vertical signs (Fig. 3).



Figure 3 Route discontinuity, warning signs about cyclists on the road [6]

In addition to this route, in 2021, a 750 meter long cycling-pedestrian path was arranged along Trstenik-Žnjan beach, primarily for recreational purposes due to its location. The typical cross section of cycling-pedestrian path from the Regulations [5] is shown on Fig. 4.

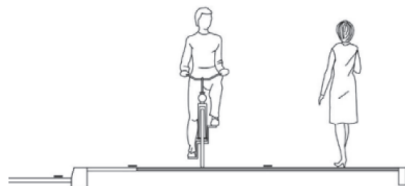


Figure 4 Typical cross section of cycling-pedestrian path [5]

In the same year, a cycling-pedestrian path was built in the residential area of Kila as part of a new access road. Although the road is new, the cycling path does not comply with regulations for cycling infrastructure and public lightening poles are located within the path width, endangering cyclists' safety and representing a poor example of planning/designing. Existing cycling infrastructure in the area of Split are shown in Figure 5. Field inspection revealed that most pedestrian crossings did not have area designated just for cyclists, and in certain places, horizontal signalization needed to be renewed.

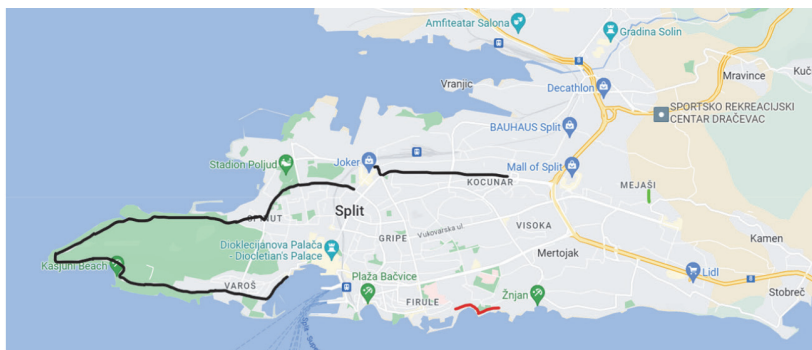


Figure 5 Existing cycling infrastructure in the area of Split [6]

From the Fig. 5, it's evident that the cycling infrastructure is mostly located along the coast, and the overall length of approximately 12 kilometres is quite modest when compared to the length of the entire city network and the cycling networks of other Croatian cities presented in Table 1. Over the past few years, city authorities have been striving to promote cycling as a mode of transportation. A public bike sharing system was implemented as part of the "Choose the Bicycle" project, and it has been extremely well-received by both locals and visitors. However, the cycling infrastructure that comes with it is insufficient and inadequate, and the construction of a new one is proceeding very slowly.

3.2 Public bike sharing system

The public bike sharing system in the city of Split was introduced in July 2019. At that time, there were 4 locations with a total of 50 bicycles (20 electric and 30 conventional). Over the following years, the system was expanded, all within projects co-financed by the EU, and to date, that number has significantly increased to 67 stations with 350 bicycles. The latest stations introduced in December 2022. Existing public bike stations are shown in Figure 6 [7].

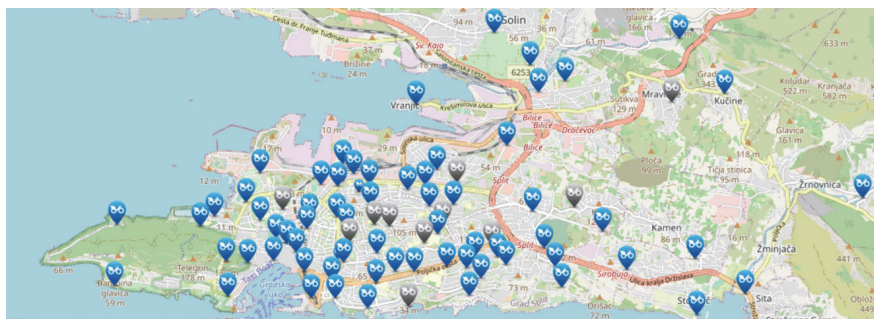


Figure 6 Public bike stations

In order to cover every city district and important institutions within the city area, new station locations were carefully picked. Based on data obtained from the company Split Parking d.o.o., which manages the public bike sharing system, a diagram showing the monthly number of rentals until the end of 2022 was made (Fig.7). It can be observed that the highest number of rentals occurs during May, June, and July, which is expected due to the period when the local population is not yet on vacation and there is a significant number of tourists. According to the data on registered users, approximately 80% are domestic residents, while around 20% are foreign nationals.

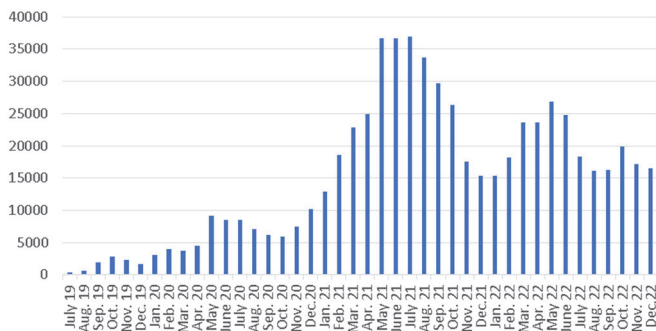


Figure 7 Monthly number of public bike rentals (from 07/2019 to 12/2022)

Considering the data on the location of bicycle pickup and return, it is possible to approximately estimate how many rentals are used for recreational and how many for transportation purposes. The total number of bicycles rented (from July 2019 to December 2022) is 643,628. Of those, 92,505 were picked up and returned to the same station. It is assumed that these 14% of rentals are for recreational purposes, while the remaining 86% of rentals are used for transport to a certain destination. According to subsequently obtained data, the record for monthly rentals since the system began is 39,974, achieved in May 2023, and the record for daily rentals is 1,746, also in May 2023. All these numbers indicate the willingness of citizens to use bicycles as a mode of transportation.

However, the lack of adequate cycling infrastructure, which compromises cyclists' safety, results in underutilization of cycling as a primary mode of urban micro-mobility. Stations with the highest number of rentals are located in the city center (Riva, Pazar) and in Split 3, which is a district with a larger population. Such data can serve as guidelines for future planning and construction of cycling paths considering the traffic demand. Improving cycling infrastructure would significantly contribute to the growth of this project, and there is certainly room for progress in this area.

4 Measures for the development of cycling

Generally speaking, there are various strategies and methods that can be used to promote the development of cycling in urban areas and motivate citizens to accept it as one of the primary modes of transportation. Several key aspects include:

- building new and improving existing cycling infrastructure, which includes not only bicycle lanes and paths but also providing facilities such as bike parking, bike bridges, e-bike charging stations, accompanying equipment, etc., to enable a safer and more enjoyable cycling experience
- introducing or upgrading public bike-sharing system that allow citizens to easily rent bikes for urban journeys
- integrating cycling infrastructure into urban transportation plans and projects as essential for the long-term development of cycling. By analyzing traffic flows, identifying key routes for cyclists, and adapting existing transportation systems, the safety and efficiency of cycling would be improved. When developing plans, it would be beneficial to involve the local community and cycling associations, which can provide important feedback on what needs to be improved to make cycling even more attractive and accessible.
- connecting cycling infrastructure with public transportation and providing space for bicycles on public city vehicles
- implementing educational programs to encourage citizens to use bicycles, providing information on safe cycling and promoting the benefits of cycling as part of a sustainable urban development strategy.

Looking at Split in the context of the mentioned measures, it can be concluded that several projects have been initiated for the development of cycling in the city over the past 5 years, resulting in the very successful implementation of public bike-sharing systems. However, the integration of cycling infrastructure into urban plans and its construction is substantially behind the needs of citizens. On street sections where it may not be feasible to design separate bike lanes, it is necessary to plan shared infrastructure with motor vehicles, emphasizing the presence of cyclists through traffic signs for safety reasons.

In October 2023, the European Parliament adopted the European Declaration on Cycling which contains eight principles with 36 commitments and should serve as a strategic compass for existing and future policies and initiatives related to cycling [8]. Furthermore, the European Cyclists' Federation (ECF) has published a Guide for Program Documentation for Croatia 2021-2027 [9], listing EU programmes that could be utilized for cycling projects funding. The implementation of cycling projects that will contribute to better infrastructure and increased safety for cyclists will certainly motivate citizens to use this mode of transportation.

5 Conclusion

Cycling is a mode of transportation that fully supports goals related to climate change, environmental protection, sustainable mobility, and a healthier lifestyle. Through the analysis of cycling infrastructure in the city of Split, it can be concluded that the supply is very limited (12 km), which is the reason that bicycle does not have a significant share in the modal distribution. The city has opportunities for improvement, and it is necessary to adjust spatial plans and reconstruction projects to meet the needs for cycling infrastructure. According to data on the use of public bike-sharing system, which is a very successful urban project, it can be concluded that residents and guests of Split perceive cycling as a possible mode of transportation, however, with the existing infrastructure, cycling cannot reach its full potential. Although some initiatives have been encouraged to improve infrastructure in recent years, they have not yet been realized. For the long-term development of cycling infrastructure, it is important to ensure continuous funding (available EU programmes) and define clear goals and plans, as well as to enable good coordination with other modes of transportation to ensure efficient and safe transitions from cycling lanes. Involving all relevant stakeholders, from local authorities and urban planners to cycling associations and citizens, is crucial for successful planning and construction of cycling infrastructure that will meet the needs of all users today while ensuring the preservation of resources and quality of life for future generations, which is the goal of sustainable mobility.

Acknowledgment

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