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INCREASING CYCLIST MOBILITY BY IMPROVING CYCLING INFRASTRUCTURE: CASE STUDY KOPRIVNICA

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Abstract

The use of a bicycle as a form of transport is an essential factor within a sustainable transport system. The increased number of cyclists is changing their need for better and better infrastructure. Koprivnica is traditional cycling city, with one of the longest cycling infrastructure in the Republic of Croatia. However, parts are disconnected and partly inconsistent with the Bicycle Infrastructure Regulations (OG 26/2016). This results with reduced mobility and safety for all road users, especially pedestrians and cyclists who often share a common surface. The paper presents a method of mapping bicycle infrastructure in the city. As a reference point for comparing the state of cycling infrastructure, data were taken from the 2015 Sustainable Urban Mobility Plan of Koprivnica. In addition to personal bicycles in the city, public bicycles are also proposed to optimize this system. After the analysis, suggestions were made for improvements and connecting parts of existing network, into a united network that would meet the highest standards. Particular attention should be paid to intermodality, ie connection with railway and bus stations, and planned parking areas around the city. This model can be applied in all cities.

Keywords: urban mobility, bicycle infrastructure, COVID 19

1 Introduction

Due to its relatively cheap construction and availability, bicycles are nowadays the most widespread means of transportation, so it is estimated that there are over one billion bicycles in the world today. The use of bicycle as a means of transport is becoming more and more common in cities of developed countries around the world. In the Republic of Croatia, bicycle traffic and use of bicycles are not keeping pace with European trends, primarily due to inadequate cycling infrastructure. Developed European countries such as Sweden, Denmark, the Netherlands or Germany, which in the past have also faced similar problems as the Republic of Croatia (increasing popularity of cars, increasing congestion and air pollution) have recognized the problem much earlier and taken appropriate measures, including systematic encouragement of cycling traffic as early as the 1970s.
The development of bicycle traffic is achieved through tried and tested strategies such as: introduction of a public bicycle system, construction of quality and safe bicycle lanes, introduction of safe bicycle parking spaces, information and education of cyclists and other road users [1]. Koprivnica, as a "city of bicycles", has a long tradition in the development of bicycle traffic, and as such is a good example for the analysis of cycling infrastructure.

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By increasing the number of passenger cars in cities, and using them to go to work and carry out daily tasks, congestion on city roads is becoming an increasing problem in urban traffic. Recent statistics show that in the most congested cities, cars are moving at an average speed of 7.5 kmh (New York [2]) or 8.2 kmh (London [3]), which is dangerously approaching pedestrian speed. On the other hand, speed in Copenhagen's busiest bike city is twice as fast. [4] Traffic jams and lack of parking space can make driving a downtown car very impractical. A bicycle is a good alternative for moving and avoiding problems faced by passenger car users. Cycling can greatly contribute to a more efficient, sustainable and healthy transport system. Good cycling infrastructure and daily bike use are closely linked. The design of the cycling infrastructure should be adapted to improve traffic safety and quality. The infrastructure should allow cyclists to do direct, comfortable cycling in an attractive and safe traffic environment. Only then is it possible to compete with the car as a means of transport.

2 Cycling Infrastructure

Towards the end of the 19th century, cycling became a common mode of transportation in cities, especially on shorter distances. Already at that time, the problem of road use was shared by cyclists, horse-drawn carriages and pedestrians. In recent decades, developed European countries have paid particular attention to the development of sustainable urban mobility and to planning cycling to reduce traffic congestion, increase safety and make cities more liveable.

Promoting daily cycling is an ongoing process that needs more than just well thought out investments in cycling infrastructure. Each city has a different approach to cycling - some implement a stand-alone policy, while others integrate cycling policy into other planning documents, eg general development plans, transport and transport policies, etc.

The strong cycling culture of a city requires well-developed infrastructure and extensive facilities that support the large amount of everyday cyclists in an urban environment. Modern trends in mobility support the idea of living without noise and in the context of sustainable development, which implies the revival of walking, cycling and public transport. Cities should maintain and improve their cycling infrastructure not only to retain cyclists but also to attract new ones [5].

According to Sindik [6], in some cities in Europe such as Copenhagen, Amsterdam, Bremen and Antwerp the proportion of bicycle traffic ranges from 20 % - 30 %. An interesting estimate is that more than 30 % of car trips in Europe are shorter than 3 kilometers and 50 % shorter than 5 kilometers. These distances can be covered by children and the elderly by comfortable biking. When considering the length of trails in terms of population as an indicator of the size of cycling infrastructure, Denmark is the leading city in Copenhagen (454 km / 770,000 inhabitants) and the Dutch cities Amsterdam (400 km / 1,300,000) and Utrecht [7].

3 Case study Koprivnica

According to the Sustainable Urban Mobility Plan of the City of Koprivnica [8], there are around 70 km of cycling trails and more than 15 km of cyclotouristic routes in the city, leading Koprivnica even ahead of European cities in terms of length of tracks in terms of population. However, motor vehicle traffic in the City of Koprivnica is still far ahead in the overall modal split of travel. Considering that Koprivnica is an industrial hub affecting a large number of daily migration trips from the surrounding settlements and municipalities, one of the main reasons for the high intensity of motor vehicle traffic in the very center of Koprivnica is the lack of adequate transport alternatives to private vehicles to reach the town of Koprivnica from the surrounding settlements. and the municipality.

3.1 Methodology of data collection

Prior to the process of mapping bicycle infrastructure, it was necessary to define which roads would be covered by the mapping. The analysis covers only a narrower area of the city, without suburban settlements. The mapping includes only roads that fall into the category of cycling paths, bicycle lanes and cycling and walking trails and are marked with vertical and horizontal signage. The map thus obtained does not include interruptions in traffic routes due to unsettled bicycle crossings. Improperly marked crossings are therefore not considered as interruptions, so any street with a broken track or lane is shown on the map as continuous. Unfortunately, there are more than 80 % of them in Koprivnica [9].
If two-way lanes are on either side of the road, then their length is counted on each side individually, but if it is a two-way track on one side of the road only, then the length is counted only once and not for each direction separately.

3.2 Field mapping

Road mapping was performed between July 10 and July 19, 2019. For mapping, an Android-based mobile phone device was used. The software used for the mapping was OsmAnd, while map creation and analysis of the cycling trail data were made using the OpenStreetMap and QGIS computer applications. The reason for choosing these road mapping applications is that they are free, easy to use and offer complete freedom for users to create and analyze roads.
Entire cycling infrastructure was passed and recorded by bicycle. Each track is stored as a gpx file. All such files were later imported into the OpenStreetMap online map. After the bicycle roads were imported and loaded, any defects and errors were manually corrected. After that, each of the paths has been assigned attributes to further define:

- the type of road ('Generic path' is entered here to separate it from other roads in OSM-u
- street name
- type (cycling or cycling-walking)
- direction (one-way or two-way, ie track on one side of the road or on both sides).

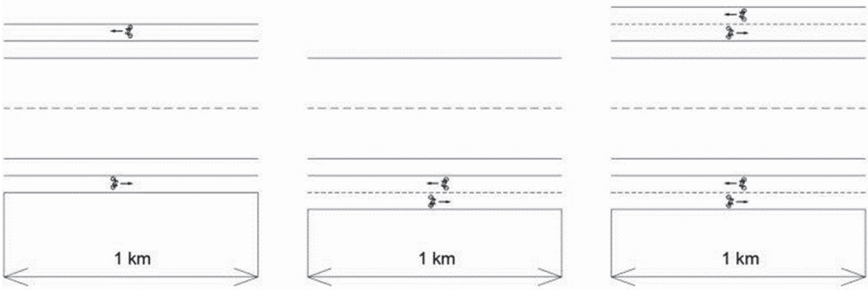

Figure 1 Methodology for calculating the length of bicycle infrastructure (created by the author)

The attributes mentioned are important because of the further processing and analysis of the data that is made in the QGIS application. QGIS allows users to create maps with multiple layers that use different map projections. The maps thus created consist of raster or vector layers. Vector data can be stored as points, lines, or polygons, and various types of raster images are supported.
After importing the vector data, it was first necessary to filter out any data that was not needed for analysis. OSM distinguishes three main types of spatial data and organizes them into these categories: points, lines, and polygons. Since the bike lanes and paths are line ob-

jects, the export of line objects is selected. Furthermore, if all the line objects (roads, paths, lanes, etc.) are to be singled out for cycling lanes and paths, it is necessary to define fields for which certain attributes will take on value [9].

3.3 Data analysis

The paper defines the questions to be answered after the map has been created:

- Where are the bike lanes and paths located in Koprivnica?
- Can the principles for planning and designing cycling infrastructure as set out in the Cycling Infrastructure Regulations (safety, economy, integrity, directness and attractiveness) be applied to the existing network?
- What is the total length of bike lanes and paths in Koprivnica? [9]

Comparing with the primary and secondary networks presented in Figure 1, it can be concluded that the cycling infrastructure is being built as planned. Except for the part in the western part of the city where most of the infrastructure has not yet been built.

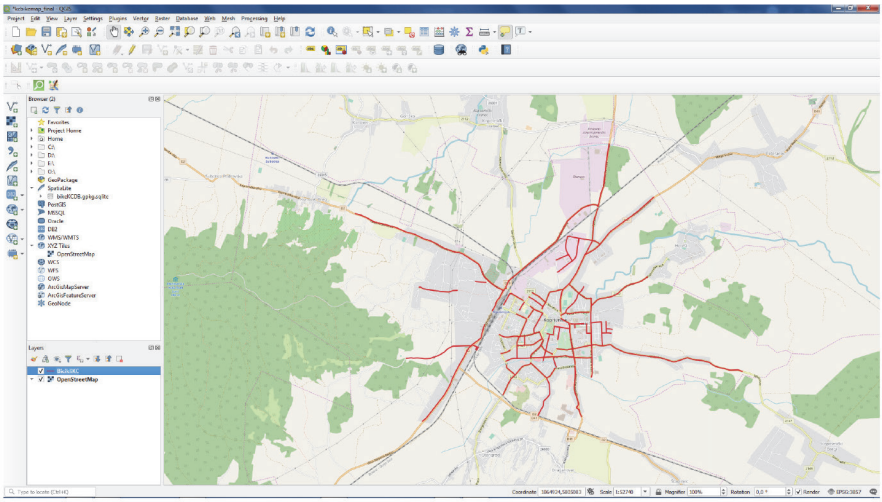

Figure 2 The layout of the resulting map after merging the vector file and the geospatial file section from OSM (created by the author)

According to the results, unmarked and undeveloped crossings of bicycle infrastructure over pavements, bridges or rail crossings in the city represent the biggest problem in the safety of bicycle traffic (Figure 4). As a consequence, the cycling network is disconnected, which is why cyclists are often forced to violate regulations and continue to drive on the roadway or sidewalk, endangering themselves or pedestrians.

This situation is largely due to the lack of regulations for the design of cycling infrastructure at national level, which was adopted in 2016 [10], so it is difficult to expect that existing pedestrian-cycling paths will be harmonized with the basic needs of sustainable forms of traffic, which is ultimately the cause of reduced safety. pedestrian and bicycle traffic.

A total of 61 streets were processed through field mapping. The obtained statistics are classified in two ways: in the first column of the table, the length of the road corresponds to the length if it counts only in one direction, and in the other if it counts in both directions, ie those bicycle roads which are constructed as two lanes on either side of the road. The total length of bicycle lanes in Koprivnica is 53.5 km, counting the roads with two bicycle lanes on either side of the road.

According to the available data on the length of bicycle roads, Koprivnica should in total have about 70 km of bicycle infrastructure [8]. The assumption is that this data also includes suburban settlements that were not included in the analysis and as well as the possibility that this length is increased by the value of the paths marked on one side in both directions.

Figure 3 Interruption of the cycle path on Starogradska and Miklinovec Street (created by the author)

3.4 Survey research

In addition to field mapping, a survey was conducted among the city residents about the state of cycling infrastructure and cycling habits when participating in traffic. According to the survey, one third of users (33 %) use bike daily or almost daily, and only 12 % said they did not use it at all. 42 % of those polled go to work, college or school with a bicycle, while as many as 49 % of respondents said that they use the bike most for recreational purposes or for going to sports. Respondents were also asked what would contribute to greater use of the bicycle as a means of transport. Most of them (more than 70 %) are not satisfied with the safety on bikes and want more safety at intersections and separate bike paths. [11]

4 What to do?

There are many parameters that affect the development of cycling in a city. Certainly good infrastructure and safety are among the most important. However, in recent days, public bicycle system as well as events organized for the benefit of cycling, must be considered.
In terms of population, Koprivnica has an above-average infrastructure, especially within the Republic of Croatia. One part of the infrastructure is not in compliance with the Rule book [10] and should be affected as soon as possible. This would allow, where possible, the separation of cycling from other infrastructure, thereby affecting the safety of cyclists and thus other road users.
In addition, most of the crossings of bicycle paths across the intersection are not properly marked, which means that the cyclist should get off the bike and push it over the pedestrian crossing. There are more than 80 % of crossroads like these in the city [9] , and it does not take much to improve this situation.
Regarding the public bicycle system, there is a completely free system in Koprivnica consisting of 60 bicycles, 7 docking stations with IT surveillance of the system and publicly available GIS tickets for tourists. The number of borrowings varies from 15,000-25,000 per year with

over 1,000 registered users. It can be concluded that such a system is sufficient for the current and future development of cycling in Koprivnica. [11]
Furthermore, this research needs to be extended to the surrounding settlements, since there are many people who communicate with the city center on a daily basis, and if they had secure and sufficient infrastructure, they would probably use bicycles more for daily communication.

5 Bicycle infrastructure in COVID 19 crisis

During the pandemic, the possibilities and needs for mobility, primarily the use of passenger cars, were partially reduced, thus freeing up more space for other modes of individual mobility - walking and cycling. To provide city dwellers with the recommended distance, many cities began "taking" from cars and "giving" to pedestrians and cyclists.
This was done by temporarily rearranging parts of the pavement into bicycle paths (so called "pop-up bike lanes"), thus partially relieving the common areas of pedestrians and cyclists and thus increasing the space for pedestrians. This satisfies the condition of the prescribed distance, thus relieving the already overcrowded public transport, and increasing the safety of all traffic participants. This has led to increased use of bicycles in cities that have implemented this measure of sustainable mobility.

6 Conclusion

Within modern sustainable transport systems, bicycles play an increasing role as a means of transportation. Koprivnica, as a "smart" city that strives for sustainability at all levels, realized that only investments in sustainable transport projects would reach other European and world cities that have already made progress in this regard. Good cycling infrastructure is the first and foremost prerequisite for this. The results obtained show good integrity and directness, but poor safety and attractiveness of the infrastructure. The major problems are caused by the inconsistency of old infrastructure with the new Bicycle Infrastructure Regulations, which was adopted in March 2016. Many of the temporary measures introduced in pandemic will remain after returning to "normal" and thus contribute to sustainable mobility. Now is the opportunity for our cities to expand their cycling infrastructure and help return to a healthier and more sustainable lifestyle.

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