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# Planning and evaluation of the service of bicycle traffic

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***ABSTRACT :*** *Today, many cities, thanks to the modern way of life, face traffic congestion, an increase in the number of vehicles, a lack of parking spaces and green spaces, which together affect the economic, ecological and health aspects of living in cities, as well as the traffic safety. A large number of traffic planners and designers are daily looking for measures and solutions that would improve the lifestyle. The main goal is for citizens to have better mobility and accessibility, while simultaneously reducing negative effects on the environment and a better environment for everyone. With the increase in motor traffic and re-design of green areas, walking and the use of bicycles have been neglected, and thus the desire for their use has decreased, while the maintenance and construction of their infrastructure is as if it does not exist at all. The purpose of this paper is to present the procedure for determining the level of service of bicycle flows using the BOLS linear regression model, and bicycle traffic planning in Macedonia.*
***KEYWORDS*** *planning, bike, level of service, sustainable.*

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## I. INTRODUCTION

Traffic planning is in close correlation with the planning and design of traffic infrastructure. As for motor, pedestrian and bicycle traffic, it is necessary to establish the level of service offered by the area. Bicycle traffic has a direct connection with the points of creating better public spaces, better cities to live in and safety in traffic.

The bicycle from the moment of its invention until today is increasingly perfected, and is placed in the group of non-motorized traffic that has a number of advantages in terms of health, the environment, because it does not cause noise and emissions, it is used to promote sustainable development and mobility in cities. It is used for different purposes, and it takes place through specially separated bicycle paths and lanes, and for safe inclusion in traffic there are special rules and regulations that should be observed.

In the second part of the seminar work, it will be shown the BOLS- (Bicycle Level of Service) linear regression model, which analyzes the factors where cyclists feel safe, based on three road categories and six levels. of services from A-F by entering data, we determine what the conditions are and what should be undertaken for bicycle traffic.

## II. TERM OF BICYCLE

Bicycle (colloquial and wheel or bicycle) — a vehicle propelled by a person using pedals. A bicycle has two wheels attached to a frame, one behind the other. A person who rides a bicycle is called a cyclist. Bicycles appeared in the 19th century in Europe and by 2003 more than one billion had been produced, twice the number of cars produced. They are one of the primary means of transportation in many areas. They are also a widespread form of recreation, accepted to be used as children's toys, for physical activity, used in the military and police, courier services and bicycle racing.

The appearance of the bicycle as an invention had a huge impact on the development of society from the point of view of culture as well as the advancement of modern industrial methods. According to the law on road traffic safety, a person who has reached the age of ten can drive a bicycle on the road, while in a zone of calm traffic, a person under the age of ten accompanied by a person older than 16 years can drive a bicycle. A bicycle is a means of transportation that does not emit harmful gases, takes up very little space and is more energy efficient compared to other means of transportation. Mobility studies show that the majority of bicycle trips in urban areas are shorter than 5 km. In German cities, about 66% of total trips are shorter than 5 km, while in Polish cities, trips up to 5 km reach up to 80% of the total number of trips1. Trips of up to 5 km are considered the most appropriate for using a bicycle because door-to-door travel is the fastest by bicycle compared to other modes of transport. If we also take into account that in urban areas space is a limited resource, it is precisely in trips up to 5 km that the potential for increasing the use of the bicycle as a means of transport should be sought. In the last two decades, cycling has become popular again, and its health, environmental, economic, and transportation benefits are increasingly understood and accepted. Fig. 1 shows a bicycle.

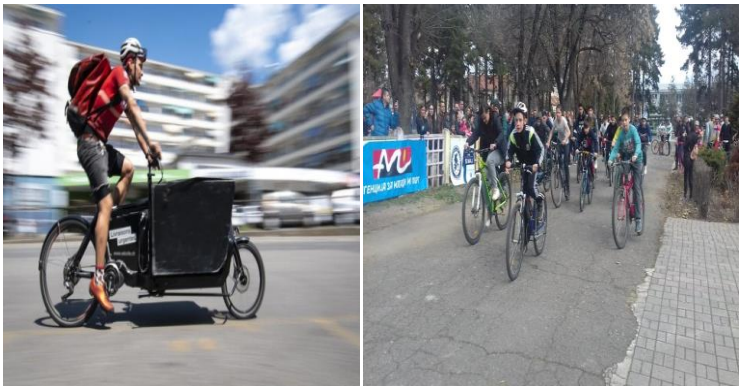

**Fig.1. Bicycle**

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## III. ADVANTAGES AND DISADVANTAGES OF CYCLING

Cycling is widely recognized as a very effective and efficient mode of transport ideal for short or moderate distances. The bicycle is slowly but surely taking precedence as a means of fast, cheap and alternative transport. In addition to this, cycling is a sport and a bicycle is a tool for sports, recreation, socializing and adventures.

- Sport without limits,
- A vehicle and friend to the environment,
- It improves the health of a person,
- Economical,
- Practical

The following disadvantages can be listed: exposure to pollutants, reduced safety, accessibility, poor weather conditions, unfavorable road conditions and others.

## IV. CYCLING INFRASTRUCTURE

A good and high-quality infrastructure for bicycle traffic is key to increasing the use of bicycles. Measures in this area should result in guidelines and standards for bicycle infrastructure, provision of a high-quality, safe, comfortable and well-connected bicycle network, as well as installation of facilities and equipment for safe parking of bicycles. The development of bicycle traffic in European cities is an integral part of the numerous activities undertaken to encourage cycling as a daily mode of transport, as it is increasingly evident that it is good and appropriate for urban environments. In doing so, it is very important to consider the cyclist as a special type of traffic participant, which further means giving space and taking care of his unique needs. The necessary infrastructure for the development of bicycle flows should fit into the surrounding space, which is

often congested. This means reconciling the mutually conflicting needs in space of the various traffic participants, while not losing the quality of the urban design.

- Bicycle lane
- Bicycle path

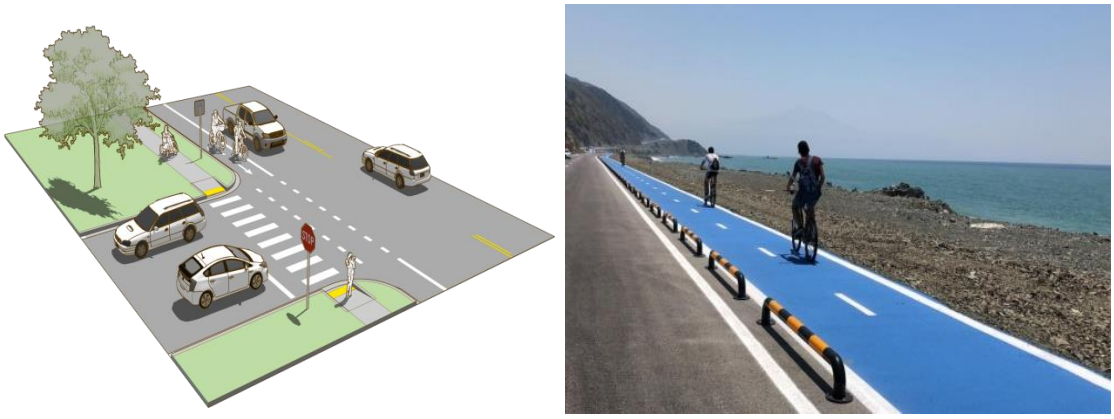


**Fig.2 Bicycle lane and path**

## V. LEVEL OF SERVICE

Traffic engineers often use Service Levels A to F to describe the amount of delay and always recommend wider roads. What might be the Level of Service for cyclists? Perhaps Service Quality is a better measure. The level of service for drivers, cyclists and pedestrians is determined based on various criteria.

BLOS (Bicycle Level of Service) for motor vehicles is primarily based on speed, density, flow and congestion, while the calculation of BLOS for cyclists is based more on comfort and safety. The level of service of bicycle traffic is a function of different operating conditions, that is, of a set of factors that describe the conditions of movement that appear on a certain part of the bicycle paths.

Factors that determine the conditions of movement are:

- Speed of movement
- Travel time
- Interrupt; Freedom of movement
- Driving safety
- Driving comfort
- Price, etc.

The cyclist perceives and evaluates the riding conditions and based on that freely chooses the path and the speed of movement, as well as the physical and psychological benefits of riding. Cyclists are affected by the degree of risk they are exposed to, the relative likelihood that they will not meet their riding goals, and the cost of the service. Some of the listed factors are measurable, such as speed, while the comfort of the cyclist is immeasurable. The speed, flow and density criteria are commonly used to describe the level of service, as they are easier to understand and measure.

## VI. BICYCLE LEVEL OF SERVICE MODEL (BLOS)

Traffic experts have developed a linear regression model to calculate the bicycle level of service (BLOS), taking into account:

- The flow of traffic during peak hours
- The speed of the traffic and the percentage of heavy vehicles
- The condition of the surfaces of the bicycle paths
- The width of the bike path

The level of bicycle services is divided into six grades which are marked with letters from A to F (A-best, F-worst). Each service level is determined by the number of points shown in the following figure 3.

| BLOS Grade | BLOS Score |
|---|---|
| A | <=1.5 |
| B | 1.5 - 2.5 |
| C | 2.5 - 3.5 |
| D | 3.5 – 4.5 |
| E | 4.5 – 5.5 |
| F | > 5.5 |

**Fig.3 Show bicycle level of service**

A BLOS assessment can be useful in a number of ways:
- A cycling map can be produced for the public to assist in route selection.
- The most suitable routes for inclusion in the community bicycle network can be identified.
- Can identify "weak links" in the network and prioritize pages that need improvement.
- Alternative treatments can be evaluated to improve the bike's road adaptability.
- Design road selection formulas can include a BLOS or BCI term to encourage the implementation of bicycle planning goals.

$$\mathbf{BLOS = 0.507 \times \ln(Vol15/Ln) + 0.199 \times SPt\,(1+ 10.38HV)^2 + 7.066 \times (1/PR5)^2 - 0.005 \times (We)^2 + 0.76}$$

(1) The BLOS regression equation

Where,

Vol15 – traffic volume during the peak 15-minute time slot,

Vol15 = (ADT x D x Kd ) / (4 x PHF) where,

ADT – Daily average traffic,
D – Factor of direction ,
Kd – Daily factor,
PHF – Peak-hour factor (1.0)
Ln - Number of lanes in each direction,
SPt- Effective speed limit,

SPt = 1.1199 x Ln( SPp – 20 ) + 0.8103 where,
SPp – Speed limit.
HV - Percentage of heavy trucks,
PR5 - Pavement condition rating based on the FHWA 5-point scale,
We - Average effective lane width,

We = Wv – (10 ft x % OSPA), for WI=0
We = Wv + WI (1 – 2 x % OSPA), for WI > 0 and Wps = 0,
We = Wv + WI – 2 (10 X % OSPA), for WI >0, AND Wps > 0 and there is a bicycle lane,

Where,
Wv - effective width as a function of the traffic volume,

Wv = Wt if ADT > 4,000 veh/day
Wv = Wt (2- 0.00025 x ADT), If ADT ≤ 4,000 vehicles during the day and the street is not divided,
Wt - total pavement width from outside lane,
WI - width of paving between outer lane and curb,
OSPA – the percentage of the segment occupied by street parking
Wps - width of the parking strip.

In the first part of the BLOS equation, it measures the impacts of peak hour traffic flow on cyclists. Roads with high traffic volumes on the outside lane would receive a high BLOS score, indicating low suitability for bicycle travel.

The second part of the BLOS equation measures the impacts of travel speed and percentage of traffic density (buses and trucks) on the environment for bicycle commuting. Roads with a high posted speed limit and a high number of trucks and buses would receive a high BLOS score, indicating low suitability for cycle travel.

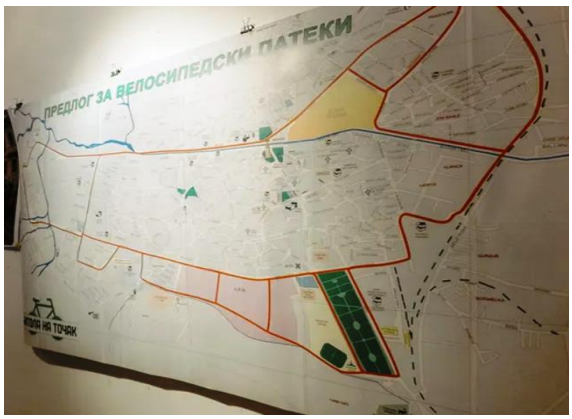
Similarly, the third part of the BLOS equation measures the influence of pavement surface condition on cycling quality and assigns a high BLOS score to roads with degraded pavement. These first three parts of the BLOS score are added together to calculate the raw BLOS score.

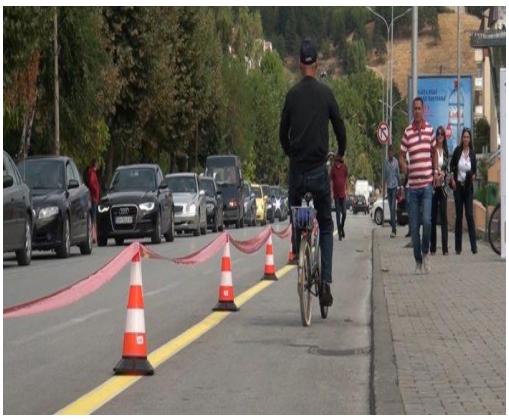
The final BLOS score is calculated by subtracting the benefit score based on the width of the pavement available for cycling from the raw score. Roads with bicycle lanes, wide lanes, paved surfaces, or a small amount of on-street parking would receive discounts from the raw BLOS score, resulting in low BLOS values or good service levels.

## VII.BICYCLE TRAFFIC PLANNING IN MACEDONIA

Macedonia is one of the countries with the most dangerous traffic in Europe, and when the infrastructure design is the primary factor for safety; the standards and norms for planning and projecting traffic are completely autocentric and unchanged for half a century. We have no standards for cycling and pedestrian infrastructure, and the regulations favor the car and high speeds over safety. In addition, the public space in our cities is completely flooded with cars. The right of free movement of pedestrians, people on bicycles, people with strollers, activities with children in strollers, all participants are disabled, even their lives are threatened, and the victims are exposed to the large types of photos, hard particles and noise that originate from the extensive and fast automobile traffic.

In Macedonia, there are cities that have built and installed a bicycle infrastructure. Such as the city of Skopje, Prilep, Bitola, Ohrid, Strumica and others. Plans for sustainable transportation systems are of great importance for building a sustainable urban city. Cycling in Macedonia is still at a very low level. Bitola is one of those cities whose size, favorable topographical location and annual weather conditions are an excellent opportunity for good bicycle infrastructure. The weak side is the narrow geometrical profiles of the street network and the need to take space from motorized or pedestrian traffic, and the fact that for a long time the bicycle has been neglected in the planning of the city's infrastructure, as well as the awareness and tradition of its use. With the help of this regression model, a number of calculations can be made and the level of service that would be offered by the bike lane/path can be determined.



## VIII.CONCLUSION

More and more cities around the world are focusing on increasing the use of bicycles as a means of transport. But getting more people to ride bicycles instead of cars isn't. Cyclists must feel safe getting from point A to point B on two wheels, regardless of the distance. It is a fact that many do not feel safe. One thing that could happen is for cities to plan and implement a comprehensive street change policy, funding cycling infrastructure, building protected bike lanes, and talking to people about what will make them feel safe on the road and give them we offer bicycles as everyday transportation. By using lanes as well as other infrastructure that will improve connectivity between neighborhoods with bikes, jobs, shops, cities will encourage people to use bicycles instead of cars for everyday transportation.

We can conclude that cycling is a non-motorized traffic that has a large number of advantages, through which cities apply means and measures for the realization of sustainable mobility and development. As a result of the increased number of motor traffic, lack of parking spaces, air pollution, congestion, a large number of traffic accidents, the bicycle is a solution that will solve many problems, and the environment would be grateful to us. But in order to achieve this, we need to respect the demands of cyclists, in terms of the necessary space, safety, accessibility, good infrastructure, mobility, paths, etc.

Determining the level of service is of great importance in certain segments of the roads, in order to answer the question of whether the existing ones should be expanded, connected or added to new bicycle lanes. We have established that there are six levels of service and the lower the values, the more favorable the conditions for the movement of cyclists.

With the help of the BLOS regression model we can determine the level of service where several parameters are taken such as: daily average traffic, factor of direction, daily factor, peak-hour factor, number of lanes in each direction, effective speed limit, speed limit, percentage of heavy trucks, average effective lane width, and other key parameters for solving the regression formula.

Macedonia is a country in which motoring and low safety in traffic is at a high level, but there are efforts to build policies of sustainable urban transport, building a green cities, where the construction of bicycle paths and lanes with a good level of service will satisfy the needs of the users, and on the other hand will attract more.

## REFERENCES

[1]. https://www.radiomof.mk/shto-treba-da-znae-sekoj-velosipedist-koj-saka-da-vozi-nadvor-od-gradot/
[2]. https://pluspharma.mk/2019/03/01/velosipedizam-zhivot-na-dve-trkala/
[3]. https://mk.wikipedia.org/wiki/%D0%92%D0%B5%D0%BB%D0%BE%D1%81%D0%B8%D0%BF%D0%B5%D0%B4
[4]. https://mk.koshachek.com/articles/prednosti-za-velosipedizam-nedostatoci-trikovi.html
[5]. https://www.transportation-planning.com/blog/what-do-cyclists-think-of-bike-facilities-my-take
[6]. https://rideillinois.org/advocacy/bikeped-level-of-service-measures-and-calculators/
[7]. https://rideillinois.org/wp-content/uploads/2015/10/TransChi2001.pdf
[8]. file:///C:/Users/Acer/Desktop/.pdf
[9]. https://rideillinois.org/blos/blosform.htm
[10]. file:///C:/Users/Acer/AppData/Local/Temp/sustainability-12-02944.pdf
[11]. https://www.sciencedirect.com/science/article/pii/S209575641630294X
[12]. https://www.cityofspartanburg.org/cms_assets/Bicycle-Ped%20Plan%20-%20Appendix%20C%20-%20BLOS.pdf
[13]. https://natochak.blogspot.com/2020/11/blog-post_25.html