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POLICY AND PROGRAMS FOR CYCLING IN THE CITY OF ZAGREB – A CRITICAL REVIEW

ABSTRACT

Studying cycling traffic issues in a beginner city – City of Zagreb, stems from unclear development policy, an increase in cycling volume, a large number of traffic accidents, an inadequate infrastructure and legislation, a small number of high quality studies and published papers, and the question, did current cycling policy and programs advance cycling? A comprehensive search of available literature, including data from the Zagreb Traffic Department, was made. These data do not adequately address the direction of causality, such as whether current cycling policy and programs advance cycling or whether cycling demand led to increased levels of cycling. This review paper suggests that, it is not yet possible to evaluate which pro-bicycle packages are the most effective and, development of cycling traffic requires a coordinated holistic planning strategy. Results could serve as a beacon light for similarly sized beginner cities, especially those who are located in South-eastern and Eastern Europe.

KEY WORDS

cycling traffic; policy and programs; legislative regulations; sustainable urban mobility; City of Zagreb;

1. INTRODUCTION

Besides contributing to the health of its users, cycling also decreases air pollution, carbon emissions, congestion, noise and other harmful effects of car use [1]. Systematically developed cycling traffic is, along with an adequate public transportation, one of the most significant forms of achieving sustainable level

of citizen mobility and city development. Cycling as a means of transport enables changes in planning, organisation and management of traffic demand, especially in urban centres. Cycling is therefore considered [2] as a vital measure in creating and choosing an optimal traffic demand management strategy.

Certain cities have in the last ten years doubled or quadrupled the number of cycling trips while serious cyclist injuries decreased by 10 to 40% [1]. Apart from the registered demand, space availability and appropriate cycling infrastructure are basic prerequisites for the development of cycling traffic. According to previous studies [3,4], attributes which define a quality cycling infrastructure are: a roadway's physical, functional and operational characteristics (lane width, design speed, manoeuvring space, existence of sharp turns and obstacles), motor vehicle speed, intersection sight distance, presence of intersections and street trees (shading). Advantages, disadvantages, and experiences of cities and countries under development, implementation and evaluation of cycling traffic policy and program measures are demonstrated in detail by Pucher et al. [1]. Thus, we orient our framework on Pucher et al. [1] to study the City of Zagreb (Zagreb).

An insufficiently clear development policy, a non-existing systematic monitoring and analysis of the current state, an increase in cycling volume, a large number of traffic accidents, inadequate infrastructure and legislation, a small number of high quality studies and published papers and the question, if current cycling policy and programs did advance cycling, are reasons to study the problems of cycling traffic in Zagreb.

So, the main purposes of this paper are: (1) study, describe and analyse the current state of cycling traffic; (2) list and describe implemented policy and program interventions to promote cycling; (3) show on where and to what extent these interventions are currently being implemented; and (4) assess the actual impacts of various interventions on the level of cycling in Zagreb. For this purpose, a comprehensive search of relevant and available literature has been made. Results and recommendations of Ključarić et al. [5] were used as a basis for this study. Data from the departments of Urban Development and Traffic, which greatly contributed to the quality of the analysis, were also used.

Section number two enumerates known basic cycling data of Zagreb in terms of volumes and safety, while the pro-cycling policies and measures are described in section three. Section four discusses this appraisal to lead to section five where conclusions are drawn.

2. BASIC DATA ABOUT CYCLING TRAFFIC IN ZAGREB

The administrative surface area of the City and County of Zagreb covers 3,701 km² (6.53% of the Republic of Croatia), and is inhabited by 1,107,623 residents, according to the census of 2011, or 25.84% of Croatia's population [6]. In 2013, there were 470,787 motor vehicles registered, constituting a motorization rate of 425 vehicles per 1,000 inhabitants [7]. Zagreb covers flat and hilly terrain of 641 km². Of this area, 67% is flat terrain with slopes up to 8.8% and lowland climate (average annual air temperature is 10.4 °C with average annual rainfall of 923.3 l/m²) [8,9]. Planning of cycling traffic began in the 1980s when the first General Plan for Urban Zoning (GPUZ) was passed. At that point, cycling traffic and provided infrastructure were exclusively oriented toward recreational and sports purposes (e.g. recreational and sports centre "Jarun").

Considering a comprehensive search of work done on cycling traffic in Zagreb, one can conclude that the initial research was the critical analysis of the current state. Study methodologies varied notably in type and quality. Thus, Kelčec-Suhovec [10] presents the possibilities, the general need for considering the development of cycling within the GPUZ, and the utilisation of the bicycle as a means of commuting. Also, Kelčec-Suhovec and Matos et al. [11] state the importance of city authorities in the development of cycling traffic. Later writings emphasised the advantages of cycling for the environment and human health [12], and the need to implement a PBSS [13].

2.1 Volume

For the purpose of a traffic study [14], first official cycling volume data was recorded in spring 1998 with the help of a household survey on 1.200 respondents. This research showed that only 0.7% of the daily trips were made by bicycle. It is interesting to note that 51% of households claimed to have at least one bicycle. In the study performed by ISIP-MG [15], manual counting of cycling traffic was conducted at 16 locations on walkways with cycling lanes on the city's busiest traffic corridors. Measurements were conducted for one week in April 2010 from 11.00 a.m. to 1.00 p.m. and from 3.00 to 5.00 p.m. (Figure 1.a). Weather conditions were appropriate: it was mostly sunny with dry pavement, but data about air temperatures is not known. Based upon these limited measurements, it can be assessed that there is a certain amount of increase in cycling traffic (Figure 1.a). Furthermore, the Faculty of Transport and Traffic Sciences (FTTS) from the University of Zagreb measured cycling traffic at certain locations for the needs of the project CIVITAS ELAN Zagreb [16]. Measurements were conducted for one week in April 2008 and 2012 from 4.00 to 5.00 p.m. Both measurements [15,16] were performed manually. Weather conditions were appropriate: it was

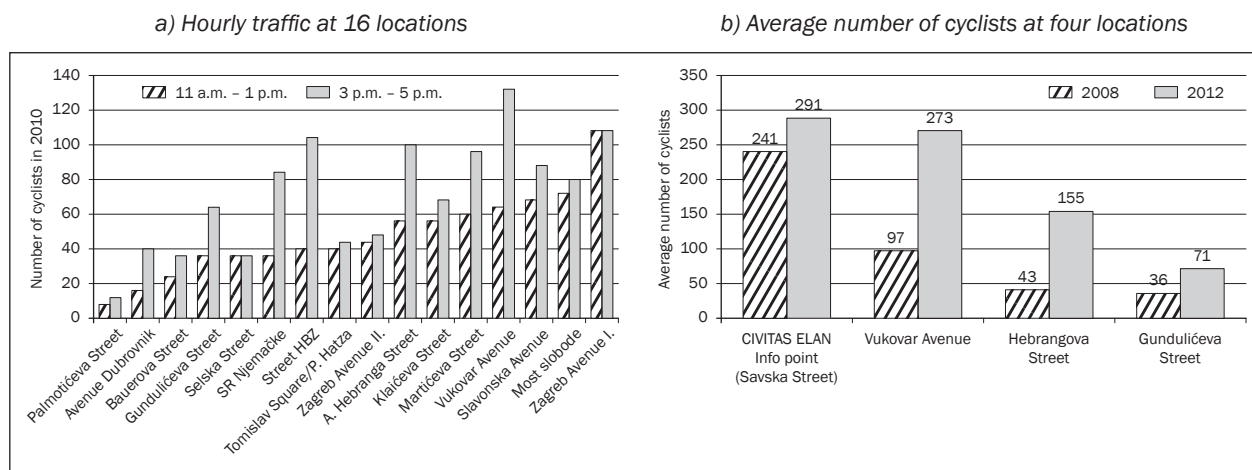


Figure 1 - Cycling volume: a) hourly at 16 locations [15] and b) average number at four locations [16].

Table 1 – Absolute and relative numbers and consequences of traffic accidents involving cyclists in the Republic of Croatia (CRO) and Zagreb (ZG) for 2011 and 2012 [7].

CRO – Croatia ZG – Zagreb	absolute numbers				per 10,000 population of entity				ZG per CRO [%]	
	2011		2012		2011		2012		2011	2012
	CRO	ZG	CRO	ZG	CRO	ZG	CRO	ZG		
participants	1,486	414	1,474	404	3.47	3.74	3.44	3.65	27.9	27.4
fatalities	29	7	23	2	0.07	0.06	0.05	0.02	24.1	8.7
injured	1,210	297	1,227	309	2.82	2.68	2.86	2.79	24.5	25.2
seriously injured	351	84	337	85	0.82	0.76	0.79	0.77	23.9	25.2
slightly injured	820	229	797	238	1.91	2.07	1.86	2.15	27.9	29.9

sunny with dry pavement and air temperatures were normal for this time of year in these areas (*Figure 1.b*). By comparing the results one can conclude that at the observed locations a significant increase in cycling traffic was recorded between 2008 and 2012, ranging from 17.2% to even as much as 72.3%.

In 2008 authors [17] conducted a survey between students on five faculties of the University of Zagreb that are located in the central part of Zagreb and concluded that less than 7% of the student population use bicycle as a means of transport regularly. In June of 2010, under the PRESTO project, a survey was conducted using a sample of 600 students of the University of Zagreb [18]. The research showed that a third of the students use the bicycle to get to the University on a daily basis.

The ELAN project [16] resulted in data on Modal Split which was collected by carrying out a survey at the City level. For the population of 779,000 inhabitants (official number of citizens of Zagreb at 2009), with an error margin of 5%, a confidence level of 95% and a proportion of 0.5 the required sample size is 384. In 2009 501 correctly completed questionnaires were obtained and in 2012 that number was 504. The statistical error in 2009 equals to 4.38%, while in 2012 the error is 4.36%. The sample was stratified by neighbourhoods and by age population. The share of cyclists in the modal split for 2009 was 2.96% and for 2012 it was 4.0% (*Figure 3*).

In an attempt to form a better traffic database on the volume of individual modes of transport, the city authorities plan to create the Traffic Strategy of Zagreb and the belonging traffic model in 2015.

2.2 Safety

The Zagreb Police Department (ZPD) is responsible for traffic safety monitoring in Zagreb and Zagreb County. The data for 2011 and 2012 on the number and consequences of traffic accidents involving cyclists is shown in *Table 1*. Unfortunately, data compiled by the ZPD for 2013 and previous years was not available. In general, the number of traffic accidents involving cyclist with 409 per year is big. For 2012, in

relation to 2011, *Table 1* shows a significant reduction in the number of fatalities by as much as 250% and the total number of accidents by 2.5%. However, the number of injured (seriously and slightly) increased by 3.9%. According to statistical reports [7], the most frequent causes of traffic accidents involving cyclists are the following: failure to use cycling paths/lanes, riding on sidewalks, and no lights at night. It should be mentioned that during 2012 about two thirds of traffic accidents involving cyclists were caused by cyclists.

Based on the comparison of data in *Table 1*, we can conclude for 2012 that the share of traffic accidents involving cyclists in Zagreb compared to Croatia amounts to 27.4% of all accidents, 8.7% of all fatalities and 25.2% of all injuries, which is in line with population distribution as Zagreb is about one quarter of Croatia's total population. The per capita accident rate issues Zagreb a better rating than the total country in terms of fatalities, injured and seriously injured. For slightly injured and participants, Zagreb has figures slightly less favourable than the country.

3. CYCLING POLICY AND PROGRAMS IN ZAGREB

The following section summarizes the development and implementation of pro-cycling policies and measures in Zagreb, hence, in the earlier stage the presence of a Bottom Up approach (citizens, activists, associations), and more recently a Top Down approach (Mayor, Politicians, Municipal Departments).

3.1 Administrative framework

Responsible for the planning, implementation and coordination of the cycling traffic program in the City and County of Zagreb is the municipal "Traffic Section" department. In coordination with representatives of the Cyclists Union and cycling associations they define, in line with available finances and regulations, implementation priorities for individual activities. Some of these activities are: visiting disputed locations and suggesting measures that can therein be implemented; taking part in the making of traffic solutions for

the forthcoming reconstructions and building of public traffic surfaces; and analysing the cycling safety level. So, development of cycling policies in Zagreb is focused on interventions that can be defined as follows: the development of cycling infrastructure, implementation of a PBSS, amending legislation for cycling traffic and various educational and marketing activities.

3.2 Cycling infrastructure

From 1995 to 2010, cycling paths have been gradually created and reconstructed to a final extent of 210 km. From 2010 to May 2014, an additional 21 km were added to this in the wider city area, as well as 138 km of recreational and sports cycling trails on the Zagreb side of Medvednica Nature Park (Figure 2), which sums up to approximately 370 km in total.

Over 90% of cycling routes have been arranged as cycling lanes on the walkway of city roads separated from the pedestrians by a yellow line. Only in the city centre on one main longitudinal road a cycling lane was established in the pavement section of the road spanning 1,300 m. Project ELAN [16] resulted in developing blueprints for the introduction of cycling

lanes in Southern part of Savska and Frankopanska Street, where a two-way cycling lane, 1.8 m in width and 2,500 m in length, is planned. In the next 15 to 20 years, in alignment with the GPUZ, cycling paths are projected to be extended by 5 to 7 km per year. The priority for expansion is to close gape in the route network. Therefore, in collaboration with the cycling associations, a need to introduce a “cycling magistral” (Figure 2 – upper left corner) was identified. This would enable an unobstructed connection from East to West. The “cycling magistral” is intended to be two-way and at least 2.5 m wide.

Various technological measures are being taken to further develop cycling infrastructure: removing urban-architectural barriers (lowering of curbs and bevelled ramps), adjusting/amending the signal equipment on signalized intersections, marking cycling surfaces red, installing fixed/elastic posts and creating cycling lanes during the reconstruction of important roads.

Initially, bike racks were placed near public institutions which covered 50 locations. However, project ELAN [16] resulted in a significant improvement of the cycling infrastructure within the ELAN corridor (Figure 2)

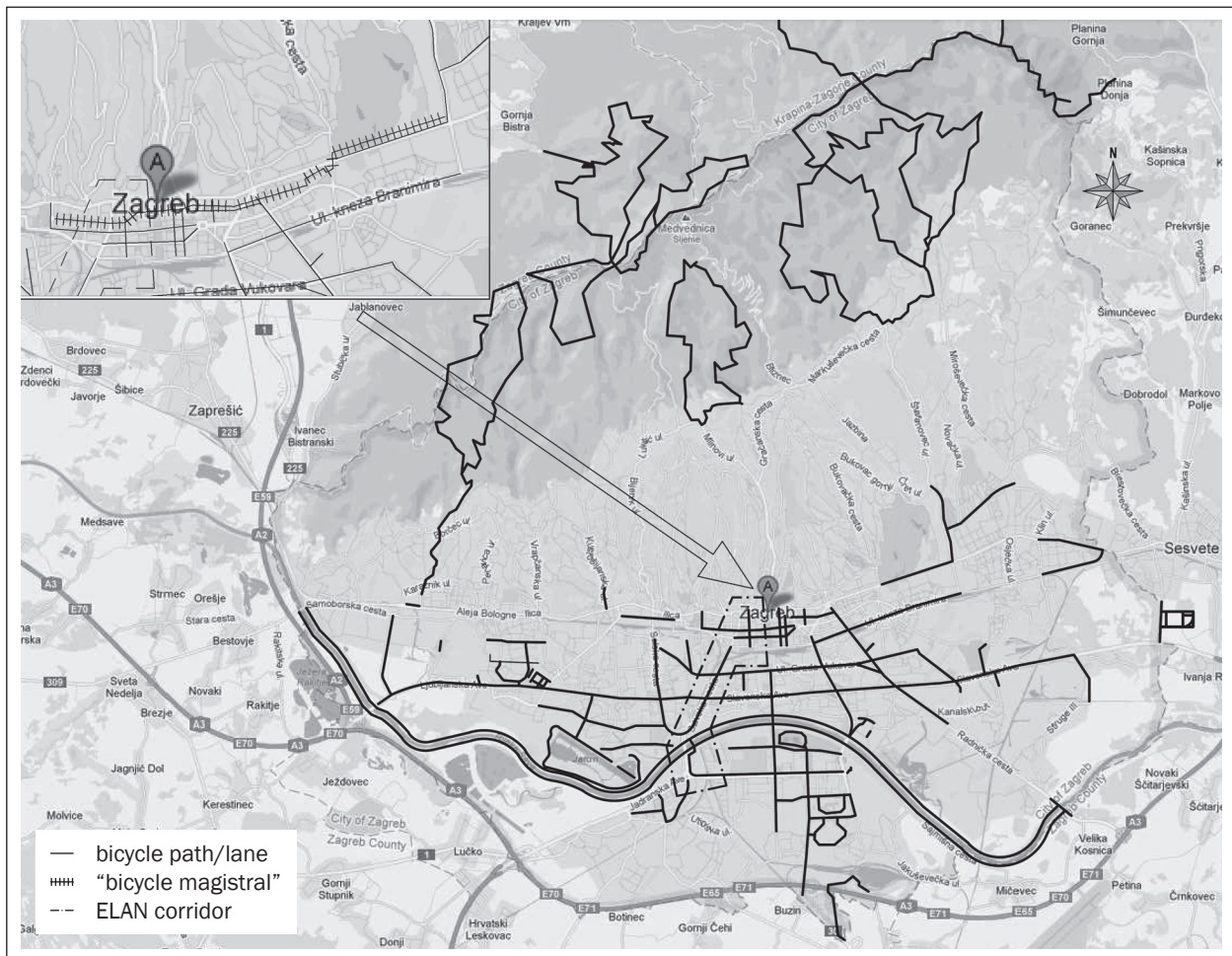


Figure 2 – Existing cycling network in Zagreb, July 2014

and outside of it as well. Thus, 150 parking spaces at 15 locations were introduced within the corridor, while 190 additional parking spaces were introduced outside of it at different points-of-interest (in front of shops, theatres, largest concert hall, PT stations, underground garages, on squares etc.).

Among other measures worth mentioning is the "Bicycle to the Garage". A bicycle rack offering 20 parking spaces has been placed in the public garage in Martićeva Street, at the ground level. The parking spaces were free for the first month and require a small fee now.

Also, the project ELAN [16] resulted in developing the Cycling Master Plan. It defines a vision, objectives and general measures for improvement of cycling traffic, but was not officially accepted by the City Assembly.

3.3 Public Bicycle Sharing Systems

Establishing a PBSS in Zagreb is not expected to pose a notable financial burden and has great potential to influence the mobility habits of the citizens in terms of alternative modes [5]. A PBSS pilot project led by a private partner *nextbike* was started in June 2013. At the moment 13 locations with 75 bicycles are in operation. Bicycle stations have been placed in city locations with highest frequencies of pedestrians [19]. Registration is done in three ways: through a web page, a mobile phone application or directly at the bicycle terminal. Activation of the account is made with a credit or debit card for a price of 79 Kuna (around 10.4 Euros, also the fare for rent), or through certain Telecom companies (activation and further payments through SMS). The first half hour is free, and after that every hour is 8 Kuna with a maximum rental period of five hours. In May 2014 already four thousand users were registered, with over 25 thousand rentals and 44 thousand kilometres covered [19].

Within ELAN [16] the *Studocikl pilot project* was designed and initiated bringing a PBSS to the University of Zagreb's Borongaj campus. The first phase included only the FTTS and the second phase is planned to include the remaining faculties located at the Borongaj campus. The idea was to provide students and faculty staff easier transportation between the two remote locations of the FTTS. The Borongaj campus currently consists of three faculties with a total of 4,500 students. The FTTS currently has about 1,450 full-time students, 710 part-time students and 179 members of staff. The *Studocikl project* has three basic features: 20 blue bicycles with logos, two depots (headquarters of FTTS at Vukelićeva Street and at Borongaj campus) for bike disposals and a web portal for login and logout. The service is free of charge for users, and maintenance costs are covered by FTTS. The rentals and disposals can be done during workdays (8.00 a.m. – 8.00 p.m.) and Saturdays (8.00 a.m. – 4.00 p.m.). At

Sundays the service is not available. All the bicycles meet the requirements of current Croatian legislation. The web portal is used to monitor bicycle depots in real-time in order to provide information about currently available bicycles and depot occupancy online [20]. From October 2012 until October 2013, there were 140 registered users who had rented the bicycle at least once. 360 rentals in total were registered. In 60% of the total rentals, the duration of the rental was less than 30 min. The future development of the *Studocikl project* is conceived to have the following: installation of GPS-trackers (this would prevent possible bicycle thefts and provide the data for scientific research), introduction of smart phone application, full automation of login/logout process, introduction of electric bicycles and expansion of the service to the entire University of Zagreb. In addition, the project aims to promote itself as well as the public awareness of cycling as a transport mode in general [20].

3.4 Cycling traffic legislation

Existing cycling legislation consists of national legislation: Law on the Safety of Road Traffic (NN 158/13), Ordinance on Traffic Signs, Signalization and Road Equipment (NN 14/11), Ordinance on Ensuring Accessibility of Buildings for Persons with Disabilities (NN 78/13), Ordinance on Basic Conditions to Which Public Roads Outside of Settlements Must Adhere from the Traffic Safety Aspect (NN 110/11), Ordinance on Technical Requirements for Vehicles in Road Traffic (NN 51/10), and local legislation: Decision on Traffic Regulation in the City of Zagreb (SGGZ 23/03), Decision of Adopting the GPUZ (SGGZ 7/13) and the Cycling Master Plan [16,21–27].

The Law [21] defines: cycling areas (paths/lanes), behaviour and movement of cyclists in/on traffic/roads exclusively for motor traffic, the movement of motor vehicles with regard to cycling, and the ability to ride a bike according to age. Management of cycling traffic through the light, vertical and horizontal traffic signalization is defined in [22]. Width, clearance of cycling paths and lanes are defined in the regulation [24] as the conditions for setting cycling racks and design of demarcation of cycling paths/lanes from public area is defined in [23]. Technical requirements and traffic equipment that bicycles must meet for safe traffic are defined in the technical guidelines [27].

The local legislation [25,26] defines cycling areas, depots, lowering of curbs and sidewalks, guidance and marking of vertical and horizontal signalization, and widths of cycling paths/lanes. Supervision of the legal implementation is carried out by municipal and traffic marshals with a specific area of supervision. However, the differences between the documents are reflected in the definition of a minimum width of cycling paths/lanes. The Decision [25] defines the width of cycling

path/lane up to 1.8/0.9 m and the Decision [26] up to 1.0/1.6 m. During 2014 it is planned to release a new Decision on traffic regulation in the City which, among other things, would solve aforementioned differences.

The Cycling Master Plan defines the vision, objectives and general measures for improvement of the current state of cycling traffic on the City level [16].

3.5 Promotional activities

The Department's promotional activities consist of financing various educational, and sports activities related to cycling safety and different modes of transport (regulation checks, driving skills, creating of cycling maps, manuals and others).

On the intersection of Streets Vukovara and Hrvatske bratske zajednice, a first counter/totem of bicycles was installed. From the installation on the 30th of May until the 31st of July 2014 there were around 90,000 bicycles registered which results to around 1,400 bicycles per day. This location in the city centre was chosen because of its visibility to cyclists and motorists and serves to promote and educate participants in traffic about the presence of cyclists. The installation of two additional mobile bicycle counters in the western and eastern part of the city is planned.

The *mobile2020 project* aims to encourage expert knowledge exchange and long-term development of cycling, as well as to strengthen city planners and de-

cision-makers in making quality investments and improvements in the traffic planning process. The project contributed to the Manual for Planning Cycling Traffic in Urban Centres, which is significant for physical planning, cycling infrastructure, services and possibilities of promotion in urban centres [28].

As part of the European Mobility Week, every year expert conventions on traffic safety and sustainable mobility in urban centres are held. The activities are focused on educating citizens and children about traffic culture and to encourage the use of public transportation, bicycles and walking. To promote the cycling culture by organizing targeted educational and promotional activities, in 2012 the Cycling Information Centre was opened. Also in the Centre, there is a European Cyclists Federation (ECF) point where citizens can get current information about their activities and programs [29].

Since 2012 Zagreb Cyclists Union has been organizing the biannual cycling festival *Pedalafest*. Being part conference part festival it aims to popularize the bicycle as a means of transport in the city. The program encompasses panels and workshops led by distinguished lecturers from abroad who present concrete solutions for improving the conditions for the use of bicycles as an sustainable and healthy means of transport [30]. *Pedalafest* also hosts a Critical Mass.

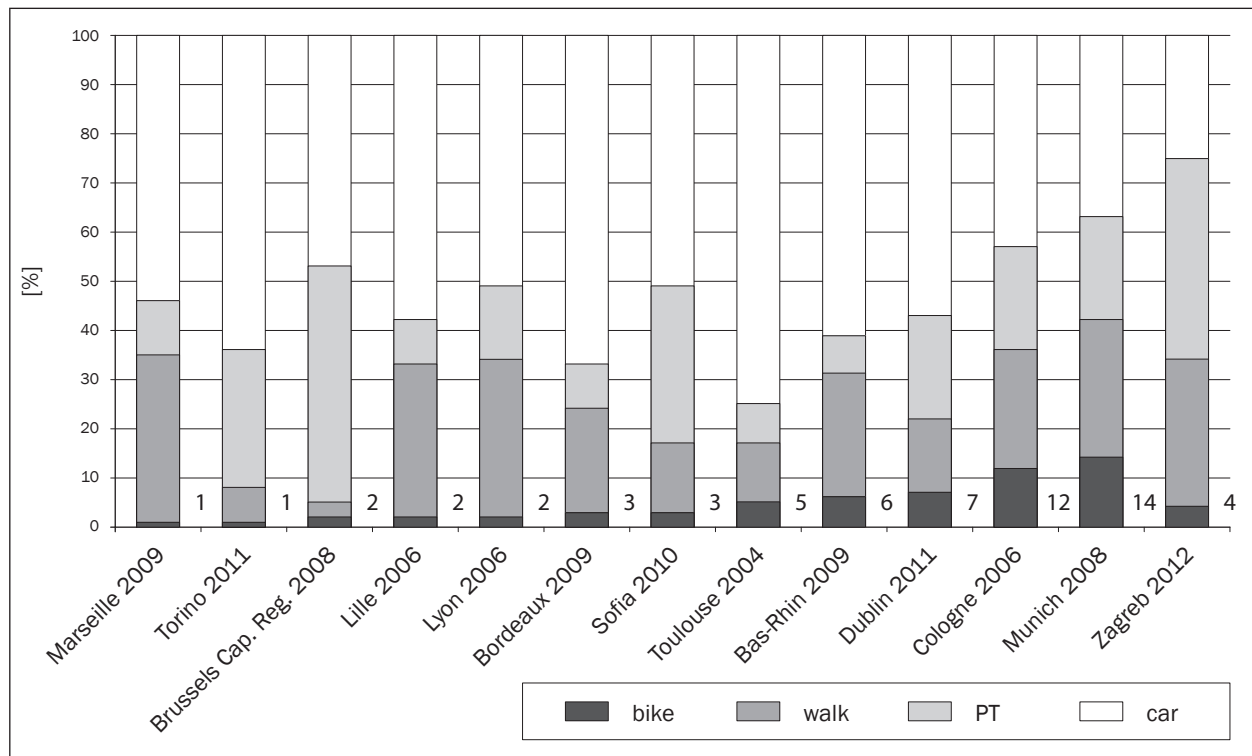


Figure 3 – Comparison of Modal Splits for European cities sized between 0.8 and 1.3 million inhabitants from TEMS database. Zagreb figures are based on the CIVITAS ELAN study [16]. Bicycle shares are depicted in black and values are shown next of each column ordered by increasing cycling share [31].

Table 2 – Absolute and relative numbers and consequences of traffic accidents involving cyclists in Austria and in Vienna for 2010 and 2011 [35,36].

AUT – Austria VIE – Vienna	absolute numbers				per 10,000 population of entity				VIE per AUT [%]	
	2010		2011		2010		2011		2010	2011
	AUT	VIE	AUT	VIE	AUT	VIE	AUT	VIE		
participants	4,847	526	5,787	639	5.79	3.10	6.89	3.73	10.85	11.04
fatalities	32	1	42	1	0.04	0.01	0.05	0.01	3.13	2.38
injured	4,835	525	5,745	638	5.78	3.09	6.84	3.73	10.86	11.11
seriously injured	1,010	69	1,229	98	1.21	0.41	1.46	0.57	6.83	7.97
slightly injured	3,317	456	3,885	540	3.96	2.68	4.63	3.16	13.75	13.90

4. DATA AND POLICY COMPARISON

Although the measurements of Zagreb cycling volumes show a remarkable increase over the period of four years, the lack of comprehensive time-series data makes it impossible to profoundly identify a trend – data remains a quantitative flashlight.

How much cycling is there in other cities of similar size? Zagreb fits in terms of size of population with other European cities from the TEMS database shown in Figure 3. Besides cities with poor cycling Modal Split, cities with exemplary cycling shares from 5% (Toulouse) to 14% (Munich) are present in this size group. A cycling share of 4.0% [16] allows us to conclude that Zagreb has a foundation for further enhancement and development. Policies implemented there could serve Zagreb as beacon light for measures to implement.

Another similar sized city is Belgrade (Serbia) where similar studies of traffic volume counts at 18 locations were conducted for 1999 and 2003. Numbers confirmed a slight increase in bicycle commuting and that the “other modes of transport” (cycling share being the most important among them) is between 3% and 10% of the Modal Split [32]. Also, this allowed the design of flexible-info systems for cyclist’s signalization and could represent to Croatian local and national traffic authorities a good working example.

Bicycle count data in a time series provides an excellent parameter for the evaluation of the success of measures taken. This is usually done using the $AADT_B$ parameter, the average daily bicycle traffic. Unfortunately the existing data of Zagreb only covers (Figures 1a and 1b) incoherent, random time intervals – one to two hours at off-peak (11.00 a.m.-1.00 p.m.) and divergent afternoon peak periods (1.00-3.00 p.m. and 4.00-5.00 p.m.). The mobility census has yet been done only in two years. This enables only for limited comparisons within the given measurement framework – e.g. during two different years – but not for a standardised compatibility.

The available accident data as well lacks a longitudinal perspective to be useful for a comprehensive appraisal. There appears to be the effect that Zagreb

attracts a slightly above average accident rate and the accidents appear to be less harmful than in the national average, as the rate of slightly injured cyclists is above the Croatian average and the rate of seriously injured ones is below.

When comparing the cycling related traffic accident figures of Zagreb and Croatia (Table 1) with Vienna and Austria (Table 2), the first notable peculiarity is the per population rate between capital and total country. Whereas Table 1 shows Zagreb’s rates being bigger than Croatian rates for accident participants and slightly injured, Table 2 shows the population related rate of accidents for Vienna not bigger than Austria. In terms of participants per population Vienna is about the size of Zagreb. When the cities’ share of national figures is used for comparison, Vienna’s share in general is smaller than Zagreb’s, while with fatalities and seriously injured this relation is much more strongly pronounced. At the city level, the Viennese rate of fatalities is distinctly smaller than Zagreb’s on the national level Austria is just slightly safer than Croatia.

Austria, which in general shows higher levels of everyday-purpose cycling than Croatia, in some categories has less favourable safety indicators. This is noteworthy due to the notion that higher levels of cycling are usually expected to lead to less risk for cycling, a phenomenon called safety in numbers [33,34]. The debate is still ongoing, if with cycling levels as low as in Vienna or Zagreb, the safety in numbers effect is not yet in effect. The rate of accident participants per population is higher for Austria than for Croatia. While the rate of injured per population in Vienna is bigger than in Zagreb, for Austria it is much bigger than for Croatia.

5. DISCUSSION

Zagreb cycling data results do not adequately address the direction of causality, such as whether cycling infrastructure led to increased levels of cycling or whether cycling demand led to investments in cycling infrastructure. Further increase of the number of bicycle counters would achieve a precondition for systematic monitoring of cycling traffic in the City.

Zagreb's PBSS data from May 2014 could represent a good addition to the development of public transportation and sustainability of traffic. But for final conclusions, these digitised data-sets are needed to be available to study travel behaviour as was for example done by Lathia et al. [37] and further sophisticated usage characteristics as for example has been done by Beecham and Wood [38].

The look at the enumerated law regulations reveals that these are not adapted the existing conditions and needs of cycling traffic in urban areas. They represent only basic term definitions and technical descriptions with general legal requirements. So, a lack of cycling-friendly and cycling-related regulations is evident. Hence, the Law [21] needs to be amended and an appropriate ordinance or decision on the regulation of cycling traffic in cities as well as guidelines for the design of cycling paths/lanes, PBSS, aprons and depots need to be created. Especially, concerning the number of flats and offices in residential buildings. Regulations are needed for: marking of cycle paths/lanes with red/yellow colour, setting the speed limit, sizing, positioning and guiding cycling paths/lanes within the profile of the road and across the intersection considering the volume of cycling and other traffic; designing the signal plans; supplementing the signalling equipment according to the needs of cycling traffic; general rules on the movement of cyclists and other participants in traffic on cycling paths, lanes, intersections and motor traffic roads where cycling paths/lanes are not yet constructed; ability and training for cycling and road-worthiness in city traffic.

As the Cycling Master Plan was not officially accepted, it may serve as a basis for future development of cycling traffic because it defines the vision, objectives and general measures for improvement. Furthermore, the upcoming Ordinance on Cycling Traffic by the federal Ministry of Maritime, Transportation and Infrastructure is planned to be aligned with the current guidelines and examples of good practice of leading cycling cities. It is essential that this new Ordinance includes very intuitive and ubiquitous regulations which are easily understood and enacted by all road users, e.g. yield rules [39].

Promotional and awareness programs like *Pedalafest* need to be supported by the municipality and be relocated from special venues and target audiences to open urban spaces for increased perception by the general public. Although Zagreb has approximately 370 km of cycling network in total, the priority for future expansion is on closing existing gaps. Continuity is of essential importance in the design of cycling infrastructure. Various authors [4,40] have shown that sufficiency and continuity of quality parameters such as organizational logic, applied design rules, types of compatible dedicated infrastructure, surface quality, radii, design speeds and lane widths are prerequi-

sites of unfolding a mainstream cycling culture. It was shown elsewhere that producing lots of debatable infrastructure alone is not prerequisite for cycling policy success [41].

We need to stress, that the decision to increase sustainability of transport in a city asks for a comprehensive bouquet of measures beyond just cycling. Sustainable transport policy is a matter of equal opportunities and space allocation between urban uses and transport modes, as only 100% of modal share trips can be distributed among the population. So, if further steps are taken to promote sustainable modes within a "push & pull" framework [42], push measures with non-sustainable modes need to be envisaged as well. Instead of producing pedestrian-cyclist conflict situations, an equal chances redistribution of urban space needs to be sought for.

Indicators are signposts that help to describe the behaviour of complex systems and thus also help to act ethically within these systems [43–45]. If incomplete or wrong data is gathered, this will likely lead to an incomplete representation of the system's status and thus likely to wrong measures. Transport systems are represented by data measured from people's mobility behaviour, (1) in *Figure 4*. Data produce a depiction of behaviour and with this representation in mind planners shape structures. But until recently the collection of data focused on car traffic and therefore measures have focused on car traffic – suppressing the remaining transport modes. For comprehensively improving this incomplete framework two extensions need to be adopted in Zagreb.

Firstly, Zagreb's data collection needs to include all transport modes to draw a representative picture that will enable planners to take improved measures. Secondly, planners need to systematically understand that people's mobility behaviour is the result of mobility structures (*Figure 4*, (2)). Herein structures are to be understood in a holistic manner, encompassing elements of the built environment, financial regulation and law as well [43]. As identified by Frey [44] and depicted in *Figure 4*, structures are a result of planning (3). Therefore the feedback of mobility data on planning procedures and planners' education plays a vital role in this new concept. The lack of comprehensive mobility data as well as the lack of a systematic understanding such incomplete data reduce the capability of policy impact evaluation.

The cycling infrastructure provided in Zagreb is still fragmentary and not at the state of the art. The collected data, albeit being very fragmented and incomprehensive, hint at a behaviour below the city's potential (see *Figure 3*). Comprehensive mobility data – including all modes, not only cars – is neither available area-wide nor in a time-series. If Zagreb's first sustainable mobility initiatives are expected to produce enduring valuable results, the continuous mea-

surement of comprehensive mobility data needs to be established in numerous locations. When planners, the general public and transport politicians will become aware of “the bicycle picture”, a qualitative public discourse on general planning paradigms or quality will be able to arise.

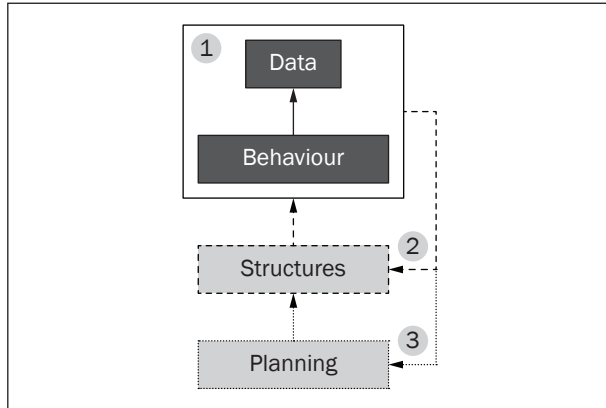


Figure 4 – The classic elements of transport planning (1) and the extension (2, 3) for a comprehensive approach; modified after [44].

Cities with a strong cycling presence such as Copenhagen, Graz and Salzburg in Austria, or Freiburg in Germany have shown first ways of implementing such a line of comprehensive planning philosophy. If Zagreb is bound to take its own transport policy goals seriously, a comprehensive transport policy from planning via education to data collection needs to be applied. If one wants to improve cycling, one needs to improve data on cycling, i.e. start counting them and change the behaviour-evoking structures. We therefore argue to establish a holistic planning strategy in Zagreb along the lines of Figure 4.

6. CONCLUSION

To achieve preconditions favourable for a sustainable development of traffic in Zagreb, it is necessary to encourage different modes of transportation, i.e. cycling [2,14,16,28].

This review sums up the available evidence of a wide variety of cycling policy measures in the beginner city Zagreb. Sections 2 and especially 3 show that a lot of policies have been introduced. Nevertheless, the crucial limitation is that there is an insufficient body of data and before/after research. This is especially true for data on the volume, structure and movement of cyclists on paths/lanes and the state of traffic safety. As a result, these data do not adequately address the direction of causality, such as whether current cycling policy and programs advance cycling or whether cycling demand led to increased levels of cycling. So, it's not possible to evaluate which measures and pro-bicycle policy packages are the most effective.

Studying cycling in Zagreb reveals that one of the most pressing problems remains the cycling network's discontinuity, i.e. the lack of wholeness, connectedness and compactness. As far as sustainable urban mobility is concerned, cycling traffic in Zagreb is a relatively new area of action. The examined policies indicate that competence building among planners and executives was only started recently. This poses a complex challenge. It is therefore necessary to adopt an appropriate integrated program for cycling traffic development. Such an integrated program utilises elements that we have outlined in chapter 5 and ranges from stakeholder education to improved planning procedures.

Results may serve as a basis for the creation of a coordinate and holistic planning strategy for development of cycling traffic in Zagreb. Also, they could serve as a beacon light for similar size beginner cities, especially those that are located in South-eastern and Eastern part of the Europe.

The need for further research implies the implementation of: systematic measurement and analysis of volume, structure and movement of cycling traffic; more extensive expert studies; improving and extending the existing cycling network; connecting the cycling network with the near-by cities and Eurovelo corridors [46]; upgrading PBSS and integration of its payment system with other city services (public transportation, parking etc.), and preventive activities. Also, the existing inadequate cycling-related legislation should be extensively complemented, according to local characteristics and aligned with lessons learned from European best cases.

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POLITIKA I PROGRAMI RAZVOJA BICIKLIZMA U GRADU ZAGREBU – KRITIČKI OSVRT

SAŽETAK

Istraživanje biciklističkog prometa u "gradu početniku" – Gradu Zagrebu, proizlazi iz nejasne razvojne politike, povećanja volumena biciklističkog prometa, povećanja broja prometnih nesreća, neodgovarajuće infrastrukture i regulative, malog broja kvalitetnih studija i objavljenih radova, te pitanja, jesu li trenutna prometna politika i programi unaprijedili biciklistički promet? Opsežno istraživanje obuhvatilo je svu dostupnu literaturu, te interne podatke iz Sektora za promet Grada Zagreba. Prikupljeni podatci nisu odgovarajući za utvrđivanje uzročnosti, da li su trenutna prometna politika i programi unaprijedili biciklistički promet, ili je biciklistička potražnja uzrokovala povećanu razinu biciklističkog prometa. Pregledni rad ukazuje da nije moguće ocijeniti koji pro biciklistički paketi su dosada najučinkovitiji, te da razvoj biciklističkog prometa zahtjeva koordiniranu strategiju cjelovitog planiranja. Rezultati mogu poslužiti kao orijentacijski primjer "gradovima početnicima" sličnih dimenzija, posebno onim smještenim u jugoistočnoj i istočnoj Europi.

KLJUČNE RIJEČI

biciklistički promet, politika i programi, zakonska regulativa, održiva urbana mobilnost, Grad Zagreb;

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