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# Road and Rail Infrastructure V

Stjepan Lakušić – EDITOR



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# Road and Rail Infrastructure V

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## GEOSPATIAL ANALYSIS OF TRAFFIC ACCIDENTS IN URBAN AREAS – CASE STUDY OF CITY OF SISAK

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### Abstract

Common issues affecting urban areas are traffic jams and the safety of road traffic, both of which are the consequence of the excessive usage of private cars. A large number of pedestrians and cyclists in urban traffic, specific features of the urban area, insufficient education and training of road users, as well as unregulated infrastructure, play a part in making public safety a growing issue in urban areas. The paper is primarily concerned with the analysis of road traffic accidents in the urban area of the City of Sisak, which is carried out using the geographic information system (GIS). The analysis offers an insight into the information concerning dangerous areas of road network, thus enabling the identification of areas which pose a higher risk and the proposition of suitable countermeasures in order to create a safe environment for road users and improve safety. In addition, the paper gives insight into a survey which estimates the subjective perception of safety of road users in the city of Sisak. Moreover, the paper includes a statistical analysis of the data processing on traffic accidents based on national database of the Ministry of the Interior. Furthermore, the paper also comprises measures such as the removal of problematic areas by introducing a new regulation of traffic flow organisation in the city centre, as well as indicators which have to be monitored on a yearly basis in order to increase the safety of all citizens in urban areas.

*Keywords: the safety of road traffic, traffic accidents, GIS, urban area, the city of Sisak*

### 1 Introduction

During 2016, the Faculty of Transport and Traffic Sciences and Deloitte Advisory Services Ltd. drafted a plan for a sustainable urban mobility plan for the City of Sisak. The City of Sisak is the center of the of Sisak-Moslavina County. According to the census conducted in 2011, the population of Sisak stands at 47,768 inhabitants. An analysis on the state of road safety was performed as a part of the project SUMP Sisak. The paper focuses on the downtown area of the city of Sisak, where the main city contents are concentrated. The center of the city covers an area of about 0.3 km<sup>2</sup> functioning as an ideal area for a 5-minute walk, considered the most natural form of movement.

The road network in the area of Sisak has been developed over a long period of time. Moreover, the road network is adapted to the role and function of the city's traffic system. In those conditions, numerous issues regarding the functioning of the road transport system occur. The issues may not be solved in an optimal manner because solutions are most often only partial. The allocation of space to motor traffic has caused local weaknesses due to the increase in the degree of motorization over the past two decades. Consequently, intense vehicle and pedestrian flows pass through downtown area of Sisak, possibly resulting in a conflict between pedestrian traffic flow and vehicle flow. The result of such traffic are numerous traffic accidents.

In order to obtain a precise picture of the current state of the traffic system in the City of Sisak, as well as a precise image of the planned development of the traffic system of Sisak, an analysis was conducted on all existing plans and projects related to the traffic system. After that, a field survey was conducted, which included traffic counts and citizen surveys. The paper proposes a comprehensive plan for sustainable urban mobility in the context of the multifunctionality of traffic (public transport, pedestrians, cyclists, personal transportation in motor vehicles), while taking into account the safety of all participants in the transport system.

## 2 Data Collection and Processing

In order to create a relevant local database, we obtained the following data: the data related to traffic accidents of the Ministry of the Interior of the Republic of Croatia [1], the official data of the City of Sisak [2] and the public data from the OpenStreetMap project [3]. An additional field research was conducted in order to collect data on the structure of the traffic flow. The usage of that data enabled the determination of the intensity of traffic load on the characteristic road network locations. Survey conducted on households provided the data on the modal split of journeys in the City of Sisak, as well as other data pertaining to the traffic system, such as the information on public transport, personal transport in motorized vehicles, pedestrian transport, bicycle traffic and more.

The pedestrian traffic in the city center takes place almost entirely on the sidewalks, located on both sides of the street. Intense pedestrian flows are connected to the downtown area, as well as to the area of the Old Bridge. The bicycle network in Sisak is fragmented and somewhat unsafe. Moreover, it does serve as a link between important travel destinations. Nevertheless, it is important to point out that significant progress has been made in the construction of new bicycle routes in the city area over the past few years. In the future, we may expect the elimination of some of the observed shortcomings, leading to the development of a positive infrastructural and service environment for cyclists. The regulation and organization of traffic flows and the network of one-way and two-way streets is well established (Figure 1a). Two one-way streets (Rimska Street and S. and A. Radića Street) make up two transversal streets parallel to the river Kupa. Such one-way streets ensure relatively good permeability and incorporate the motor traffic. The intersections of the city center are regulated with traffic lights at three locations. At other locations, the traffic is regulated with traffic signs.

The road traffic network of the downtown was analyzed using the PTV Visum macrosimulation tool. On the basis of the collected data, a traffic model of the existing state in morning and afternoon peak hours was developed. The traffic model highlights the problematic points of the high level of traffic network. The analysis of traffic intensity and service level conducted on most intersections in the city center indicated a good service level (A or B). E level of service was determined on only one of the analyzed intersections (S. and A. Radić – I.K. Sakcinskog). That level was due to the high concentration of pedestrians. Figure 1b shows the results in the afternoon peak due to higher traffic loads. Motor vehicles cause significant traffic load, noticeable in the very center of the city.

The analysis of the mode of travelling indicated the following: the highest number of journeys in the city center amounts to 47 % for personal cars, followed by 36 % for walking, 8 % for bicycles, 8 % for public transport and 1 % for motorcycles. Other surveys have shown that 38 % of citizens consider the introduction of the pedestrian zone in the center of the city to be the most important measure of the improvement of the quality of life in the City of Sisak. For the purpose of the project, a survey was conducted on the use of transport services in the city area with regard to hiking and cycling. The results show a weaker status of bicycle traffic in comparison with pedestrian traffic. The subjective perception of traffic safety in the city earned an average rating of 3.6 out of 5 for pedestrian traffic and grade 3 for cycling traffic. It must be mentioned that rating 1 indicates complete dissatisfaction, whereas 5 indicates complete satisfaction.

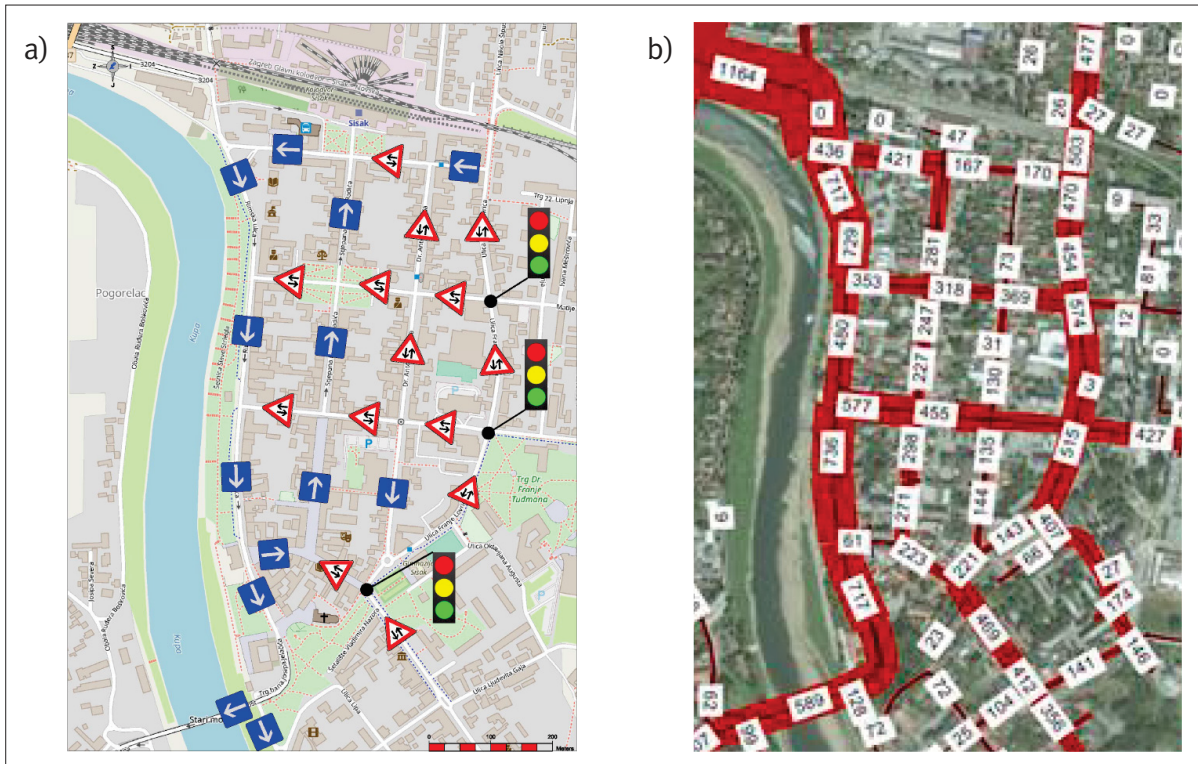


Figure 1 a) Traffic flow regulation, Sisak 2015; b) Traffic load in the afternoon peak hours, Sisak 2015

Surveys conducted on bicycle commuters revealed the lack of security (subjectively) in parts of the road network, especially at crossroads. Approximately 28 % of the participants puts forward the main demand for an increase in the construction of the cycling network, while 15 % of participants demands a reduction of the speed of personal vehicles.

In order to provide a statistical examination of traffic accidents, an analysis was performed on the official data on traffic safety of the Ministry of the Interior of the Republic of Croatia in Sisak. The road traffic safety of the city of Sisak in the period from 2005 to 2015, i.e. the total number of traffic accidents and their consequences, is shown in Figure 2. Figure 2 shows a trend of decrease in the total number of traffic accidents in the last ten years and an increase in the amount of 16,1 % in the last two years of observation (2014-2015).

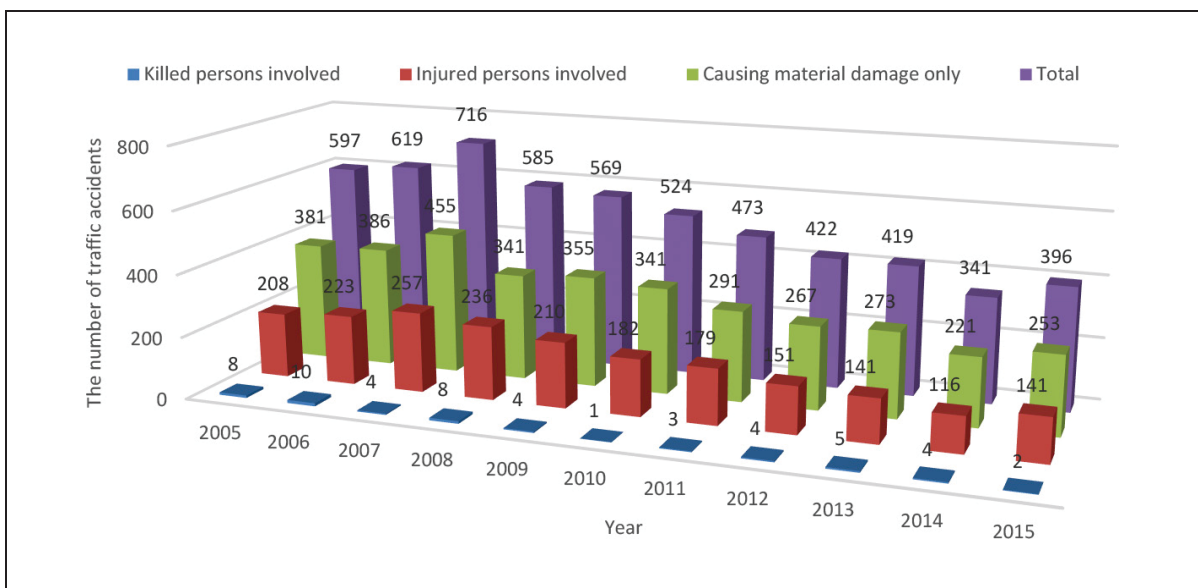


Figure 2 Traffic safety of the city of Sisak from 2005 to 2015

Further analysis conducted on the participants of traffic accidents has shown a noticeable decrease in the number of injured pedestrians and cyclists. However, the positive decrease of traffic accidents which affect vulnerable traffic participants does not meet the reduction of the number of road accidents of motorists and drivers at national level. Reduction in the number of traffic accidents in the area of Sisak can be attributed to the continuous construction of new road infrastructure, taking into account the pedestrian and cycling requirements. The streets and intersections where the largest number of traffic accidents takes place are mostly downtown. The highest concentration of motor and pedestrian traffic occurs there.

### 3 Geospatial Analysis of Traffic Accidents

The visualization and the data processing was conducted in the QGIS computer program (formerly known as Quantum GIS). The usage of the GIS tool enables one to show the density (focal points) of traffic accidents in a different context, in the wider geo-spatial environment of urban areas, [4, 5].

Data processing indicated several issues regarding the deviations of recorded traffic accident locations from actual geographic locations. This lack has been pointed out earlier by authors in the essay [6] on the area of the City of Zagreb. Therefore, some traffic accident locations were manually corrected on the basis of well-known traffic accident records which contain information such as the name of the street and house number.

On the basis of the data on traffic accidents from the Ministry of the Interior, a thermal accident map of the city of Sisak was created (Figure 3). The analysis of the map indicates that intersections which lack semaphores register an increased share of traffic accidents, as well as significant traffic loads with motor and pedestrian traffic flows. When it comes to semaphored intersections, the number of traffic accidents is significantly smaller despite a nearly identical traffic load.

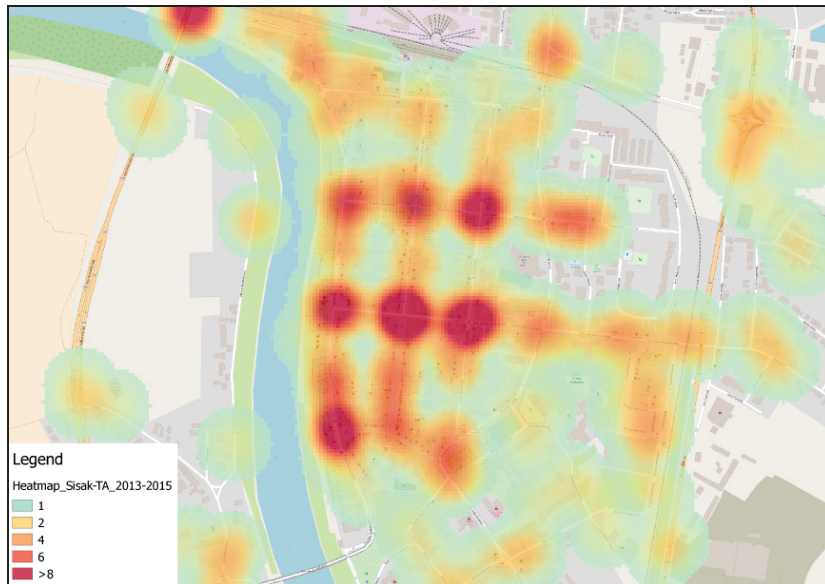


Figure 3 Traffic accidents in Sisak, 2013-2015

### 4 Solution proposal

One possible solution is the vision of the development of a pedestrian zone in the center of the City of Sisak over a period up to 2025 (Figure 4a). A pedestrian zone covered by the plan up to 2017 (green color) has been built, while the rest is planned in the next period (red and green paintings). The goal of building a pedestrian zone is the strengthening of the city center



and the creation of a city answering the needs of “men” rather than motor vehicles. The side longitudinal streets (east-west) crossing the future pedestrian zone will be made into streets without the “blind street” exit, while the transverse parallel streets with a pedestrian zone will be made into one-way streets. Motor vehicles are forbidden in the pedestrian zone, which reduces the negative impact of motor traffic.

According to the new organization and regulation of traffic flows, the planned traffic model for 2025 indicates a significant reduction of motor traffic in the city center (Figure 4b). Motor traffic is redirected to side traffic with semaphored intersections, leading to the expectation of a significant increase in road safety of all participants in the downtown area.

As has already been mentioned, drivers will be dissuaded from driving motor vehicles in the city center. According to the newly proposed regulation and organization of traffic flows of the road network of the city by 2025, the number of problematic points at intersections in the city center will be considerably reduced. These measures will reduce the risk of traffic accidents.



Figure 4 a) The plan of the traffic flow regulation, Sisak 2025; b) Traffic load in the afternoon peak hours, Sisak 2025

In order to increase the safety of all participants of traffic accidents, it is necessary to continuously monitor basic indicators. Table 1 shows a proposal of measures that must be followed annually.

Table 1 Indicators of traffic safety

Indicator	Measurement	Evaluation	Methodology
Number of traffic accidents with consequences	Number	Yearly	Annual report
Type of vehicle in traffic accidents	Type of vehicle	Yearly	Annual report
Injured participants	Participants	Yearly	Annual report
Education of city services	Number of activities	Yearly	Annual report
Activities on pedestrian-cycling area	Number of activities	Yearly	Annual report
Activities intended to ensure safety	Number of activities	Yearly	Annual report

## 5 Conclusion

The issue of traffic safety is evident in the Republic of Croatia as well as in Sisak. Traffic safety is one of more frequently mentioned qualitative characteristics which indicate numerous factors of the organization of the traffic system. A special emphasis is placed on the traffic culture and the relationship of traffic participants with this extremely important segment of road traffic.

Sisak did not have a central city square with a pedestrian zone up until 2017. The main pedestrian zone was a promenade along the left bank of Kupa. The need for pedestrian zone construction was indicated by a survey. The citizens emphasized the importance of the introduction of a pedestrian zone in the city center as a crucial measure for the improvement of the quality of life in the city of Sisak.

The arrangement of the pedestrian zone in city center encourages the non-motorized form of transport and discourages the use of personal vehicles, thus making a significant contribution to sustainable traffic and the sustainable development of the City of Sisak in general. In this way, the design of the street network is changed, according to the needs, the satisfaction and the traffic safety of all traffic participants. The major goal of the urban road in the city is to enable multifunctionality of the traffic, and to replace the lack of living space.

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