

CETRA 2018

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Road and Rail Infrastructure V

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ESTABLISHMENT OF THE CONGESTION CHARGING ZONE IN THE CITY OF DUBROVNIK

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Abstract

Highly urbanized areas, such as Dubrovnik, especially in summer season are in need for traffic system adjustments. High traffic demand often exceeds road capacity resulting with constant traffic jams and high pollution level. Dubrovnik is a typical example of a small town with a traffic system that is unable to face the traffic demand generated during summer season. Significant difference between summer season and non-season is made by tourists coming with personal vehicles. Appropriate measure for pollution reduction must include decrease of number of vehicles entering Dubrovnik city centre zone. Setting the city centre zone as a congestion charging zone would have a positive impact on the entire traffic system in the city of Dubrovnik. The entrance in the congestion charging zone would be at the beginning of the Zagrebačka street near the entrance to the underground public garage. New congestion zone requires reconstruction of the part of Zagrebačka street and traffic reorganization regarding exit from the public garage and nearby signalized intersection. Congestion charging zone is a measure for development of sustainable urban mobility and it is in an accordance with Europe`s politics regarding air pollution and it is often implemented in cities around the world facing negative ecological impacts. City of Dubrovnik needs significant measures in traffic system to ensure citizens normal mobility and to maintain it`s status of a part of the UNESCO`s cultural heritage that is already endangered by uncontrolled tourism. Congestion charging zone can resolve the problem of devastation of the Dubrovnik city centre and promote alternative sustainable modes of transport.

Keywords: urban areas, traffic reorganization, pollution, sustainable urban mobility

1 Introduction

Dubrovnik is a city with a specific transport conditions. Transport demand often exceeds traffic capacity. Because of the hilly terrain and high urbanization there is not enough space for significant road reconstructions. That is why the transport conditions should be improved primary with traffic reorganization based on the newest technologies implemented in other cities facing similar problems. During summer season which is today extended throughout period from May to October, the City of Dubrovnik is facing with high amount of motorized traffic generating demand that cannot be met by the current transport system capacity. Because of that, significant measures are needed. The biggest trip attractor is Old town and surrounding area with numerous elite hotels and apartments. This is the area that has historical value and that is why it is listed into UNESCO cultural heritage. The heritage is endangered with volume of motorized traffic that is generated throughout summer season. The complete area is connected by a single lane one-way road with a pedestrian sidewalk on the one side. It is obvious that the road capacity cannot met generated demand. Because of those facts, this area should be treated as a specific zone with specific conditions.

The specified zone is proposed to be treated as a congestion charging zone. The main goal is to decrease traffic jams and improvement of environmental impact and life conditions for the local inhabitants. Implementation of the proposed congestion charging zone requires some reconstructions, mainly at the entrance to the specific zone.

2 Specific zone

The specific zone is the zone of the Old town and surrounding area. The zone is highly urbanized and densely built with not much space left for any kind of reconstruction. The zone is a big trip attractor not just because of the Old town, but also because of the four luxury hotels, numerous private apartments, schools and working places. Those attractors generate high transport demand throughout the whole year, but especially in summer season. The specific zone location is shown at the Fig. 1.



Figure 1 Specific zone

2.1 Road infrastructure

The specific zone is very poorly accessible because of the non-adequate road network for that type of highly populated area. Because of the previously mentioned facts it is not possible to widen streets or build extra parking lots that are needed. Current transport network is made of single lane one-way streets (Fig. 2) set to make a circle around the specific zone.



Figure 2 Zagrebačka street [7]

2.2 Traffic demand

Dubrovnik has two significant transport terminals which generate most of the trips made during summer season. Those terminals are port of Dubrovnik located in the western part of the City and Airport Dubrovnik located 20 km far from the City in Konavle municipality.

The hotels and private apartments are already mentioned in previous chapters as a significant trip attractor. Most of those trips are generated from the Dubrovnik airport by organized transport or by personal vehicles. Arrivals at the airport are shown in the Table 1. which indicates constant growth expected to continue in the 2018.

The other significant generator is the Port of Dubrovnik which has numerous cruising ship arrivals on daily basis. Number of passenger from the cruising ships is shown in the table 2.

Table 1 Airport arrivals

Year	June	July	August	September	October	TOTAL
2015	245063	328400	335585	254454	148615	1693934
2016	288809	383032	378473	305900	202703	1993243
2017	338729	442122	440789	348749	218088	2323065

Source: [5]

Table 2 Cruise ship visitor arrivals

Cruise	June	July	August	September	October	Total
2011	94125	103361	98957	103428	116626	704725
2012	101982	105055	120730	104863	115389	743087
2013	124662	139476	154173	140328	134342	942909
2014	127101	101480	122071	132390	113626	806558
2015	109148	129972	135671	116250	110292	768434
2016	107284	117075	124481	130703	104661	799916

Source: [6]

Table 1. and Table 2. show data for the summer season months because that is the period when the traffic demand is highest and the traffic reorganization is most needed. During peak periods of the season there is sometimes up to 9 000 visitors from the cruise ships. All those visitors are being transported to the Old town from the Port of Dubrovnik by shuttle buses which means that 180 buses enter specific zone resulting with the constant traffic jams, congestion and generally cultural heritage devastation.

3 Congestion charging

The specific zone described in the previous section is proposed to be set as a congestion charging zone. For the adequate implementation of the zone it is necessary to make some road reconstruction to ensure system functionality.

The main area that needs to be reconstructed is the area around the public underground garage. The entrance and exit from the garage is constructed from the Zagrebačka street where would be the entrance to the congestion charging zone. The exit from the garage would change from the current situation and that means that the Volantina street and Don Iva Bjelokosića street would also need to be reconstructed.

3.1 System organization

The implementation of the congestion charging zone requires transport reorganization. The proposed system can be implemented with various organisation models. The first and the simplest one would be the one-time payment system. There are constant and occasional users. The constant users can be identified by their licence plate using some of the adequate technologies and the occasional users would have to pay at the entrance to the zone or at some organized shop at the entrance to the city or by internet. If the occasional users pay at organized shop outside the city or by internet, their licence plate would automatically enter the system and the users would not have to wait at the entrance in the congestion charging zone. The price for entering the zone does not include parking ticket or free parking lot. Because of that the users would be identified only at the entrance to the zone regardless of the duration of their stay in the congestion charging zone. Organization scheme is shown at the Fig. 3.

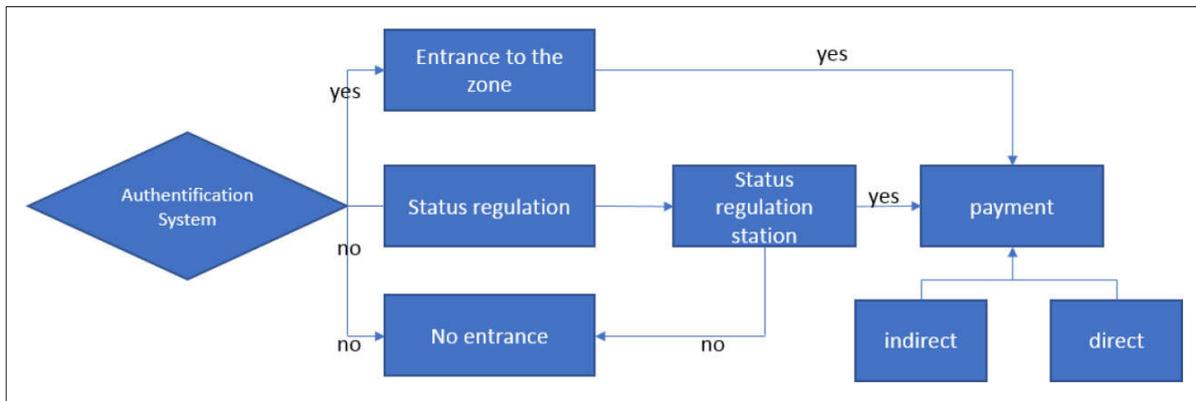


Figure 3 Organization scheme

The other organization model includes parking tickets. The charging price would be defined based on the duration of the stay in the congestion charging zone. The entrance to the zone would be organized same as in the previous model. The constant users would be authenticated and the occasional users would have to take the ticket for identification. They would be charged at the exit from the zone based on the duration of their stay. This organization model requires two identification areas, one at the entrance and the other at the exit from the zone. Organisation scheme is shown at the Fig. 4.

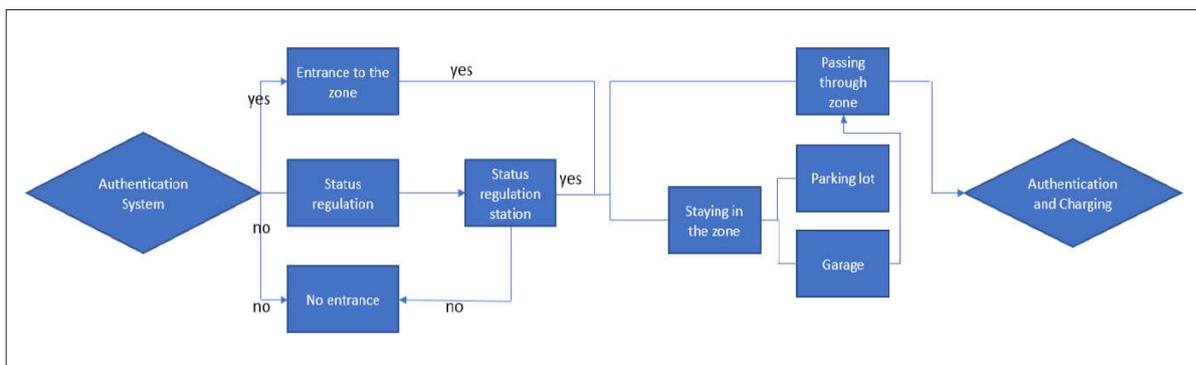


Figure 4 Organization scheme 2

Both versions of the model require reorganization of the transport process and regulation. Some of the streets would have to change direction and nearby intersection would have to be adapted. It is important to mention the significance of the pricing system. The system must be implemented based on detailed expert analysis because of the complexity. The prices will surely affect the number of vehicles entering congestion charging zone, but it is hard to

estimate to what extent. With the environmental and economic expert analysis the prices should be set to optimal level that will ensure environmental and economic sustainability.

3.2 Transport planning

Zagrebačka street is the most important part for the congestion charging zone. In current condition it is a two-lane two-way street from the intersection at Ilijina Glavica to the entrance in the public garage. At the entrance in the garage there is one lane heading towards Old town, right turn lane for the entrance in the garage and one lane in opposite direction for the exit from the garage.

In the proposed solution of the congestion charging zone implementation Zagrebačka street is planned as a one-way street with three lanes at the entrance to the zone. The left lane would be reserved for constant users with monthly or yearly ticket, the middle lane would be intended for occasional users to collect their ticket at the machine and the right lane is planned for the entrance to the public garage. The proposed solution of the Zagrebačka street is shown at the Fig. 5.

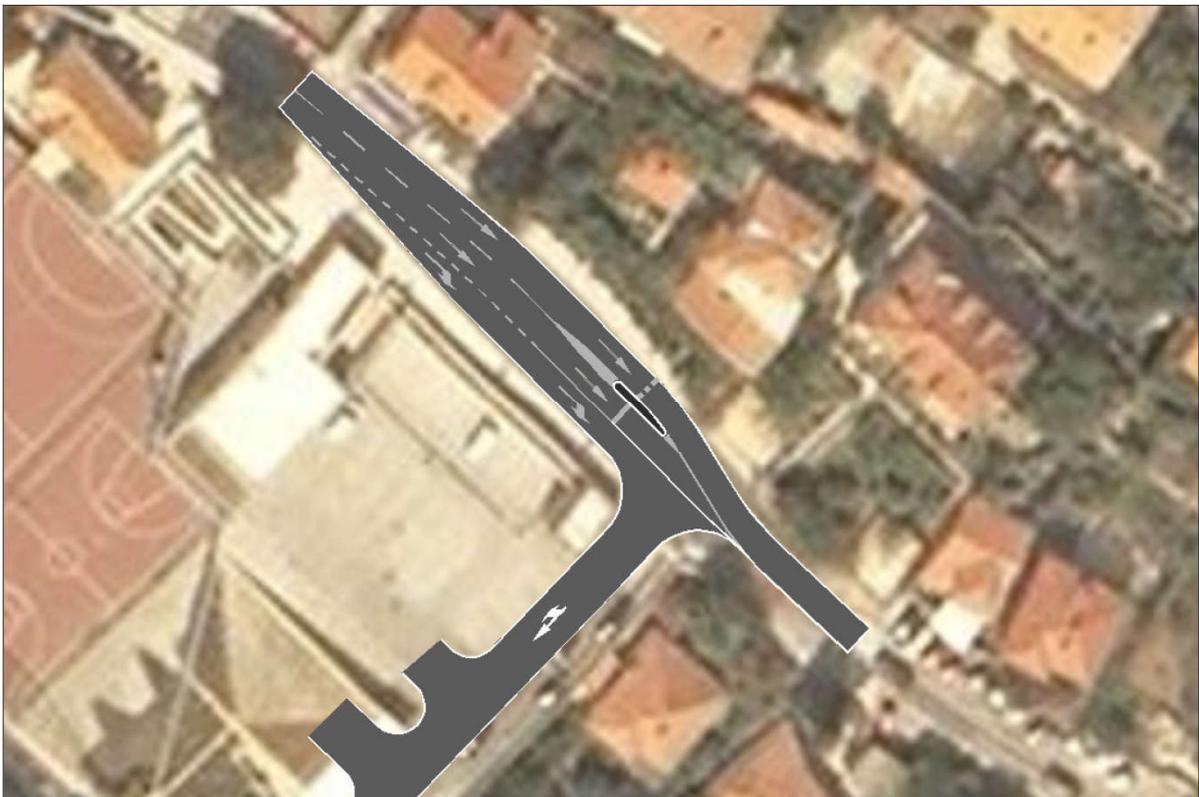


Figure 5 Zagrebačka street proposal

The opposite direction lane for the exit from the garage is removed to ensure road capacity that can face the generated demand during summer season. The exit from the garage is planned by single lane one-way streets shown in the Fig. 6. Those streets are currently organized in opposite direction so the reorganization is needed. Also, the high traffic demand requires adequate road infrastructure so the one-way streets should be widened. The vehicles leaving from the public garage would come directly to the signalized intersection near the public garage. Currently, one-way single-lane street does not affect the intersection but with the implementation of the proposed solution the intersection would have one new approach road so the signal plan should be adjusted for the new traffic regulation. The figure shows the whole reconstruction including Zagrebačka street as a one-way three lane road and single-lane one-way roads leading towards the signalized intersection.



Figure 6 Traffic reorganization

4 Conclusion

The City of Dubrovnik needs measures for the reduction of the negative ecological impact produced by the uncontrolled tourism. One of the biggest negative impact generator is traffic system with low capacity. Traffic demand is too high for the existing traffic network and it should be managed based on capacity of the roads. The proposed measure for the traffic demand management is implementation of the congestion charging zone which can be implemented using several models. Setting a congestion charging zone would have positive impact on the environment, society and traffic system. It would improve living standard for the local inhabitants of the special zone and it would reduce the endangering of the cultural heritage of the City of Dubrovnik.

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