

WPT1

SOLEZ Action Plans for an effective usage of LEZ and other access restriction schemes in project territories

Activity A.T1.3

Elaboration of SOLEZ Action Plans in the 8 project target FUAs

Action Plan for integration of LEZ policies in the mobility planning in City of Dubrovnik FUA Version 4
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1 Introduction

The global problem of CO₂ emissions is present in many cities and urban centers. One of these cities is the City of Dubrovnik and its functional urban area, a densely populated tourist center with approximately 40,000 inhabitants. During the period outside the tourist season, the functional urban area is functional with its 40,000 inhabitants, but the population increases significantly during the summer season, leading to an unsustainable state. In 2017, about 2,000,000 visitors visited Dubrovnik. This information clearly shows the non-summer and summer population ratio.

The SOLEZ Action Plan for the development of low-carbon solutions in the transport system will contribute to solving one of the key problems of the Dubrovnik's FUA, which is the negative impact of the transport system on the environment. The current transport system does not have the capacity to meet the traffic demand generated during the summer months. Significantly increased number of vehicles in the summer months, compared to the rest of the year, leads to constant jams resulting in longer travel times and harmful effects of noise and emissions of harmful gases. Driving mode during the traffic jam is the most unfavourable from the ecological aspect.

Dubrovnik is a city on a hilly terrain, unfavourable for construction. In addition, residential buildings are densely arranged, and narrow city streets stretch between them. Given this spatial construction, large-scale construction work is not possible within the urban center and that is why the city needs to rely on quality organizational and management measures with the implementation of modern technologies.

Dubrovnik is a tourist center and one of the most attractive destinations in Europe. In addition, it is a cultural and historical center and is therefore included in the UNESCO List of Protected World Heritage Sites. It is necessary to preserve the values of the FUA and to improve living conditions.

The SOLEZ project, through which the low-carbon measures will be defined, will certainly contribute to the preservation of local values and the reduction of the problem of excess CO₂ emissions. Two pilot actions will be implemented within the project, which will serve as a basis for assessing the feasibility of individual projects. Pilot actions will be carried out through telemetry monitoring of public transport buses and collecting, processing and analysing the data on vehicles entering and leaving from the Dubrovnik's FUA.



2 Baseline scenario for the Functional Urban Area of The City of Dubrovnik

2.1 Mobility planning and sustainable energy plans

The City of Dubrovnik has already adopted certain strategic documents related to mobility and energy efficiency. The University of Zagreb, Faculty of Transport Sciences, developed a document "Energy Efficiency Program in Urban Transport of the City of Dubrovnik", which is a key strategic mobility plan. The document defines infrastructure and organizational measures to improve the current transport system. Apart from the "Energy Efficiency Program in Urban Transport of the City of Dubrovnik", the City of Dubrovnik also accepted the documents:

1. "Sustainable Transport Strategy of the City of Dubrovnik" (2008),
2. "Local Sustainable Mobility Plan" (2013).
3. "Traffic Study" (2012),

- 1. The Sustainable Transport Strategy of the City of Dubrovnik** was developed in 2008 by the company FORMAPLAN in cooperation with Transports Metropolitans de Barcelona (TMB) and Trames d.o.o. As part of the project, a field survey was carried out to determine the modal split and average vehicle occupancy. Based on the research, the most critical locations, the key disadvantages in the transport system and the ratio between the emission of harmful gases in the summer and winter months were defined. Based on research and analysis, strategies (Green and Desirable) for the future development of the City of Dubrovnik have been defined. It should be noted that the Study was made in 2008, when a significant increase in the number of visitors began and since then the city has recorded a constant increase in the number of tourists. It is therefore questionable whether the data at that time can be considered for a significantly changed current situation.
- 2. The Local Sustainable Mobility Plan** was developed by LUZ d.d., Faculty of Traffic Sciences, Università IUAV di Venezia and Ipsum d.o.o. in 2013 as part of the ADRIA MOVE.IT project funded by the EU with a goal of promoting sustainable mobility and improving transport efficiency in the Adriatic coastal area. Apart from Dubrovnik, the local plan for sustainable mobility was also developed by the cities of Umag and Novigrad. The local plan proposed measures for the reorganization of the transport system and promotion of pedestrian traffic in accordance with the principles of sustainable mobility, some of which were accepted and implemented. The local plan identified the problem of overflows of visitors from cruising ships, and the emphasis was to create an adequate connection of the Port of Dubrovnik with Pile Gate (entrance to the Old Town) through footpaths and cycling zones.
- 3. The Traffic Study of the City of Dubrovnik** was developed by Promel Projekt d.o.o. from Zagreb and the Faculty of Civil Engineering of the University of Zagreb in 2012. As part of the study, field research and analysis of the results was made. The analysis resulted with the proposal of measures for the improvement of public and pedestrian transport. In addition, the study defined traffic light system deficiencies and proposed the draft of the ITS system for automated traffic management. The study also suggested significant infrastructural interventions such as road tunnels and metro construction.



2.2 Push and pull measures at Functional Urban Area level

"Push" methods aim to reduce the traffic volume on a given area, "suppress" vehicles from a particular area. Such measures are applied in areas where traffic has negative impacts on the environment, and users by means of "pull" methods are being "drawn to" the use of sustainable forms of transport. "Push" methods can be implemented as a complete removal of personal vehicle traffic in a particular area, additional billing for a particular road section (zone), increased parking cost, and similar.

In order to carry out the "push" method and to achieve the desired effect, **in this case the reduction of personal cars in the functional urban area of the City of Dubrovnik**, it is necessary to provide users with a quality alternative in terms of improving the quality of public transport services, establishing cycling and pedestrian zones with option of e-bikes due to the unfavourable terrain configuration. Improving the quality of these alternative forms of transportation is a "pull" method.

The primary purpose of the "push and pull" method is to create an **optimal transport system** through implementation and promotion of sustainable mobility. The sustainable forms of transportation are not developed in the Dubrovnik's FUA and there is plenty of room for improvement.

The only implemented measure representing the "Push" method is the reorganization of the parking system which increased the price of parking ticket and limited number of parking lots for visitors by reserving a large share exclusively for local population.

2.3 Main critical issues and bottlenecks of mobility in the Functional Urban Area of the City of Dubrovnik

The main disadvantage of the Dubrovnik's FUA is the inadequate transport infrastructure which cannot withstand the traffic demand that arises during the summer months. Existing roadways do not have sufficient capacity which leads to constant jams. Additionally, roads are laid through a dense urban settlement, which eliminates the option of significant construction upgrades (e.g. by adding traffic lanes). Apart from the roads that do not meet either the capacity or the technical parameters, an additional problem is the lack of parking areas, i.e. **lack of information on occupancy of the most of the existing parking lots**.

Transport infrastructure is a problem within the urban settlement of Dubrovnik, but also in the rest of the functional area where the main road is the state road D8 (Adriatic road), which was built in the 1960s for that conditions and traffic demand and is not suitable for today's transport needs.

The main **transport hubs in the Dubrovnik area are Port of Dubrovnik and Dubrovnik airport**, both of which are inadequately connected and accessible. The Port of Dubrovnik is situated on the western entrance to the City and is connected by local roads, while Dubrovnik Airport is located in the municipality of Konavle and is accessible by the state road D8.

The Port of Dubrovnik, which operates only as a passenger port, is connected with the center of Dubrovnik (Old Town) by local roads, mostly one-way roads with one traffic lane. During summer month, several cruise ships arrive in the Port of Dubrovnik on the daily basis with a total of **10,000 to 12,000 visitors**. Many visitors go to Old Town by organized shuttle bus service, which brings up to **200**



buses daily on the route from the Port of Dubrovnik to the Old Town. The buses use the mentioned route made of mostly one-way roads with one traffic lane. Apart from the shuttle buses, this route is used by the local population and public transport. All having said, existing roads cannot withstand generated traffic demand.

Dubrovnik Airport is connected by the state road D8, which is in an unacceptable state for existing conditions. There are two critical points regarding the safety aspect, the capacity and the environmental impact, the four-way intersection in Srebreno and the inadequate intersection of the D8 state road and local road heading towards the Bosanka settlement.

Numerous critical points on local and state roads significantly jeopardize traffic safety. According to the data of Ministry of Interior, in 2017 there were 476 traffic accidents in the area governed by Police Administration of the City of Dubrovnik. 7 accidents were with fatalities, 235 with injuries and 234 with material damage.

The most critical section is the one between the public garage and entrance to the Old Town at Pile Gate. The road section consists of Zagrebacka Street and Street Iza Grada, which are constructed as single-way one-way roads. According to the traffic counting made on 2.6.2011., in the morning peak hour in Zagrebacka Street, there are 888 vehicles. Considering the steady growth of tourism activities since 2011, there has been also an increase in transport demand.

The other critical road section is the Street Branitelja Dubrovnika between Pile Gate to Boninovo. Road transport is organized in such a way that the traffic lane in the direction of Boninovo is open to all vehicles, and the lane to Pile Gate is reserved only for public transport. The road is also characterized by inadequate pedestrian walkway of insufficient width. On certain sections the sidewalk width is insufficient for two pedestrians to safely pass each other and thus significantly jeopardizes pedestrian safety. Due to such condition pedestrians are forced to use motorized transport.

As part of the main strategic document "Energy Efficiency Program in the City Traffic of the City of Dubrovnik", a reference model for CO₂ emissions has been developed. The emission is calculated according to the guidelines prescribed by the **European Environment Agency**. For the calculation of CO₂ emissions, a used methodology considers next data:

- Consumption and fuel type
- Number and category of vehicles
- The distance travelled by type of vehicle and type of road
- Average speed by vehicle type and by road category

Based on the collected and available data from 2012, 2013, 2014 and 2015, and the previously described methodology, the total CO₂ emissions from the transport sector is 20.096,61 tons. Covered area consists of a network of 63.68 kilometres of roads.

The wider area of the Old Town represents a specific area characterized by a traffic jams and extremely low travel speeds. Therefore, an additional emission calculation was made specifically for this area. Low speed, waiting in the line with a running engine and an unfavourable terrain configuration create conditions of high emission of harmful gasses.



The average daily emissions per year are 1.41 tons of CO₂. However, at peak period, when the vehicle speed is less than 5 km / h, daily emissions amount is 8.12 tons, which is extremely high and points to the extreme need for **emission reduction measures**.

It is important to note that the calculations were based on data from 2012, 2013, 2014. and 2015, and that since then, Dubrovnik has recorded a constant increase in the number of visitors, generating higher transport demand. The above may only mean that the calculated and estimated quantities of emissions can only have a tendency of growth.

In addition, the new *Law on Road Transport*, adopted in May 2018, has contributed to the rise in CO₂ emissions, particularly in the specific zone of the City of Dubrovnik. The Law liberalized the transport market, which can be a good solution at the national level, but the Law does not recognize a large diversity and specificity of individual locations. At the local level of the City of Dubrovnik, the functionality of the traffic system is further compromised and the harmful impact of traffic on the environment has significantly increased. The law facilitated the procedure for obtaining a concession for taxi transport and the territorial restriction have been removed, which attracted a significant number of carriers in Dubrovnik. The increase in the number of carriers negatively affected the local public transport, which recorded a significant drop in the number of passengers. It is also a bad impact on the environment because taxi vehicle (personal vehicle) generates higher CO₂ emission per passenger.

Without significant organizational and management measures in traffic system, there is a steady increase in traffic demand in the FUA, and thus a rise in the emission of harmful gases and noise. **The LEZ / LTZ concept** would certainly contribute to addressing this problem, but such concepts are not on national level, and need to be implemented through national legal regulations inspired by European states such as Germany and Italy.

In addition, the **local population** is not sufficiently eco-conscious and does not understand the importance and severity of global issues related to emissions of harmful gases. Therefore, it is necessary to implement educational measures aimed at the ecological awareness of the local population.



3 Reasons and strategic objectives for the Functional Urban Area of the City of Dubrovnik

3.1 Opportunities for sustainable mobility in the Functional Urban Area

In previous chapters the emphasis was on the increasing number of visitors as a main reason and a warning to the need for measures to reduce the harmful effects of the traffic system in the form of emissions of harmful gases and noise.

On the other hand, the increase in the number of visitors is one of the main advantages of the City of Dubrovnik by enabling it to further develop and invest in innovative technologies. Proposed measures require significant investments, and the increase in the number of tourists also means greater income and financial capacity of the City of Dubrovnik and its citizens.

One of **the already implemented measures is the establishment of a restricted traffic zone**. Motorized transport is not permitted in the Old Town since the 1970s, which is a logical move by the local authorities at that time, since in 1979 the Old Town was included in the UNESCO World Heritage list. With the aim of preserving it, removal of motorized vehicles was a logical decision. Now, it is necessary to consider the wider area as a restricted transport area, as the motorized transport in the wider area also adversely affects the Old Town. Such damaging influence has led to questionable status of the Old City in UNESCO World Heritage because of the so-called "Uncontrolled tourism".

Quality cooperation between local government, local carriers, other key stakeholders and the local population is needed for the implementation of the proposed measures and the establishment of a restricted motorized transport zone. Local transport and management of parking areas are carried out by city companies Libertas Ltd i Sanitat Ltd which is one of the key advantages given to the current quality cooperation of the company and the local government.

As previously mentioned, there is a problem with the lack of information on occupancy of existing parking places. **The City of Dubrovnik has recognized the importance of real-time information for the users and accordingly the city company Sanitat d.o.o. implements Smart parking solution**. All parking areas are equipped with sensors that will provide users with real-time information on parking lot occupancy, thereby reducing the number of vehicles in search of a parking space and thus increasing the flow in the functional urban area of Dubrovnik.

The restricted motorized transport area is a key and initial measure that is the basis for the implementation of other measures. The area refers to Zagrebacka Street and Street Iza Grada. The entrance to the proposed zone would be in Zagrebacka Street next to the entrance to the underground public garage. Restricting transport on this section is key to road offloading and giving space to public transport line which would be rerouted from the Branitelja Dubrovnika Street to Zagrebacka Street. An additional reduction of traffic demand can be achieved by eliminating the vehicle in search of a parking lot, but it is necessary to equip the parking area with sensors that will, through ITS systems, provide **current information to the user about the occupancy of parking spaces**. Pilot project on two parking lots, conducted a few years ago, showed positive results.



By establishing a restricted motorized transport zone, the basis would be made for the construction of a **pedestrian path from the Port Dubrovnik to Pile Gate** and the redesigning of the public transport lane in the Branitelja Dubrovnika Street in the pedestrian zone using **dynamic lane change** system.

Efficient implementation of measures to encourage sustainable forms of transport, public transport and walking, will lead to the removal of the jams that are created at numerous locations, such as in the Port of Dubrovnik at the arrival of multiple cruise ships. Redirecting a part of visitors to public transport and using future pedestrian routes, will relieve the traffic system and remove part of the personal vehicles from local roads.

A high-quality efficiency indicator of the implemented measures can be obtained through **telemetry monitoring of public transport vehicles**. The telemetry monitoring system enables remote measurement and remote transmission of data on vehicle speed, fuel consumption, consumption cost-effectiveness and driving mode (steady braking, acceleration). **As part of the SOLEZ project activities, a pilot project of telemetry monitoring** is currently being conducted on **company Libertas** public transport buses. The pilot will provide realistic data about a current state, based on which it will be possible to define the level of improvement after the implementation of the measure.

The second pilot action for road entrance and exit control from the Dubrovnik's FUA, which is also being carried out within the **SOLEZ project activities**, will provide important information on transport demand and its structure. The obtained data will give an insight into the capacity and demand ratio and thus create the prerequisites for quality transport planning with the aim of equalizing capacity and demand. Balancing can be achieved by increasing capacity (e.g. parking lots and garages) or reducing demand by encouraging sustainable forms of transportation.

The planned highway will also contribute to the reduction of the demand on local roads if it is laid in such a way as to adequately connect the airport with Dubrovnik. The fast connection between the city and the airport is one of the key strategic goals at the local and national level. In case the project of the highway to the south of Croatia within the Adriatic Ionian Corridor does not come to realization soon, it is necessary to build a **motorway between airport and the city**. The motorway is a more necessary project for the Dubrovnik area than it is a highway. The two projects mentioned are not mutually exclusive because the motorway can be subsequently upgraded to the highway level.

As another measure for a good connection between the airport and the city, it is necessary to introduce a railway link. However, due to the great complexity of the terrain, and therefore the very high cost of realization, feasibility and justification of this measure should be detailly analysed.

3.2 Strategic objectives for low-carbon mobility in the Functional Urban Area

Strategic goals of the City of Dubrovnik for low-carbon mobility are defined in the "Energy Efficiency Program in the Urban Transport of the City of Dubrovnik". The City has accepted the document as a key document in the area of mobility and as a basis for the development of the urban transport system in a sustainable direction. The document defines measures at the local level of City of Dubrovnik. The most important measure of the wider Dubrovnik area, linking the Dubrovnik airport with the city itself, is found in all the national strategic documents and represents a national strategic goal.



By implementing measures to achieve strategic goals, it will be contributed to reduction of the share of passenger cars on the road network. This will achieve **ecological sustainability** by reducing emissions of harmful gases and CO₂ and by reducing the number of traffic accidents. The future system must also be **financially sustainable** which requires quality management and detailed economic analysis for the introduction of tariff systems. In addition, the system must be **socially sustainable** and ensure mobility and accessibility across the urban area.



4 Short-medium and long-term strategies for the Functional Urban Area of City of Dubrovnik

The basic document in the field of traffic, at the national level, is the "Transport Strategy of the Republic of Croatia (2017. -2030.)" which defines strategic goals according to which all strategies at the lower levels should be developed.

"The Master Plan for the Development of the Functional Region of South Dalmatia and the Strategic Assessment of the Environmental Impact with Heritage Impact Assessment (HIA) on the World Heritage (WH)" is the second strategic document at the South-Dalmatia region level, which is actually the territory of Dubrovnik-Neretva county. It sets out the main and specific goals under which short-medium and long-term strategies are defined:

General objectives:

1. Reduction of the negative environmental impact of transport system
2. Increasing competitiveness of the economy
3. Improvement of the efficiency of the transport sector
4. Enhancement of security and protection
5. Improvement of the sustainability of the transport system within cities and in urban centers

Specific objectives:

1. Introducing Integrated Passenger Transport System (IPT)
2. Increasing the level of transport service
3. Improving PT availability
4. Improving passenger information
5. Improving Data Management System
6. Raising public awareness of the benefits of using public transport
7. Increasing access to public transport information to tourists
8. Enhancing long distance passenger accessibility
9. Enhancing connectivity within cities and settlements
10. Reducing the negative impact of road transport
11. Increasing the efficiency of public transport financing
12. Reduction of total external costs of traffic
13. Ensuring responsibility and cooperation of relevant stakeholders

4.1 Short-medium term strategy

The short-term strategy for sustainable mobility development in the functional urban area of the City of Dubrovnik defines organizational and infrastructural measures for reduction of motorized transport as the main pollutant and for encouraging usage of sustainable forms of transportation according to strategic goals and European policies.



The proposed measures within the Action Plan are fully in line with the general and specific strategic objectives defined in the fundamental national document and the regional master plan.

General objectives of the Transport Strategy of the Republic of Croatia (2017.2030):

1. Change the modal split of passenger transport in favour of public transport (PT) and modes of transport with zero emission of harmful gases. This includes PT in agglomerations and the local regional context (trams, local bus lines, etc.), rail transport, public transport by sea, regional and long-distance bus services as well as pedestrians and cyclists
2. Develop a transport system (management, organization and development of infrastructure and maintenance) according to the principle of economic sustainability
3. Reduce the impact of the transport system on climate change
4. Reduce the impact of the transport system on the environment (environmental sustainability)
5. Increase the security of the transport system

Specific objectives of Transport Strategy of the Republic of Croatia (2017.2030):

1. In some parts of Croatia complement, where applicable, the development of the tourism sector as the main economic factor with the adequate development of transport, particularly in favour of the PT and green mobility
2. Resolve a specific situation in Croatia resulting from seasonality of transport
3. Increase the attractiveness of the PT by improving the management and modernization of the fleet

4.2 Long-term strategy

Long-term strategy has also been made in accordance with the national general and specific strategic goals.

1. To further develop the Croatian part of the TEN-T network (basic and comprehensive)
2. Improve access to specific parts of Croatia (e.g. islands, southern Dalmatia mountainous areas, border areas...)
3. Improve the performance and of the Dubrovnik Airport in order to preserve the accessibility of the South Dalmatia
4. Reduce the impact of the oldest parts of the Croatian road network on the environment
5. Improve the accessibility of airports, particularly by public transport



5 Low-carbon mobility actions for the Functional Urban Area of the City of Dubrovnik

5.1 Short-medium term actions

The short-term strategy defines measures that do not represent major construction projects such as the one in the long-term strategy. Measures are **organizational and infrastructural**, and some of them can be implemented over a short period of time, which would initiate a shift towards a sustainable transport system.

The defined measures will significantly improve the transport system from an ecological aspect in the urban settlement of Dubrovnik. The reorganization of individual roads and the implementation of a limited motorized transport zone (congestion charging zone) will solve the congestion problem in the **narrower area** of the Old Town.

Considering **wider zone**, the proposed measures will increase the capacity of the existing state road D8 at the critical locations, which will result in better connection between the airport and city. This will improve the touristic offer of the wider area, as well as the living conditions of the local inhabitants.

Action 1	PILOT ACTION 1 - Telemetry monitoring of public transport vehicles (Libertas d.o.o.)
Action description	Provision of the fleet of Libertas d.o.o. with GPS / GPRS tracking modules (fast tracking, sampling time of 1 second) and collection of driving data (24 h / day for 1 year). Application of ICT tools to collected data (DPPM, EBSM, COM & TEAM). Detailed technical-economic analysis for electrification of urban transport.
Addressed strategic objectives and goals	Obtain realistic data on the current state to determine the degree of improvement after the implementation of the measure.
Territorial area(s) for action implementation	Dubrovnik's FUA
Timing for action design and implementation	The Pilot project and data gathering will be conducted for 1 year
Assigned responsibilities within Public Authorities	The Traffic Department
Key stakeholders to be involved	City of Dubrovnik; Libertas d.o.o.
Assigned resources (human, knowledge, funding sources)	50.000,00 HRK



Action 2	PILOT ACTION 2 - Supervision of road entry and exit from Dubrovnik's FUA
Action description	Gathering the actual data on the entrance and exit of the vehicle on 4 road entrances. Processing and categorization of vehicles by vehicle category and direction of movement. Analysis and storage of collected data. Presentation of processed data on computers in traffic / communal monitoring center and traffic police in real time.
Addressed strategic objectives and goals	Getting an insight into the traffic capacity and demand ratio as the basis for quality traffic planning.
Territorial area(s) for action implementation	Area between 4 road entrances to Dubrovnik's FUA
Timing for action design and implementation	The measure will be implemented in SOLEZ project duration by May 31, 2019.
Assigned responsibilities within Public Authorities	The Traffic Department
Key stakeholders to be involved	City of Dubrovnik;
Assigned resources (human, knowledge, funding sources)	76.800,00 HRK

Action 3	Smart parking
Action description	Installation of smart parking sensors at all parking lots, including taxis and places for people with disabilities and development of applications for users who will have real time information about the parking lots occupancy.
Addressed strategic objectives and goals	The aim of equipping parking spots with sensors is to reduce the number of vehicles on the roads in search of a free parking lot. The overall goal is to contribute to the relieving of the roads and accelerating the traffic flow, thus achieving a higher level of sustainability.
Territorial area(s) for action implementation	Dubrovnik's FUA
Timing for action design and implementation	The implementation of the system is ongoing and the system should be operable at June 13,2019
Assigned responsibilities within Public Authorities	The Traffic Department;
Key stakeholders to be involved	City of Dubrovnik; Sanitat Ltd
Assigned resources (human, knowledge, funding sources)	3.300.000 HRK



	Estimated value of the required work is 3.600.000,00 HRK
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Action 4	Setting a congestion charging zone
Action description	Establishment of a congestion charging zone that would regulate the status of the vehicle when entering the zone and accordingly charge entry, pass the vehicle in the zone or direct it towards the exit route. Entering the zone would be additionally charged according to a tariff system chosen by the local government as optimal.
Addressed strategic objectives and goals	The establishment of the congestion charging zone will significantly reduce the number of personal vehicles in the proposed zone, and thus the CO ₂ emission. In addition, roads will be less occupied, and conditions will be created for faster public transport and implementation of the Action 5.
Territorial area(s) for action implementation	The specific zone includes a wider area of the Old Town, starting at the entrance to the public garage in the Zagrebacka street to Boninovo (Branitelja Dubrovnika Street) where motorized traffic has a significant negative effect due to low traffic capacity and constant traffic jams.
Timing for action design and implementation	The City of Dubrovnik already has a study for the establishment of the proposed zone, which is the basic document for the start of the implementation
Assigned responsibilities within Public Authorities	The Traffic Department; Administrative Department for Construction and Project Management; Administrative Department for Urbanization, Spatial Planning and Environmental Protection
Key stakeholders to be involved	City of Dubrovnik; Sanitat Ltd - The city company would manage the charging and regulatory systems at the entry into the zone
Assigned resources (human, knowledge, funding sources)	The action requires significant reconstruction of the area and reorganization of traffic with the arrangement of supporting facilities and signalization. Estimated value of the required work is 3.600.000,00 HRK



Action 5	Reorganization and modernization of the public transport
Action description	Reorganization of the system in the form of public transport lines rerouting and removal of part of public transport from Branitelja Dubrovnik Street to Zagrebacka Street. Modernization of public transport in the form of the application of the latest technology for informing passengers based on current dynamic information. Data collected from the pilot project of public transport bus telemetry monitoring will be valuable for the implementation and validation of the action.
Addressed strategic objectives and goals	The reorganization of the public transport system (rerouting) will create the basis for the implementation of the remaining actions (pedestrian zones, dynamic lane changes). Modernization will contribute to public transport quality increase, all with an aim to reduce the share of personal cars on the roads and thus reducing CO ₂ emissions and harmful gases.
Territorial area(s) for action implementation	Dubrovnik FUA
Timing for action design and implementation	After the implementation of the action 4
Assigned responsibilities within Public Authorities	The Traffic Department
Key stakeholders to be involved	City of Dubrovnik; Libertas d.o.o. – local carrier
Assigned resources (human, knowledge, funding sources)	Reorganization of the system through route change does not require additional costs, while modernization through information systems requires approximate 950.000,00 HRK

Action 6	Conversion of the public transport lane into a pedestrian zone by dynamic lane change system
Action description	The dynamic modification of the traffic lane direction allows management of road traffic capacity based on current situation. The practice is that these systems are applied on multi-lane roads, but it is feasible also on two-lane roads, which would be the case in Dubrovnik. In the Branitelja Street, one traffic lane would, depending on the period of the year, change the function between the pedestrian zone and the motorized traffic lane.



Addressed strategic objectives and goals	The dynamic lane change is a measure to encourage pedestrians, given that the pedestrian zone is formed in an attractive location. At the proposed location, pedestrian walkways are extremely narrow and dangerous which is eliminated by the proposed action.
Territorial area(s) for action implementation	Urban settlement Dubrovnik, Branitelja Dubrovnika Street
Timing for action design and implementation	After the public transport reorganization and setting of a congestion charging zone
Assigned responsibilities within Public Authorities	The Traffic Department; Administrative Department for Construction and Project Management; Administrative Department for Urbanization, Spatial Planning and Environmental Protection
Key stakeholders to be involved	City of Dubrovnik; Dubrovnik roads – company in charge of road maintenance
Assigned resources (human, knowledge, funding sources)	The estimated investment for the action is 2.000.000,00 HRK which includes the preparation of project documentation, procurement of surveillance cameras and signalization

Action 7	Setting a charging stations for the electric vehicles
Action description	Setting a charging stations for the electric vehicles in order to encourage inhabitants to use state aid for the purchase of electric vehicles and potential additional subsidies at the local level. Stations must be initially deployed at multiple locations and adapted with the increased number of electric vehicles. This measure is fully in line with European policy and the directive on the establishment of infrastructure for alternative fuels.
Addressed strategic objectives and goals	The proposed action will provide a basis for encouraging the population to purchase electric vehicles. By shifting the local population to the use of electric vehicles, fossil fuels are gradually being removed. Considering that in the Dubrovnik area a significant proportion of the population is engaged in touristic transport, surely the action will be useful, primarily from a financial point of view.
Territorial area(s) for action implementation	Dubrovnikš FUA, Župa dubrovačka municipality, Konavle municipality



Timing for action design and implementation	It is possible to approach the decision-making process in a short time, and then the estimated implementation time is 12 months
Assigned responsibilities within Public Authorities	The Traffic Department; Administrative Department for Construction and Project Management; Administrative Department for Urbanization, Spatial Planning and Environmental Protection; Administrative Department for Communal Services and Local Self-Government
Key stakeholders to be involved	City of Dubrovnik; HEP – Location approval
Assigned resources (human, knowledge, funding sources)	Depending on the specific characteristics of station (charging power, charging time) the price varies from 3.000,00 to 50.000,00 euros per station

Action 8	Regulation of the bus arrivals at the Pile Gate bus terminal
Action description	Regulation of the buses at the Pile bus terminal by tracking the number of buses on the terminal and on the way to the terminal and accordingly limiting the departures of the buses from the port. The action requires ITS system for obtaining current "in-time" information.
Addressed strategic objectives and goals	A defined action will eliminate the traffic jams at the entrance area of the bus terminal. The jams are caused by the single lane approach which does not allow vehicles to pass the bus waiting for the entrance to the terminal. It is necessary to connect 3 locations, terminal at Pile Gate, port of Dubrovnik, and bus stop in the restricted traffic zone where a bus waits for a free lot at the terminal
Territorial area(s) for action implementation	Dubrovnik's FUA; Port of Dubrovnik, bus stop in the zone of restricted motorized traffic
Timing for action design and implementation	It is possible to immediately start the process of preparing the documentation and no significant prerequisites are required. The measure is enforceable over a period of 1-3 years
Assigned responsibilities within Public Authorities	The Traffic Department
Key stakeholders to be involved	Carriers, travel agencies, tourist agencies



Assigned resources (human, knowledge, funding sources)	Estimated investment for the implementation of a complete system including, light signalization, authorization systems is 450.000,00 HRK
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Action 9	Reconstruction of the intersection at the state road D8 and local road towards the Bosanka settlement
Action description	Reconstruction of the critical turning point for the Bosanka settlement in the form of adding a traffic lane for the left-turn from the direction of Dubrovnik.
Addressed strategic objectives and goals	This action would eliminate the traffic flow stoppage at the state road D8 due to the left-turns from Dubrovnik. Because of the high traffic volume in both directions, the vehicle cannot make a left turn due to the vehicle from the opposite direction. The lack of time gap stops the traffic flow. This action will significantly increase the capacity of intersection and security.
Territorial area(s) for action implementation	Intersection at the state road D8, 1.5 km east of Dubrovnik
Timing for action design and implementation	It is necessary to initiate a procedure for solving property-legal issues
Assigned responsibilities within Public Authorities	The Traffic Department Dubrovnik-Neretva County Administrative Department for Spatial Planning and Construction
Key stakeholders to be involved	Dubrovnik-Neretva County Croatian roads – road under their jurisdiction
Assigned resources (human, knowledge, funding sources)	Estimated cost of construction work is 1.500.000,00 HRK

5.2 Long-term actions

Action 1	Pedestrian corridor Port of Dubrovnik – Old Town (Pile Gate)
Action description	Establishment of a pedestrian zone from the Port of Dubrovnik to the entrance to Old Town (Pile) with the aim of eliminating the bottlenecks in the Port of Dubrovnik due to the large number of buses that transport visitors from the cruise ships. The length of the pedestrian corridor would be about 3.2 km and would require a certain reorganization of the motorized traffic system. A part of the proposed corridor would be a road with a dynamic lane change system implemented through short-medium term Action 5.



Addressed strategic objectives and goals	With high quality infrastructure, a part of the visitors would have been switched to pedestrian corridor, reducing the number of buses needed, and thus the CO ₂ emission and harmful gases. This measure will contribute to improving living conditions in the city, increasing mobility options and increasing the city's FUA attractiveness.
Territorial area(s) for action implementation	City of Dubrovnik, Branitelja Dubrovnika Street, Ante Starčević Street, Nikola Tesla Street, Stjepan Radić Coast,
Timing for action design and implementation	Following the implementation of the reorganization of the traffic system and the establishment of a system of dynamic lane change (short-term measures)
Assigned responsibilities within Public Authorities	The Traffic Department; Administrative Department for Construction and Project Management; Administrative Department for Urbanization, Spatial Planning and Environmental Protection;
Key stakeholders to be involved	Croatian roads; Dubrovnik roads
Assigned resources (human, knowledge, funding sources)	The investment for the construction work is estimated at 3,100,000.00 HRK due to the section that requires major construction work

Action 2	Motorway Dubrovnik Airport - City of Dubrovnik (section of the future highway)
Action description	A motorway is needed for an adequate connection of the airport with the city. Considering the traffic isolation of Dubrovnik, the airport is the main link of the FUA with the rest of the country and must therefore be highly accessible. The motorway would be a section of the highway in the future.
Addressed strategic objectives and goals	Current transport connection is carried out through the state road D8 that pass through many settlements, in which a significant motorized traffic has bad impact. The motorway will remove a significant share of motorized traffic from settlements since all transit to Montenegro, Albania, also runs on state road D8.
Territorial area(s) for action implementation	Area from the city to the airport
Timing for action design and implementation	The estimated time for motorway construction is 8-10 years



Assigned responsibilities within Public Authorities	The Traffic Department; Administrative Department for Construction and Project Management; Administrative Department for Urbanization, Spatial Planning and Environmental Protection; Dubrovnik-Neretva County Administrative Department for Spatial Planning and Construction
Key stakeholders to be involved	Government of the Republic of Croatia; Croatian roads; City of Dubrovnik; Dubrovnik - Neretva County
Assigned resources (human, knowledge, funding sources)	Because of the complexity of the project it is necessary to carry out detailed analyses for the cost assessment

Action 3	Railway connection between Dubrovnik Airport and City of Dubrovnik
Action description	A railway as a fast-public transport connection is a common sustainable solution for the ensuring accessibility of the airports.
Addressed strategic objectives and goals	The railway would significantly reduce the number of buses and vehicles transporting passengers from the airport.
Territorial area(s) for action implementation	Area from the city to the airport
Timing for action design and implementation	The estimated time for railway construction is 8-10 years
Assigned responsibilities within Public Authorities	The Traffic Department; Administrative Department for Construction and Project Management; Administrative Department for Urbanization, Spatial Planning and Environmental Protection; Dubrovnik-Neretva County Administrative Department for Spatial Planning and Construction
Key stakeholders to be involved	Government of the Republic of Croatia; Croatian Railways; City of Dubrovnik; Dubrovnik - Neretva County
Assigned resources (human, knowledge, funding sources)	Because of the complexity of the project it is necessary to carry out detailed analyses for the cost assessment

Action 4	Park & Ride terminal
Action description	Construction of the Park & Ride Terminal in Port of Dubrovnik located at the optimal location (entrance



	into the Dubrovnik's FUA). The Park & Ride terminal needs to be adequately connected by public transport. Data from the pilot project of monitoring road approaches to the city will be valuable for the validation of the action.
Addressed strategic objectives and goals	The terminal will contribute to reducing motorized traffic in the city as it is on the entrance to the city. The measure will set the basis for passing local regulations and the obligations associated with entering the vehicle without local register plates in the city. Combined with high quality local public transport and sufficient parking facilities, it will provide a quality alternative to visitors, as well as local residents from the surrounding area of Dubrovnik.
Territorial area(s) for action implementation	Port of Dubrovnik
Timing for action design and implementation	Depending on the type of parking capacity, the action can be implemented in a period of 2-4 years
Assigned responsibilities within Public Authorities	The Traffic Department; Administrative Department for Construction and Project Management; Administrative Department for Urbanization, Spatial Planning and Environmental Protection
Key stakeholders to be involved	City of Dubrovnik; Port of Dubrovnik; Sanitat Ltd; Libertas Ltd
Assigned resources (human, knowledge, funding sources)	It is necessary to carry out analyzes and studies to assess the specific type of parking capacity

Action 5	Parking space by the state road D8 and escalators
Action description	Construction of parking areas near the state road D8 and escalator (moving stairs) to overcome the considerable difference between the road and the city center.
Addressed strategic objectives and goals	The construction of parking areas would remove some of the motorized traffic from the urban area and would create conditions for reassign part of the parking areas in the city center. Escalators are necessary to increase the quality of the service due to the significant difference in height which affects the attractiveness of parking areas at the state road D8.
Territorial area(s) for action implementation	City of Dubrovnik



Timing for action design and implementation	This action represents a long-term measure with the time period of the implementation of more than 10 years
Assigned responsibilities within Public Authorities	The Traffic Department; Administrative Department for Construction and Project Management; Administrative Department for Urbanization, Spatial Planning and Environmental Protection
Key stakeholders to be involved	City of Dubrovnik; Croatian roads; Sanitat Ltd
Assigned resources (human, knowledge, funding sources)	The complexity of overcoming the height differences in the Dubrovnik area requires previous research and implementation study. It is not possible to estimate investment costs before



Literature

- 1 Transport Strategy of the Republic of Croatia (2017-2030), Ministry of the Sea, Transport and Infrastructure, Zagreb 2017.
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- 3 Energy Efficiency Program in the Urban Transport of the City of Dubrovnik, City of Dubrovnik, Zagreb, 2016.
- 4 Transport Regulation and Proposal for Technical Solution for Special Traffic Zone in Dubrovnik, City of Dubrovnik, Zagreb 2016.
- 5 Traffic study for the Regulation of Stopping and Parking of Tourist Buses and Personal Cars (8 + 1) in the Zone of Special Traffic Regime, City of Dubrovnik, Zagreb 2015.
- 6 Spatial Plan of the Dubrovnik-Neretva County (Official Gazette of Dubrovnik-Neretva County, 06/03, 03/05, 03/06, 07/10, 04/12, 09/13, 02/15, 07/16)
- 7 Spatial Planning Plan of the City of Dubrovnik (Official Gazette of the City of Dubrovnik 07/05, 06/07, 10/07, 03/14, 09/14, 19/15, 18/16)
- 8 General Urban Plan of the City of Dubrovnik (Official Gazette of the City of Dubrovnik 10/05, 10/07, 08/12, 03/14, 09/14, 04/16)