O.4.1 ANALYSIS OF NEW SUSTAINABLE MOBILITY SOLUTIONS

Document Control Sheet

Project Number:	10249002
Project Acronym	MIMOSA
Project Title	Maritime and MultimOdal Sustainable pAssenger transport solutions and services
Start Date	01/01/2020
End Date	31/12/2022
Duration	36 months

Related Activity:	Work Package 4 A 4.1 Analysis of new intermodality solutions
Deliverable Name:	(O.4.1) Analysis of new sustainable mobility solutions.
Type of Deliverable	Study
Language	English
Work Package Title	Analysing and piloting new sustainable mobility solutions
Work Package Number	4
Work Package Leader	PP3 (Institute for Transport and Logistics Foundation)

Status	Final
Author(s)	PP3
Version	1
Deliverable Due Date	December 2021
Delivery Date	30/03/2022

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1. Introduction

This paper aims to describe new sustainable people's mobility solutions, with particular reference to cross-border and coastal passengers' flows between Italy and Croatia.

It is based on the idea that the description of the current situation and the identification of the main strengths and weaknesses of passenger mobility solutions in use, together with the analysis of the main innovations in the passenger transport sector, make it possible to outline new mobility solutions sustainable in environmental terms and actually feasible (please, see the framework of this analysis in the next box 1 below).

To satisfy this objective, we collect and sum up the main results of the studies conducted within the Activity 4.1 of the work package 4 of Mimosa Project, which address heterogeneous issues and provide some analyses of new modes of transport from very different points of view.

Before describing the content of the reports of Activity 4.1 and before attempting a reasoned cross-sectional summary that highlights the sustainability aspects examined in each of them, it is necessary to propose a concise description of passengers' flows between Italy and Croatia, focusing on: a) their subdivision into hikers and tourists (because the length of stay and the reasons for the trip are different); b) on the areas of origin and destination; c) on the current means of transport and the use of multimodality; d) on strengths and weaknesses of mode transports.

It is followed by a description of environmental impacts of travel in terms of quantity of pollutant emissions and in particular in terms of CO2 produced (see section 5).

In order to contain the environmental impacts determined mainly by the excessive use of private cars in cross-border journeys both during a single day (hikers) and for longer periods (tourists), interventions of public bodies by territorial planning and public policies, new instruments and new ideas for transport flows data collection and analysis, introduction of innovations in transport means represent strategies and practicable ways to define and reach viable solutions. They are briefly analysed in dedicated sections (see sections 6, 7, 8, 9).

As already said, all the topics briefly outlined above and detailed in the next paragraphs are the synthesis and the re-elaboration of the main contents of the six reports of Activity 4.1 of Mimosa Project.

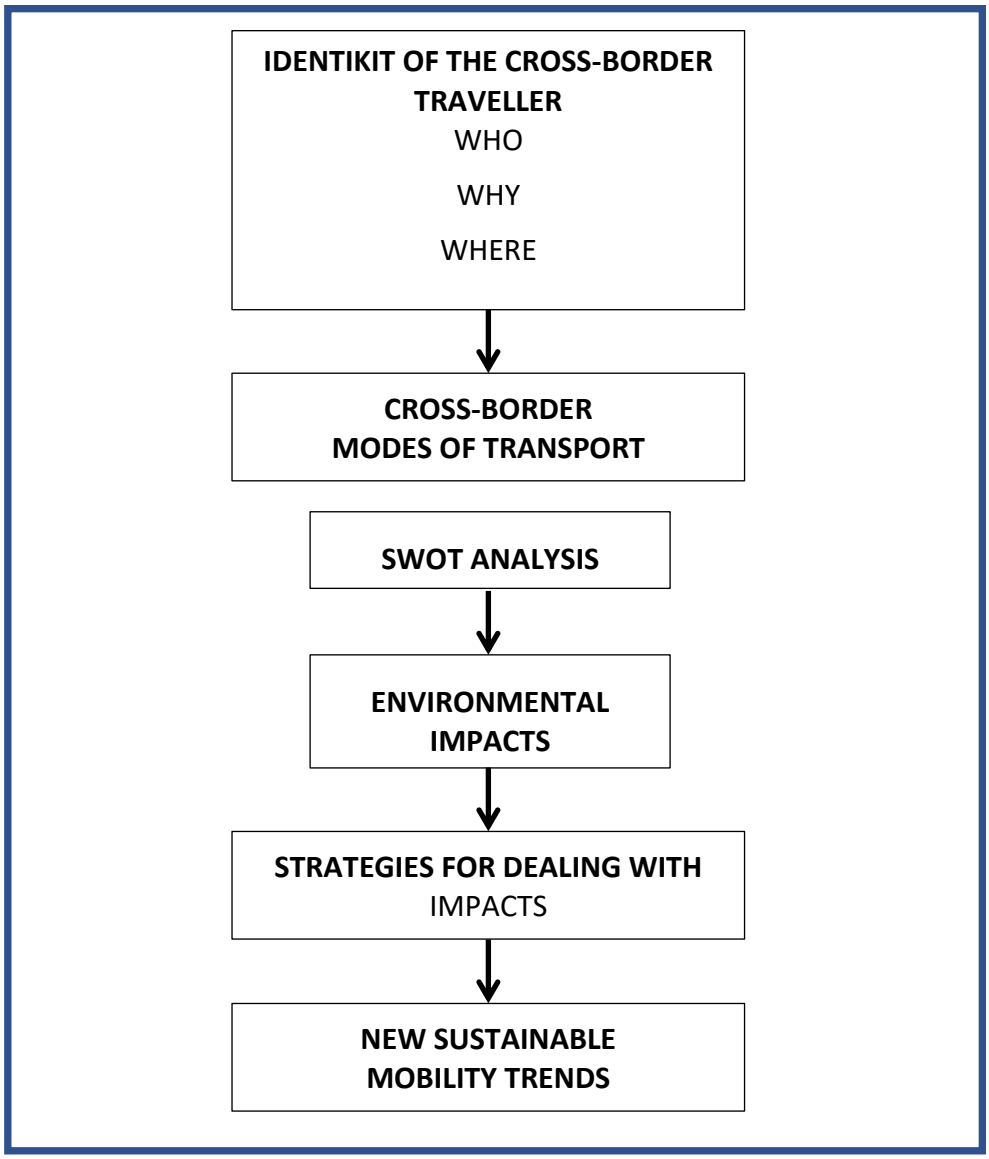
The first report (D.4.1.1 - Cost-effectiveness analysis of the present intermodal maritime transport solutions) presents a study that contributes to a better and more efficient islands' connectivity (number of travellers from Italy to Croatia, their stay in port, how many go to islands or stay on mainland, number in transit and transport means used), taking into account environment protection and transition to alternative transport modes, with an emphasis on intermodal transport, new technologies and the use of renewable energy sources.

The second (D.4.1.2 - Analysis on market potential research - with railway through Istria: route Buzet-Pula. Market potential investigation, including possible connections towards Slovenia and Italy) and the third reports (D.4.1.3 - Analysis on market potential research - with railway through Istria: route Rijeka–Šapjane. Market potential investigation, including possible connections towards Slovenia and Italy) investigate market potential, with accent on urban and suburban rail transport, with possible cross-border connections, on two specific lines.

The fourth report (D.4.1.4 - Analysis of nautical tourism ports in Dubrovnik-Neretva County. Includes intermodality analysis as directions linkage using other transport modes, primarily bike) analyses the nautical tourism ports in Dubrovnik-Neretva County, including intermodality analysis as directions linkage using other transport modes, primarily bike.

The fifth report (D.4.1.5 - Transport demand analysis and interactive tool for data visualization and reporting) is a transport demand analysis and interactive tool for data visualization and reporting. The sixth report (D:4.1.6 - Analysis and modelling. Traffic data gathering, a traffic model to improve public transport passenger flows using smart solutions and a mobile app based on traffic model) is focused on analysis and modelling traffic data to improve public transport passenger flows using smart solutions and a mobile app.

Box 1 - The framework of analysis
(adopted in this paper)



2. Two different kinds of cross-border passengers: excursionists and tourists

This first section provides the identikit of cross-border travellers between Italy and Croatia, detailing their main features, their reason of travel, where they prefer to go[1].

In cross-border passengers' movements between Italy and Croatia, the Italian flows are undeniably higher than the Croatian ones. In addition, it is also possible to identify very different reasons for travel both according to the nationality of visitors and according to the length of stay (one day for hikers; more than one day for tourists). These issues are briefly described in this section.

In 2019, the last year before the Covid-19 pandemic, it is estimated that cross-border and coastal passengers[2] reached the total number of **4.8 million** (4.2 million Italians (87%) and about 600,000 Croats, the other 13%).

In five years they are increased by 10%, passing from 4,38 million in 2015 to 4.8 in 2019.

These passengers are made up of "**excursionists**" (cross-border travellers returning to their own country in the day) and **tourists** (cross-border travellers spending at least one night in the other country). "Excursionists" are two third (3.2 million) of overall travellers, the other one third are tourists.

In fact, in 2019 the official statistic sources[3] have counted almost 1,5 million tourists travelled between Italy and Croatia. 80% (1,175,000 passengers) were Italians from Italy to Croatia and the remaining 20% (290,000 passengers) were Croats from Croatia to Italy.

Italian tourism in Croatia is mainly during the summer. It is concentrated in the coastal regions: in particular four counties (Istria, Primorje-Gorski Kotar, Split-Dalmatia and Lika-Senj) receive about 78% of Italian tourists.

Croatian tourism in Italy is more distributed throughout the year and also throughout the territory; six Italian (NUTS 2 level) regions (Veneto, Lombardy, Trentino Alto-Adige, Tuscany, Lazio, Friuli Venezia-Giulia) are the destination of about 79% of Croatian tourism in Italy.

The main **travel reason** for Italian tourists is vacation and holiday in coastal Croatian places. Instead, for Croatian tourists they are cultural interests, cities of art and naturalistic sites.

[1] Data and information reported below are the result of the analyses carried out in the WP 3 of Mimosa Project and are described in detail in some deliverables (in particular D.3.1.1 "Quantitative analysis of the existing demand" and D.3.1.2 "Segmentation analysis") and in the Output 3.1 entitled "Passenger Transport Demand Analysis".
[2] They are passengers travelling by car, coaches, planes, vessels (high speed vessels), liners.
[3] They are the two national Italian and Croatian bureau of statistics (DSZ - Državni Zavod Za Statistiku, and Istat - Istituto Nazionale di Statistica). In addition, data have been consulted also from OECD (Organisation for Economic Co-operation and Development).

The main reasons why “excursionists” travel cross-border are “business/work related”, visiting parental and shopping (reason stated exclusively by Croatian hikers).

3. Transport modes currently used

In cross-border connections between Italy and Croatia all the main modes of transport are used: car, bus, ship, train, plane[4]. A particular role is played by intermodal transport solutions.

Currently “**excursionists**” usually use some transport means and not all those are used by tourists, for reason of travel time. Excursionists (as daily visitors) travel usually by **car** or **coach**, respectively 99.3% and 0.7% of them. It is estimated that they generate an annual flow of between 1.3 and 1.5 million cars.

On the other hand, for “**tourists**” of both nationalities, between Italy and Croatia, the preferred transport mode is the **car**, which in the case of Italian tourists is estimated to be used by 90% of travellers, while for Croatian tourists this percentage drops to 76%.

Italians also use **ships** more than Croats. 7% of people from Italy to Croatia travel by vessels or liner ships. This percentage decreases to 2% for Croats from Croatia to Italy.

The main reason is due to the fact that most Italian travellers go to Croatia for tourism on the Adriatic coast or in the Croatian islands, and the best way to make at least the last few kilometres of the trip is by boat.

Instead, unlike what happens for ships, Croats use **plane** more than Italians: 6% of travellers from Croatia to Italy use airplane, and just 2% of Italians from Italy to Croatia. It is due to the fact that among the preferred destinations of Croatian tourism there are also cities of art and natural and cultural sites located far from ports (or at least, from those in the Adriatic Sea).

It is estimated 1% of Italian tourists travel by **bus** from Italy to Croatia, and this percentage becomes 16% for Croatian tourists.

The **train** is a residual modal transport for cross-border tourists (but also in some cases for excursionists).

But, at least one in two travellers on their cross-border journey between Italy and Croatia uses more than one transport means. In fact, it is estimated that a percentage between 55 and 60% of tourists and excursionists both Italian and Croats have a **multimodal trip**, meaning that they use at

[4] For details, please see the Output 3.1 of WP3 of Mimosa Project: O.3.1 - Passenger Transport Demand Analysis.

least two transport modes during their travels. The public transport as additional mode is higher than expected, about 67,9% including bus, local public transport and long-range bus transport that are the three most used. Then car rental / taxi, ferry / cruise, train and bicycle follow in this order.

3.1. Cross-border passenger liner ships

As the natural border between Italy and Croatia is entirely on the sea, maritime transport should have a relevant role in the cross-border transport mode in use. Even if, as said just above in previous paragraph, less than 10% of all cross-border Italian and Croat tourists travel by sea, respectively 7% Italians and 2% Croats.

So, in this sub-section, we propose a brief description of passengers' liner ships fleet operating in cross-border connections between Italy and Croatia, one of the transport mode in use[5].

Currently 21 passenger liner vessels operate between Italy and Croatia, offering connections with the mainland and between the islands.

They are of different types[6]: 4 of them are coastal liner passenger ships, 9 are Ro-Ro passenger ships (ferry) and 8 are high-speed passenger crafts.

Apart from the effects of adverse weather conditions (e.g.: adverse effect of the wind when manoeuvring the ship due to the large surface areas in relation to the small draft), the efficiency of their propulsion, the power required and the behaviour of the ship in the various possible sailing conditions are measured by some parameters such as tonnage, length, draft, speed. In addition, the age itself is related to overall efficiency and environmental impact.

The 4 coastal liner passenger ships and the 8 high-speed passenger crafts have a very similar gross tonnage (between 170-200 tonnes and 350-400 tonnes) and length (between 30 and 50 meters). The main difference between these two boats is the speed, the former can travel till to 12-16 knots and the second one may have a double or a triple speed.

In addition, the 4 coastal liners have an average age of service of approximately 56 years. On the other hand, the 8 high-speed crafts have a lower average age, around 27 years old.

The 9 Ro-Ro passenger ships (ferry) travel short-medium and long distances. The 5 out of 9 for short-medium distances have a lower gross tonnage (between 1,400 and 6,700 tons), a shorter length (50 – 90 meters) and an average age of 31 years. The other 4 of 9 Ro-Ro passenger ships are for long distances, they have a greater gross tonnage (between 10,000 and 21,000 tons) a greater length (120 – 150 meters) and an average age of 39 years.

[5] For details, please see the Output 3.5 of WP3 of Mimosa Project: O.3.5 - Cross border transport sustainability Action Plan, and in particular section 2.5 and its table 8 on page 25.
[6] For an introduction to main types of passenger liner ships, please see: Jugović, A., Mezak, V., Lončar, S. (2006) Organization of Maritime Passenger Ports. Journal of Maritime and Transportation Sciences. 44(1). pp. 93-104.

Although currently the use of ferries for cross-border passenger transport is minimal and the connections offered are few, they represent an important element in helping to make cross-border transport intermodal. Strengths are certainly represented by the shortness of connections and the availability of Ro-Ro passenger vessels and high-speed passenger craft.

Relevant weaknesses are represented by the fact that the fleet operating in the cross-border area is very old: 39 years for long distance Ro-Ro passenger vessels and 27 for high-speed passenger crafts.

It inevitably leads to strong pollutant according to the propulsion system, fuel in use and ship construction.

An effective way of achieving sustainable transitions in the maritime passenger transport is to assess the technological innovation in existing passenger liner ships. The reason for this is that the implementation of technological innovation in general, and in ships in particular, is closely linked with sustainable development and growth, and therefore will have an essential role in the future development of cross-border area.

3.2. Means of transport and infrastructure for Croatian nautical tourism

In previous sub-section, analysing transport modes used by cross-border passengers, a particular attention has been dedicated to passenger liner service and tourist shipping service. This second sub-section analyses a particular segment of maritime transport: means in use and infrastructure of nautical tourism[7].

In cross-border tourism between Italy and Croatia, nautical tourism is mainly practiced by Italians in Croatia. One of Its features is that nautical tourists can stay in port aboard the boat all the time or move along the Adriatic coast by means their boats.

Usually, average stay of boaters is twice as long as the average stay of other kinds of tourists. In addition, two thirds of nautical tourists use charter boats for navigation and the sailing season correspond to the period between April and October with a peak in July and August.

Therefore, they need adequately equipped **port infrastructures**. The inclusion of ICT system in technology of production of nautical tourism ports services is necessary to improve quality and streamline operations. In fact, modern ICT technology allows most of the classic port functions such as berth reservation, vessels monitoring or online service payment.

[7] The main source for this section is the Deliverable D.4.1.4 - Analysis of nautical tourism ports in Dubrovnik-Neretva County. Includes intermodality analysis as directions linkage using other transport modes, primarily bike.

But they need also **multimodal transport solutions**, in particular **light modes of transport** that connect the docking port areas to the hotels for any overnight stays and to the urban centres for any visits and excursions during their stay in port.

In the remainder of this paragraph we analyse the issue related to infrastructure and then multimodal solutions for transport of nautical tourists.

For the development of projects of most nautical tourism ports in the Republic of Croatia, it is necessary to develop lower-level spatial plans with the definition of the port area. The inconsistency of ownership and title deeds in some planned ports with lengthy legal and registry procedures and lengthy preparation of lower-level spatial plans due to overlapping interests within the area or other reasons has a demotivating effect on investors for the development of nautical tourism ports.

Location of all nautical tourism ports, except smaller number of exceptions mainly planned within the hotel complexes, are planned within guidelines of the Spatial Development Strategy, defined at County level. Main obstacles are related to outstanding communal sewage infrastructure, especially on islands. Therefore, the most important thing is to resolve land sewage infrastructure utility as base of installations of sewage system collection plant from yachts. It is also necessary to solve the collection and disposal of waste on the islands in accordance with EU legislation and MarPol 73/78 Convention[8].

Part of the planned nautical tourism ports (up to 2,200 berths) is paired with the construction of hotel resorts jointly creating a synergy and it is the only way to cost-effective construction of nautical tourism ports in that particular locations. The construction of a hotel and nautical tourism complex are classified into:

a) dominant hotel complex and nautical tourism port is a supplement with added value for the hotel

or

b) dominant nautical tourism ports and the hotel facility is in function of nautical tourism ports with added value for ports.

In the first group, indisputably, nautical tourism port creates added value to the quality of the hotel resort. In these cases, when nautical tourism ports is planned in isolated locations, the construction of nautical tourism ports without the construction of a hotel resorts is not realistically expected.

Another case is the construction of hotels to complement the content of nautical tourism ports, due to lack no or insufficient capacity in existing hotels in the vicinity. Such an example is the

[8] The International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978.

planned nautical tourism port Ploče. In this case, the construction of the hotel enables more profitable business to the nautical port and better service to the yachtsmen. It is not uncommon in the world that hotel and nautical tourism ports complement each another and in that case hotels are mostly B&B (4*) services with open facilities such as restaurants and bars, becoming cult gathering places for sea lovers. Usually in such cases, hotel chain and marina chain enter into strategic alliances, adding each of them contribution to the overall result.

Spatial plan of some Municipalities and Counties foresee additional capacity building in **public ports**.

This form of competition at public ports built with public money, adversely affects the investment entrepreneurial climate, especially on islands where revenue is based mainly on transit seasonal nautical tourism.

Positive impact of the construction of nautical berths in public ports is the management of the use of the coast and anchorages in an environmentally acceptable manner and provision of services in ports for environmental protection. Therefore, this part of ports development should be focused on the arrangement of the quayside and anchorages at planned locations by installing anchor systems with buoys at anchorages and by granting concessions to the local population under strict supervision with use of modern ICT technologies. In parallel with the installation of anchorages, it is necessary to prohibit anchoring outside managed quayside and anchorage area.

Multimodal transport of nautical tourists can be divided into a part of the trip from and to the region of origin, with the predominant use of cars and airplanes, the biggest traffic polluters. The second part of multimodal transport takes place in the ports of nautical tourism where yachtsmen berth and use car rental, bicycles or wind or kite surfing for sightseeing or active holidays.

For the part of their trip related to region of origin, the construction of modern railways with modern passenger transport solutions in cross border links between Italy and Croatia and with other significant emitting regions (Czech Republic, Slovakia, Hungary, Austria ...) would contribute faster and more comfortable travel to and from tourist emitting regions, and a cleaner mode of transport to the environment. On the other side, taking into account the second part of multimodal transport of nautical tourists, the opportunities listed just above are provided at all mainland ports of the nautical tourism, where yachtsmen can cycle around the natural and cultural values of the landscape and get acquainted with ways of life of rural areas. On some islands, recreational cycling has been developed with the possibility of renting a bicycle, while on others there is a lot of room for improvement. Implementing cycling into the nautical ports, their land parameters will be cognitively expanded adding new value to port (please, for details see Deliverable 4.1.4 cited at the beginning of this paragraph).

4. Strengths and weaknesses of transport modes currently used

This paragraph describes the main strengths and weaknesses of the modes of transport most currently used by cross-border travellers: car and ship. To these, we add rail transport because, if its weaknesses and constraints were overcome, it would be a useful mode of transport to reduce the environmental impact of passenger mobility.

Road transport

Private car is the most used transport mean by cross-border travellers between Italy and Croatia: 99% of hikers (returning to their own Country in the day), 90% of Italian tourists and 76% of Croatian tourists (section 3). So, in the Republic of Croatia, road infrastructure is crucial for transport and passengers' movements.

Related to cross-border travellers and tourists between Italy and Croatia, the most important road connection is the highway A1 Zagreb - Ploče, continuing as the Adriatic tourist road (D8) to the border with Montenegro. The road passes through the Neum Corridor (BiH), where border crossings slowing down traffic, especially during the tourist season. The problem of the border crossing will be overcome by the completion of the construction of the Pelješac Bridge and the road route across Pelješac in 2022. The completion of the bridge will significantly improve the road connection to the Peljesac peninsula and the islands of Korcula, Mljet and Lastovo, as well as to the whole Dubrovnik Neretva County, providing an opportunity for their development, as well[9].

In addition, ~~D4.1...,~~ on the other hand, Rijeka road junction is one of Croatian main traffic junctions and plays an important role in linking the Croatian motorway network: A7 motorway links A8 motorway (Istrian "Y") and A6 motorway (Rijeka – Bosiljevo)[10]. The Port of Rijeka is the main Croatian port (core port) and the development of the port must be harmonised with road development. Rijeka bypass is part of the A7 motorway, being one of the roads in Croatia with the highest traffic intensity. All necessary measures for port modernization must be coordinated with the reorganisation of the internal road network in the City of Rijeka, taking into account the necessities for public transport and soft modes, the development of the port and the development plans of other relevant stakeholders such as the railway company. For that reason, further analyses through Functional Region Concept are necessary to define the final set of interventions as well as the required technical parameters, taking into consideration the expected demand and economical and environmental aspects.

Maritime transport

[9] For details, please, see the Deliverable D.4.1.4 - Analysis of nautical tourism ports in Dubrovnik-Neretva County. Includes intermodality analysis as directions linkage using other transport modes, primarily bike (in particular on page 6).
[10] More insights are in the Deliverable D. 4.1.3 - Analysis on market potential research - with railway through Istria: route Rijeka-Šapjane. Market potential investigation, including possible connections towards Slovenia and Italy (page 15).

In Italy and Croatia there are 24 seaports that provide access to cross-border travellers. The Italian coast is home to 14 of the 24 ports, with the 10 remaining on the Croatian side of the Adriatic area. Passenger terminals are located near widely known sights and they get visited by millions of tourists each year. General terminals infrastructure is adequate for existing traffic demand.

In seaborne passenger transportation, a distinction should be made between passenger liner service and tourist shipping service.

Passenger terminals are being integrated into a single transportation network and should be better coordinated with air, rail, and road transport to ensure the fastest possible passenger traffic. Despite that, passenger terminals should have possibility to extend port limits and general activities in function of prosperity and future development. But there is low possibility to expand their terminal infrastructure areas.

Analysing services provided into these passenger terminals, lack of adequate service activities/infrastructure is observed inside the Port area or in vicinity, in particular: passenger long-stay accommodation facilities, food facilities, rent a car/bike, etc.. But also lack of communication services through ICT integration which support interoperability (free Wi-Fi availability, ICT tools for providing adequate real-time information for the passenger, on-line ticket purchasing, etc.). Furthermore, for promote sustainability in function of environmental protection, port area vicinity should have possibility for rent and infrastructure to charge of electric vehicles and bicycles[11].

Railway transport[12]

For cross-border travellers between Italy and Croatia the train is a residual modal transport, both for excursionists and tourists. In fact, railways have relevant disadvantages and bottlenecks.

If cross border rail services are taken into consideration, surely one of the main troubles is represented by the lack of efficient direct linking between Italy, Slovenia and Croatia.

As regards infrastructures, one of the main problems is the state of degradation of some lines and some stations as well as the need to improve the efficiency of the connections. Tracks and infrastructure are dated and in poor conditions. Waiting rooms in stations often are in many cases not very comfortable.

Trains and rolling stocks for passengers are too old and worn.

Other disadvantages are the timetables, which are not properly regulated, and the travel time, which is too long. Often, ticket machines and timetable information are missing.

[11] More insights are available in the Output 3.5 - Cross border transport sustainability Action Plan (pages 14-15) of WP3 of Mimosa Project.

[12] The main sources for this sub-paragraph are the Deliverable D.4.1.2 - Analysis on market potential research - with railway through Istria: route Buzet-Pula. Market potential investigation, including possible connections towards Slovenia and Italy, and the Deliverable D.4.1.3 - Analysis on market potential research - with railway through Istria: route Rijeka–Šapjane. Market potential investigation, including possible connections towards Slovenia and Italy.

In addition, people traveling by train report that urban centres are distant from train stations in many cases. And connections between railways and other modes of passenger transport are not frequent.

This short list of weaknesses highlights that the Republic of Croatia needs quality railway infrastructure. Recently, investments are being made to improve connections in particular of Istria with the rest of the Country and with the European Union. Among these, a good example of sustainability transition is the new passengers' bike-friendly service train connecting Pula to Buzet, with the particular feature of allowing passengers to travel with their bicycle alongside[13].

But railway still remains a largely unexploited resource despite all advantages it can offer.

5. Pollutant emissions

Another issue as important as those previously analysed and closely connected to scenarios on the development of cross-border transport demand is related to its environmental impacts in terms of pollutant emissions.

It is estimated that the yearly CO2 ascribed to cross-border travel between Italy and Croatia is 219,614 tons, 83.5% attributable to Italian travellers. The average emissions per capita is 72,7 kg per year. In case of no-changes (i.e.: same technology, same modal split) the expected increase in the number of travellers by 2030 would result in an increase in overall emissions of between 2,8% (low estimate) and 35% (high estimate).

Environmental impacts are caused by **extensive car use** (90% of Italians and 70% of Croats travel cross-border by car) and by the further increase in car use recorded between 2015 and 2019 (+ 10%). Some of the negative effects include mission greenhouse gas emission (GHG), traffic congestion, increased energy consumption, air pollution and noise.

In addition, there is a particular traffic congestion problem at national borders due to the fact that at the end of 2021 Croatia is still outside the Schengen Area. Therefore, every border crossing is subject to checks.

On the other hand, **seaports** and **passenger liner shipping** also have an unavoidable impact on atmosphere, hydrosphere, and land. Passenger vessels are one of the major sources of environmental pollution, posing the greatest threat to the marine environment.

[13] https://www.croatiaweek.com/new-pula-buzet-bike-friendly-train-presented.

Even on short voyages, passenger liner vessels generate a surprising amount of waste, which must be stored on board until the next port of call. Meanwhile, the way ship waste is handled at the passenger terminal/port is critical.

There are lot of national, regional, and international legislation that lays out the rules for the proper processes. Ship waste is governed at the international level by the International Convention for the Prevention of Pollution from Ships 1973, as amended by its 1978 Protocol (MarPol)[14]. And Directive (EU) 2019/883 on Port Reception Facilities for Ship Waste Delivery provides an important opportunity to assess the integration of ship waste management into broader EU waste legislation and national waste management plans.

But there is a considerable lack of environmental procedures and initiatives towards pollution reduction, and the mitigation of potential environmental impact which appears in function of the transport process and all related services inability of particular procedures.

And there is a lack of environmental infrastructure facilities and organisational reception aspect for ship waste (garbage management), waste oils and oily water, ballast water sediments, air pollution, etc.).

The next section shows the strategies that can be adopted to contain the impact of cross-border transport flows on the environment.

[14] https://www.imo.org/en/OurWork/Environment/Pages/Garbage-Default.aspx.

6. Strategies for dealing with environmental impacts of cross-border passengers flows

As said in previous sections, passenger flows between Italy and Croatia cause significant environmental problems, that can be quantified by pollutant emissions (please see section 5).

But there are at least four ways that are considered viable for the reduction and containment of the environmental impacts caused by cross-border travel:

1. changes in the habits and behaviour of cross-border travellers;
2. intervention by public bodies (State, Regions, Counties) for the definition and implementation of targeted public policies and reliable public transport solutions;
3. adoption of innovations by cross-border passenger transport operators.
4. introduction of new data collection, analysis by traffic models and visualization by Web-GIS tools related to both transport solutions and passengers' habits and behaviours;

In this section, the first two issues above are described, the third and the fourth ones are in the next sections 7 and 8 respectively.

Public policies and transport solutions, adoptable to reduce the flow of cars between Italy and Croatia and the consequent environmental damage, must take into account various aspects, related to people's behaviours and habits, in particular: their travel reasons and length of stay in the host country (hikers, tourists).

In fact, as seen above, around three quarters of cross-border travellers are hikers (daily visitors). From the analysis of geographic distances and travel times, these hikers generally (for the most part, more than 80%) reside in the north-eastern regions of Italy (within three hours of travel) (section 2 above). These travellers are mostly inclined to use the following means of transport: **car**, **bus**, high-speed **vessels** (mainly from Venice and Trieste). Both Trieste and Venice are within the daily-trip range to Istria and Primorje-Gorski Kotar County (the two main destinations for Italian visitors).

The other one quarter of cross-border travellers are tourists. They use the same transport means of excursionists but also **plane** and **train**, having decided to spend more time traveling between Italy and Croatia.

In order to influence behaviour and habits of passengers (to orient them more towards environmental protection), it is necessary to know them. In recent times, technology has been making new tools available to collect information on the habits and behaviour of passengers. Private companies and public bodies can adopt these new technologies for collection and analysis of data on the modes of transport used (whether car, bus, ferry, airplanes, train, indicated just above), on routes taken, on frequencies and more other.

These instruments can be useful to choose the transport mode, to help change their travel behaviour. In addition, on the side of public bodies, they can provide data useful in planning the mobility of people at local, regional and national level and could contribute to contain pollutant emissions.

The change - voluntary or induced by public policies - in the travel habits of cross-border travellers from the use of the car to the use of the **bus** could be a solution, because it is much more environmentally-friendly than the car: the bus has a much lower rate of pollution per passenger than car. In fact, double-deck coaches can transport up to 80 passengers, thus substituting on average from 15 to 35 cars, while smaller coaches can provide up to 45/50 seats, virtually taking away from the road up to 25 cars. But the tendency to travel by bus is decreasing, with a decrement of about -13% over the time period between 2015 and 2019.

Another important transport mean, that can be used by both hikers and tourists, is the **high speed vessel** from Venice and Trieste to Istria and Primorje-Gorski Kotar County, as said above. In addition, for travels by tourists 2 ports in central and southern Italy can also assume a certain importance respectively Ancona (in Marche region), and Bari (in Puglia region). These two ports are considerably distant from each other (about 4h45m by car) and leave important destination like Rome, Naples and their surroundings at the limit of their catchment area[15]. The Port of Vasto, in the Abruzzo region, can be added to them, because it would be a possible boarding point falling in the middle between Bari and Ancona (about 2h35m from both of them by car) and providing an effective alternative for travellers whose origin or destination is between Lazio and Campania. It should be noted, however, that because of its location, a possible **ferry line** linking Vasto with Croatia would probably not reduce the number of cars, because it would not attract those who already make the journey by car. Rather, it would increase demand, since it would enhance accessibility to areas of cultural and natural value on both sides of the Adriatic.

The current status of the **railway line** can represent an obstacle for cross-border travellers (for a series of reasons analysed in the dedicated paragraph). But the opening of a new railway line or the launching of a new direct train service would, of course, have a much greater capacity and could be a way to improve cross-border connections Italy-Croatia[16]. This new prospect is justified in the analysis of the market potential of railways connecting Istria and Rijeka with the Slovenian borders carried out with users of the Croatian railway service. In fact, in this study (please see, D.4.1.2 and D.4.1.3 of Mimosa Project) it is evident that Croats travellers show a clear propensity to use rail mode also in a near future. And it is a fundamental prerequisite for the economic viability of routes extending across the Italian border and to Trieste in particular.

[15] For details, please, see section 3.1, pages 15-21, of the Output O.3.1 - Passenger Transport Demand Analysis.
[16] More insights are available in the Deliverable D.4.1.2 (pag,42) and in the Deliverable D.4.1.3 (pag,50), cited above.

6.1. Railway lines in perspective

In Croatian territory a new sustainable mobility solution – shifting people from road mode – could be a new concept of railway connection between Trieste and Rijeka, based on a build of new high-efficiency two-level railways over the area of Istria and partly through the territory of the Republic of Slovenia (it is a foreseen project, described on pag. 42 of the Deliverable D.4.1.2 of Mimosa Project, cited above).

On a large part this railway line has yet to be built, in particular, the new track Trieste – Rijeka, and existing lines need to be reconstructed.

The construction, reconstruction and modernisation of these infrastructures meet three criteria: a) completing the Mediterranean Corridor on the area of Croatia, b) connecting the North Adriatic ports with the Danube and the Black Sea and the direct Istrian railways, c) which needs to be modernised.

In fact, rail traffic in Istria County is in a major crisis. For decades, passenger transport is minimised. For half a century it has been out of traffic on route Kanfanar - Rovinj and several decades on route Lupoglav - port Bršica. The corridors of these lines should be used for other types of traffic. In Istria County in 2013 there were 91 km of regional railway lines (Pula-Pazin-Buzet-Slovenia) and 53 km of local railways (port of Bršica-Lupoglav), or a total of 144 km of railways. The **only connection** between the **Istrian County** and the Croatian and **EU rail network is via Slovenia** with a track of poor traffic and transport characteristics (payload, possible speeds,

track geometry). Analyses and research within the Concept of spatial development plan in Istria region indicate that without the construction of a new connecting route and tunnel for existing railway lines, railway in Istria county do not have a survival perspective (pag. 43 of the Deliverable D.4.1.2, already cited above).

One of the priorities of railway network development is the possibility of restoring traffic on the railway line from port of Bršica to Lupoglav and the service improvement of the Kanfanar-Rovinj railway line.

According to Concept of spatial development plan in Istria region, on the route Lupoglav - Buzet - Slovenia is planned a corridor of high efficiency as an integral part of the corridor (Trieste - Koper) - Divača - Lupoglav - Rijeka - Zagreb. It is recommended to use the route of the existing railway line in the direction of Lupoglav – Buzet – Slovenia. This corridor, a high-pass-through and high-speed rail line, would allow direct railway connection of the Istrian County with Croatia and Europe. Furthermore, the planned railway route would connect three significant North-Adriatic ports (Trieste - Koper - Rijeka).

The Spatial planning documentation consider the restoration of traffic on the Lupoglav – Raša line, ports of Bršica and Štalija (the railway has so far only been used for freight transport, it should be modernised and the tunnel through Ćićarija would fit into the Croatian railway network) and also reconstruction is planned on the Kanfanar-Rovinj railway lie (new location of the railway station in Rovinj) and reconstruction of the local transport railway (please see pag. 43 of the Deliverable D.4.1.2, cited above).

The reconstruction of the Kanfanar-Rovinj railway line is probably not a rational project. In the times when across the EU, many unpromising lines are being abolished, such reflection has no basis in economic opportunities of Istria and Croatia. For freight transport, this line is not required and also, passenger traffic on it cannot be achieved on economic grounds. Therefore, suggestion is that railway corridor is used for recreational traffic such as bicycles, horse riding, carriages and various passenger vehicles (please see pag. 43 of the Deliverable D.4.1.2, already cited).

7. The role of innovation in cross-border transport modes

In the previous paragraph it was stated that there are four main ways to contain the environmental impacts of cross-border travels. The change in habits and behaviour of travellers and public intervention were briefly described above. In this paragraph we consider - just as briefly - the innovations that are taking place or will be effectively implemented in the various modes of transport. When adopted by passenger transport operators, they will prove useful in fighting polluting emissions from the means of transport currently used.

This paragraph analyses transport by car, plane, ship and the environmental impacts reduced by the innovations adopted in each of these sectors.

In the case of **air transport**, relevant innovations are expected in particular in the means of transport (airplanes). Technical details are provided by Icao (2019). By 2030 these will lead to a -13% reduction in CO2 emissions caused by planes (Icao, 2019). As said above, 6% of travellers from Croatia to Italy use planes, this percentage decreases to 2% for Italians from Italy to Croatia. These little numbers can give low contribution to reduction of pollutant emissions.

In the case of **maritime transport**, important innovations are expected that will lead to a -40% reductions in CO2 emissions caused by vessels and ships (Imo, 2021).

Maritime passenger transportation is based on national or international voyages. Passenger ships in international voyage must comply with all relevant International Maritime Organization (Imo) standards, including safety regulations in Safety of Life at Sea (SoLaS) Convention and requirements for the prevention of pollution from ships together with Load Lines Convention regulations. Nevertheless, national passenger ships also play a crucial role for passenger movement while the regulations for passenger ship safety in Imo's SoLaS Convention do not generally apply to passenger ships on domestic voyages, but many countries base their regulations on the Imo standards.

Technological innovations in ships have to be based on the current operational practices of the Italy – Croatia cross-border area fleet while taking into account economic, social and environmental criteria.

The economic criteria encompass decoupling of financial growth from social and environmental externalities by achieving social inclusivity (e.g.: affordable ticket prices), and ecological preservation (e.g.: utilization of lower carbon content fuels). The social criteria encompass ship infrastructure safety and security design in terms of mobility elements of (vulnerable) passenger groups. The ecological criteria encompass eco-efficient ship design in terms of hull shape, engine type, fuel type, propulsion and information-communication technologies use as well. Passenger liner ships have to be technologically designed in a way that will alleviate the negative consequences of passenger self-organization in terms of excessive car use, which means that ship

design has to be passenger centric and focus on creating multimodality with other environmentally friendlier modes of transport such as bicycles for achieving social inclusivity.

Focusing on **fuel types**[17] and their role in environmental protection, hydrogen propulsion systems have the best environmental balance but the conditions for their large-scale deployment will not be in place for at least 10-15 years. In the short term, **liquefied natural gas** (LNG) and hybrid systems are the most promising solutions. LNG system as a shipping fuel will have most probably wider application on the passenger vessel. LNG is already widely used, especially on freighter. In addition, passenger liner ships mostly will use LNG as a fuel in the future. Presently, one of the limiting factors for ships using LNG as a shipping fuel is the insufficient number of ports with fuel supply capabilities. On the other hand, **hybrid propulsion systems** achieve lower fuel consumption and consequently lower emissions. The application of existing hybrid solutions is possible on almost all passenger ships of coastal liner shipping and does not impose any additional restrictions. The technology is fully developed and applicable to all ships with diesel-electric propulsion and even the largest ones. The biggest barrier to this solution given by significant initial investment.

A possible alternative for ships sailing on a short distance and in protected area is the **full-electric propulsion mode**. Of course, the emissions of an electric ship are zero but this technology provides a significantly reduced range compared to a liquid fuel propulsion.

Provision of **cold ironing**, i.e. supplying vessels, boats and crafts with shore-side electrical power, represents the must-have port's ability, in order to provide a comprehensive service, while at the same time maintaining control on energy consumption. Cold ironing acts as a segment of efficient vessels handling in a whole, thus controlling emissions from vessels in terms of emissions inventories and emissions monitoring.

In **road transport**, over the last five years, trends have been underway that are leading to an ever increasing adoption by vehicle manufacturers of engines based on new forms of power supply: the main ones are hybrid and electric powertrains.

As the average life of a car in Italy is 11.5 years, based on the current renewal rate, it is possible to make some predictions on the composition of the Italian car fleet in 2030. In the most optimistic scenario, in case of enduring incentives, by 2030 the share of hybrid cars will be 20% and 10% for electric cars. Moreover, since in 2020 only 18.7% of the Italian fleet is of the Euro 6 standard, then it is estimated that by 2030 this share should have reached at least 40%. The remaining 30% will be made up of cars of the Euro 5 standard or one below this.

Consequently, the major reduction in emissions of car fleet would not come from the growth in the share of electrified powertrain, rather from the progressive elimination of older cars up to Euro 5, which currently make up more than 60% of the Italian car fleet. An average value of CO2

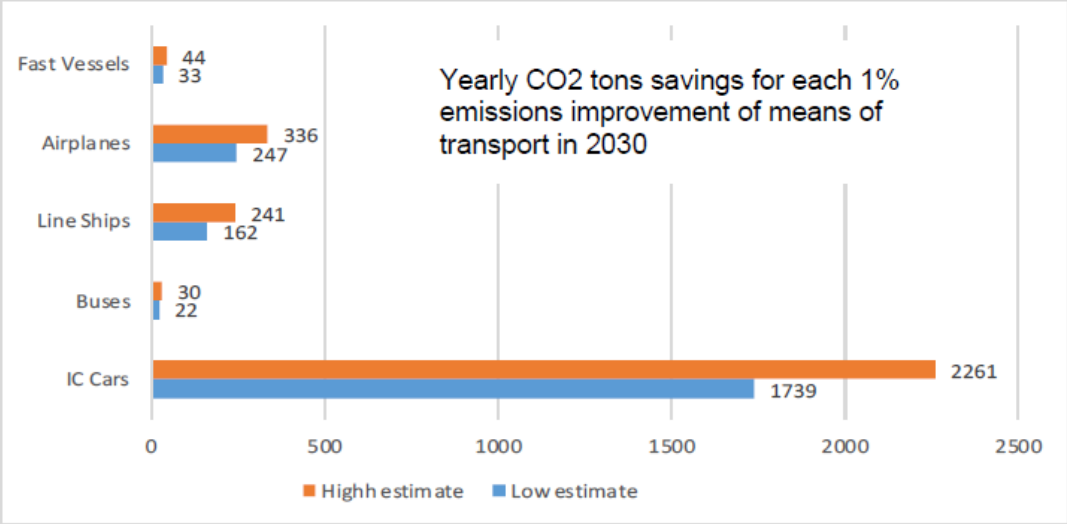
[17] Directive 2014/94 /EU of the European Parliament and the Council of 22nd October 2014 on the establishment of infrastructure for alternative fuels.

emissions per car has been calculated as weighted average of standard emissions. Since data for the Croatian fleet are not available, therefore it is assumed that the two fleets are similar in terms of composition and average emissions.

From these predictions, it emerges that at the current modal split the efficiency gain of the internal combustion (IC) car provides the greatest benefit. In fact, for every percentage point of CO2 reduction of IC vehicles, total emissions decrease by more than 1.739 tons in the low growth scenario and by 2.261 tons in the high growth scenario (Fig. 1).

Of course, the overall benefit depends on the **intensity of use of each mode**. Planes, which have much higher emissions per passenger than the car, are however much less used and therefore their improvement has a relative lower impact on the overall reduction of emissions (see the figure below). Maritime transport deserves a separate discussion, as different types of ships have very different emissions per passenger depending on their age and type. In addition, a key role will be played by the switch to liquefied natural gas, which significantly reduces emissions and for whose large-scale use both shipping companies and ports are gearing up (Fig. 1).

Fig. 1 - Yearly reduction in total CO2 emissions (tons) generated by travels between Italy and Croatia (projected to 2030) for each percentage point reduction in emissions from various transport means



Innovations in transport means can modify people behaviours and habits. But, as said above, in next years, cars are expected to remain the most used mean of transport.
Differently, a shift from cars to buses can be observed in the future years above all among the youths and visitors without accompanying children, given a series of conditions, among the following seem particularly relevant:

- there will be a further diffusion of long-distance bus or minibus lines/rental services (following the business model of, for example: Flixbus or Go-Opti, Croatia-Bus, etc.), and related services (e.g.: luggage transfer, high-comfort equipment, etc.);
- there will be an improvement of first/last mile connectivity and nodes accessibility;
- new services of (fast) vessels from and to main coastal attractors (e.g.: Trieste, Venice, Rovinj, Pula, etc.), especially within a logic of increasing the attractiveness of sea travels by offering improved services, such as bicycle transportation or all-inclusive packages.

In addition, for segments of young and highly educated people, other alternative forms of passengers mobility can be identified, oriented towards multimodality that does not use cars, but a combination of at least two transport modes, the most frequent of which are: bike + bus, bike + ship, bike + train, etc.
New technologies for transport data collection and analysis can also help to change people's behaviour, as explained in the next section.

8. New technologies for transport flows, data collection and analysis[18]

Above, in the previous section 6, we have listed four strategies to contain environmental impacts caused by cross-border passengers' flows.

Changes in travellers' behaviour and public transport solutions are detailed in section 6. Contents related to adoption of innovations in cross-border transport modes between Italy and Croatia are described in section 7. In this section we propose a brief analysis of new technologies for transport flows data collection and analysis, which represent a key element for supporting planning of sustainable and cost-effectives solutions.

Experiences gained and best practices of the countries of the European Union[19] and lessons learnt in the Anglo-Saxon world[20] allow us to affirm that the current situation in passenger transport, habits and behaviours of cross-borders and residents traveller will be changed by new technologies, innovative solutions, smart and interactive tools, which will make regional connections more accessible through multimodal solutions and sustainable passenger mobility.

These innovative technologies collect and analyse data from mobile telecommunication operators. The results of these elaborations are information for better understanding of needs and habits of cross-border visitors and residents and for taking strategic decisions on planning and development of sustainable transport solutions.

Mobile phone operators, that provide big anonymised datasets, have significant market shares, to ensure that the information contained is representative of significant shares of the resident population and tourists. Data are information records in containing the location of mobile phones referred to the cells of the telecommunication network (due to the traffic between mobile devices and the first stationary mobile network station).

So, these big datasets collect data on travel habits, intensity and structure of traffic flows by transport mode, and distribution of traffic flows for **target geographic areas**. Then, each one of these target areas is further analysed regarding its spatial content, mobility status, including infrastructure and mobility services and the identification of traffic samples within target areas for target population groups. In addition, key **points of interest** (i.e.: transport terminals, border crossing points, etc.) and the associated corridors are identified. And demographic and economic data related to these geographic areas are inserted in the big datasets.

[18] The source for this section is the Deliverable D.4.1.5 - Analysis of traffic flows, needs and habits of residents of the Primorje-Gorski Kotar County and cross-border passengers to regional destinations.
[19] Please see: UNECE THE PEP (2020), "Mobility Management: A guide of international good practices", available at this link: https://thepep.unece.org/node/805.
[20] See "The Major of London transport strategy" adopted in 2018, available in this web page: https://tfl.gov.uk/corporate/about-tfl/the-mayors-transport-strategy#:~:text=The%20Mayor's%20Transport%20Strategy%20sets,cycle%20and%20use%20public%20transport.

The observed area over which the analysis is performed using big datasets usually is larger than the initial one, in order to identify transport corridors and transits from/to neighbouring areas. To obtain a representative/typical overview of traffic, data collection should be carried out during the normal working week, during the weekend, and during the peak/off season (i.e., summer tourist season in relation to the winter tourist season in the Mediterranean). Then the observed area is segmented into smaller areas (spatial fragmentation) in accordance with traffic zoning and mobile network topology.

Then locations of stay are identified. They are called stationary locations and are determined depending on the places of stay that lasted more than a certain threshold (such as 15 minutes).

In these stationary locations are also searched the so called above "point of interest", geographical locations important for mobility analysis, that help to find the mode of transport and the purpose of the trip. Important points of interest for mobility research are elements of transport infrastructure (ports, passenger terminals, public transport stops, and the like) that can be used to detect modes of transport. Other points of interest (hospitals, restaurants, and the like) can be used to identify the purpose of travel.

The **purpose of the trip** greatly influences the behaviour and choice of the mode of travel. In order to better understand the mobility patterns, the purpose of the trip should be determined, in particular for trips not related to commuting to home and work. There are at least six main categories (but not limited to them) of travel purposes, such as commuting, school, shopping and personal care, leisure, work, transport of goods, etc.

The next step in the analysis involves the **identification of the trip**. It is defined by time, spatial and speed thresholds, that are essential to determine each trip (or travel).

Each trip is identified by the initial location of the journey (at zone level), the timestamp of the start of travel, the final location of travel (at zone level), the timestamp of the end of travel, travel duration, Euclidean travel speed, road speed, Euclidean travel distance, road distance, travel purpose, etc.

The list of all trips (travels) can be used for different types of analysis and visualizations. The analysis may include the determination of origin/destination (OD) travel matrix for all types of means of transport, the identification of OD travel matrix for specific types of transport, the calculation of travel-related statistics (e.g., average speed between zone pairs for a predefined time period, etc.). Since all travel-related data contain a geographical identifier, the data can be visualised on the map for reporting and further analysis.

The analysis of information contained in big datasets provided by mobile phone companies is completed with the display of the main results using a **Web-GIS visualization tool**. It is used to visualise, display, and generate reports based on information obtained by analysing the anonymised datasets. It has a function to display the geographical map as background, the

locations of transport terminals and other defined points of interest (e.g. ports, stations, airports, border crossings...) and their associated geographic interest zones (described above).

9. New sustainable mobility trends

New tendencies are emerging in Croatian passengers' mobility. In this section sharing mobility, demand-responsive transport, public passenger transport system, pedestrian systems, bicycle path systems, multimodal transport infrastructure are described. On the other hand, non-profit groups, that promote alternative transport modes to the private car, may have a relevant role. We start with sharing mobility.

Meanwhile, private transport is still dominant and widely used, in Istrian Region and in Croatia there is a new growing wave of mobility modes that belong to the wide sphere called "**sharing mobility**". They pay lots of attention to IT sector, digitalization processes and connecting mobility. They are next to public transportation, but public transport will not be able to accommodate the need for mobility and flexibility of modern users.

Sharing mobility is a new socio-economic phenomenon affecting transport sector both on demand and supply side. On the demand side, sharing mobility demonstrates a transformation of individuals' behaviour, as they tend to prefer temporary access to mobility services rather than using their own means of transport. On the supply side, this phenomenon consists in the affirmation and diffusion of mobility services that use digital technologies to facilitate the sharing of vehicles and/or journeys, creating scalable, interactive and more efficient services.

There are also some areas of Croatian territory characterized by low passengers' demand where regular bus or train services are not considered financially viable, such as the rural or peri-urban areas. These areas can today be reached by the so-called **demand-responsive transport** (DRT), a form of transport where vehicles alter their routes based on particular transport demand rather than using a fixed route or timetable.

In the area of urban transport, the emphasis is placed on the problem of traffic jams on the roads in the centres of major cities and tourist destinations and on parking. Upgrading the network and increasing capacity should be accompanied by improvements to the **public passenger transport** system, **pedestrian** areas in urban centres and **bicycle path systems** for daily commuters, **public bicycle systems** and traffic schemes planned to adapt the traffic to seasonal requirements.

In addition, a resilient, up-to-date, high performance **multimodal transport infrastructure** is a precondition for sustainable and smart transport and mobility[21]. Transport nodes connectivity has a significant impact on environmental aspects, because it might be the driver of the diffusion of more sustainable travel behaviours, and of the reduction of car dependency in particular.

Connecting land infrastructure and accessibility could be measured in terms of road and rail infrastructure, available parking areas, boarding areas for passengers and vehicles. The availability and proximity of connections for various transport modalities from and to a port and services to reach them as well.

After the description of new sustainable mobility solutions, we also reserve space to **non-profit groups,** that **promote the use of alternatives** to the private car, because they have a relevant role in the public transport area. There are in fact groups that promote daily bike use, other groups that watch out for passenger rights, for the maintenance of pedestrian areas or even for traffic surveillance. These groups (neighbourhood associations or common interest groups, non-governmental organisations, etc.) **can help the local administrations and transport authorities** in their duties and help to promote the use of the public transport. The participation of such associations, local groups and non-governmental organizations in the transport planning decisions should be promoted and considered.

10. Policy implications and conclusions

Previous paragraphs describe strategies and innovations being defined in individual transport areas for the containment of polluting emissions and aimed at defining new sustainable solutions for cross-border passengers' transport.

In fact, the vision of the Mimosa Project consists in improving quality and sustainability of cross-border and coastal passengers' mobility between Italy and Croatia. This vision stems both from the general development **strategies** by the **European Union**[22] over the last decade and from the strategies of the **EUSAIR pillars**[23].

[21] European Commission: Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions Sustainable and Smart Mobility Strategy – putting European transport on track for the future COM/2020/789 final, Brussels, 9.12.2020

[22] In particular: a) White Paper from the European Commission "Roadmap to a Single European Transport Area" (2011); b) Communication 2009-8 of the European Commission "Strategic goals and recommendations for the EU's maritime

So, the general EU policy framework and the current situation of the area under consideration with its strengths and weaknesses are the basis for identifying **operational priorities** for sustainability in cross-border passengers' transport. As discussed in this document, they consist essentially in: a) reducing the car use, b) reducing maritime transport-related emissions, c) improving connections to hinterland, islands and coastal areas, d) supporting multimodal transport.

Therefore, a **first important contribution** to the sustainability of the connections is given by **public policies** that support alternative means of transport to **cars**, given the very high number of cross-border passengers using the car.

It is a topic that concerns behaviours of travellers, technologies currently available, adoption of innovations in the sector of vehicle manufacturers, the speed of renewal of the fleet in use. Therefore it is a theme that concerns wide-ranging public policies, defined at European and national level, to which the EUSAIR strategy can be inspired.

A **second contribution** to cross-border connections is related to **maritime transport**, because the natural border between Italy and Croatia is entirely on the sea.

From an infrastructural point of view, in order to guarantee an efficient maritime line service, it is crucial that local spatial planning tools provide for adequate number of berths and a sufficient operational shore length. In addition, as for the passenger service, the organisational aspects of port surface area within the cross-border passenger terminal ports need to be restructured to achieve a harmonization of multimodal transport options, oriented towards sustainability principles. But, in some cases, there are system boundaries which hamper this progress. For instance, passenger terminals should encourage the use of electric bicycles and vehicles thus promoting **intermodality** and raising awareness of environmental safety, but one of the boundaries is that many ports do not have proper infrastructure (e.g.: chargers for electric bicycles or vehicles).

On the other hand, in order to facilitate passengers in the process of buying tickets, all ports should have appropriate conditions for tickets sales and availability of buying tickets online. Only few Adriatic passenger terminals fulfil these requirements. Other examples of ICT integration regarding to the passenger demands are: Wi-Fi free of charge, real-time information systems for passengers, schedule information/itinerary of maritime transportation lines.

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transport policy until 2018"; c) The "European Green Deal" (Brussels, 2019); d) "Maritime Transport Strategic Approach of the European Union" (Brussels, 2020); e) "Integrated Maritime Policy of the European Union" (IMP) (Brussels, 2020).

[23] The key strategies of EUSAIR pillars 1 and 2, respectively: Blue Growth and Connecting the Regions. More specifically: a) to improve sea basin governance, by enhancing administrative and institutional capacities in the area of maritime governance and services (pillar 1, specific objective 3); b) to strengthen maritime safety and security and develop a competitive regional intermodal port system (pillar 2, specific objective 2); c) to develop reliable transport networks and intermodal connections with the hinterland, both for freight and passengers (pillar 2, specific objective 3).

Regarding to the organisational aspect, line schedule could be implemented in function of harmonization of **multimodal** transport options.

Furthermore, consider that usually a hub terminal and its operational coast essentially consists of several ro-ro ramps for the acceptance of ro-ro passenger ferries. A larger number of the ro-ro ramp gives the possibility for mooring the few ferries at the same time which gives the possibility to enlarge organisational aspect and also organise more passenger transportation lines in function of passenger demands. Also, larger operational coast gives the possibility to enlarge the number of high-speed-passenger crafts which give the possibility for increase passenger traffic flow.

Together with multi- and intermodality, the development of environmental impact procedures of a passenger terminal acts as a key indicator of port's sustainable development in terms of reduction of pollution and raising environmental awareness.

In this field, consider supply of alternative energy sources other than fossil fuels. The main advantages of such energy are their inexhaustibility and renewability, as well as usage of techniques which, in significantly less extent, affects the environment. In terms of alternative fuels, types of alternative energy encompass wind, solar energy, hydrogen gas, tidal energy, biomass energy, and biofuels. The development of alternative energies contributes to port competitiveness on the market, as well as its environmental sustainability. For all these reasons, regional and local public authorities should support alternative energy sources also in maritime transport, even more than what is already happening.

A **third contribution** should be focused on improving connections to hinterland, islands and coastal areas, because the sustainable development of cross-border transport is determined by technologies, infrastructures but also by links between the Adriatic coast and its hinterland.

Also in this case, regional and local authorities are called to improve the infrastructural equipment and the connections (as stated in the pillar 2 of the EUSAIR strategy).

The three recalled contributions (reduction of the car use; ways to reduce maritime transport emissions; improvement of hinterland links) allow the definition of concrete and operational interventions by public entities and private operators to support new solutions for sustainable mobility and protection of the environment.

References

ICAO (2019), 2019 Environmental Report. Aviation and Environment. International Civil Aviation Organization.

IMO (2018), Resolution MEPC.304(72) Initial IMO Strategy on Reduction of GHG Emissions from Ships, International Maritime Organization.

IMO (2021), Initial IMO GHG Strategy. https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions- from-ships.aspx.

Jugović, A., Mezak, V., Lončar, S. (2006), Organization of Maritime Passenger Ports. Journal of Maritime and Transportation Sciences. 44(1). pp. 93-104.

Onofri, L., & Nunes, P. A. (2013), Beach 'lovers' and 'greens': A worldwide empirical analysis of coastal tourism. Ecological Economics, 88, 49-56.

Pafi, M., Flannery, W., & Murtagh, B. (2020), Coastal tourism, market segmentation and contested landscapes. Marine Policy, 121, 104189.

UNECE THE PEP (2020), "Mobility Management: A guide of international good practices", available at this link: https://thepep.unece.org/node/805.