“MIMOSA”

Analysis of traffic flows, needs and habits of residents of the Primorje-Gorski Kotar County and cross-border passengers to regional destinations

Report:

- Description of the methodology for collecting and analyzing data from the mobile telecommunications network
- Description of privacy policy in the collected data
- Report based on analysis of historical data from 2020
- Report based on the analysis of the first data set (June 2021)
- Web-GIS visualization tool functionality description

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Project name:	Preparation of the analysis of traffic flows, needs and habits of residents of the Primorje-Gorski Kotar County and cross-border passengers to regional destinations
Client:	prigoda.hr Regional Development Agency of the Primorje-Gorski Kotar County, Ciottina 17/B 51000 Rijeka
Contractor:	Ericsson Nikola Tesla Krapinska 45 10000 Zagreb
Authors and collaborators:	Ericsson Nikola Tesla: ● Saša Vojvodić, MSc Electr. Eng. (Project Manager and Project Implementation Specialist) ● Krešimir Vidović, BSc Transport Eng., PhD, Assistant Prof. (Application of big dataset analytics in urban mobility Specialist) ● Tomislav Tolić, BSc Electr. Eng. (Data traffic in telecommunications mobile network and radio access telecommunications mobile networks Specialist) ● Petar Čolić, BSc Electr. Eng. (Big Data Set IT Processing Specialist) ● Anamarija Blavicki, BSc Electr. Eng. (Big Data Set IT Processing Specialist) ● Grgo Dželalija, MSc Geodesy (GIS Spatial Data Processing Specialist) Faculty of Transport and Traffic Sciences: ● Marko Šoštarić, BSc Transport Eng., PhD, Associate Prof. (Transport Planning Specialist) ● Marijan Jakovljević, BSc Transport Eng., PhD (Transport Planning Specialist) ● Orsat Lale, BSc Transport Eng. (Transport Planning Specialist)

Data Protection Officer	Mislav Marović, BSc Electr. Eng.

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1 Introduction

The Regional Development Agency of the Primorje-Gorski Kotar County (hereinafter Prigoda) entrusted the Ericsson Nikola Tesla company with the project of preparation of the analysis of traffic flows, needs and habits of residents of the Primorje-Gorski Kotar County and cross-border passengers to regional destinations, and an interactive tool for the “MIMOSA” project data visualisation.

The “MIMOSA project - MarItime and MultimOdal Sustainable pAssenger transport solutions and services” was notified according to the 2nd call within the INTERREG ITALY - CROATIA 2014 – 2020 programme. The INTERREG Italy - Croatia cross-border cooperation program aims at providing a long-term vision focusing on sustainable exploitation and creating additional values of cultural and natural resources while continuously enriching cross-border links, and activities that contribute to positive and successful cooperation.

The aim of the MIMOSA project is to improve the supply of multimodal sustainable travel solutions and services, with a particular focus on promoting cross-border passenger mobility in the area of the participating countries.

The implementation of the project focuses on innovative solutions, smart tools and technologies that will change the current situation in the field of passenger transport and make regional and cross-border connections more accessible, using multimodal solutions and sustainable passenger mobility.

The subject matter of procurement includes a service for the preparation of the analysis of traffic flows, needs and habits of residents of the Primorje-Gorski Kotar County and cross-border passengers to regional destinations, and an interactive tool for data visualisation.

The result of the analysis will provide more reliable and high-quality information that enables the implementation of various evaluations. On such basis, it is possible to make business and strategic decisions important for the development of sustainable transport and a better understanding of the needs and habits of residents and tourists in the Primorje-Gorski Kotar County.

The adopted methodology encompasses advanced methods of motion in spatial analysis, and cover part of the population sample that standard methods do not normally include and represent more reliable information on movement habits than those obtained by surveying, interviewing travellers and passenger lists. The advanced methodology includes the application of data science methods, i.e., the application of appropriate methods and algorithms for the extraction of knowledge from anonymised big dataset collected from elements of the mobile network (as described above), which are suitable for the successful realization of the requirements of the subject of procurement.

The project task defines the need for detailed analysis using big dataset in the Primorje-Gorski Kotar County, for the following characteristic time periods:

- Historical analysis of the data of one selected time period collected using the same methodology in 2020;
- Off-season public holiday (extended weekend);
- Working day and weekend in peak tourist season;

- Off-season working day and weekend.

This document represents the first and second (out of three) reports of the project within the activities carried out by Prigoda. According to the defined project task, the project report contains the following:

- Description of the methodology for collecting and analysing data from the mobile telecommunications network
- Description of privacy policy in the collected data
- Report based on the analysis of historical data (2020)[1]
- Report based on the analysis of big data sets for data collected during a public holiday (long weekend) in the off-season (3rd to 6th of June 2021)
- Description of Web-GIS visualization tool functionalities

Therefore, the corresponding chapters provide a description of the methodology for collecting and analyzing data from the mobile telecommunications network, and a description of the privacy policy in the collected data, as well as improvements in methodology introduced in analytics of second data set. An analysis of existing documentation related to cross-border mobility and travel habits has been carried out to identify key points of interest (transport terminals, border crossing points) and the associated corridors. An analysis of historical data from 2020 was made, the summaries of which are presented in this document. This report contains summary results of the analysis of mass data sets for selected days in 2020, as well as the summary analysis of mass data sets for data collected during a public holiday (long weekend) in the off-season (3 to 6 June 2021).

All analytical possibilities of the collected data, including the visualisation, will be available through the online Web-GIS tool upon its delivery in the final phase of the project. At the very end, before the concluding remarks, a targeted description of the functionality of the web-GIS visualisation tool is given.

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[1] The COVID-19 crisis affected the economy in Croatia and worldwide significantly. According to the Croatian National Bank, after the continuous GDP growth from 2014 to 2018, and the record GDP in 2019, 2020 GDP has declined by 8.7% (data for 2019 and 2020 are still provisional). It was caused mainly by the COVID-19 crisis. The COVID-19 crisis had other negative consequences. According to the Croatian Tourist Board, the observed counties in the first seven months of 2020 compared to 2019 recorded a decrease in the number of overnight stays by 55%, while in 2021 there has been an increase of 32% compared to 2020. According to data of Croatian Motorways Ltd., which refers to the number of vehicles only for July, in 2021 the total traffic was 1.5% higher than 2019, which was a record year according to all tourist parameters. Traffic in July 2021 is 35% higher compared to 2020. It could be concluded that COVID-19 crisis affected the Croatian economy and transport system significantly in 2020. But in 2021, a lot of adverse effects were mitigated, and in the future, we can expect the normalization in the economy and transport sector in Croatia. Therefore, the data collected, particularly in 2021 can be considered as representative indictor of transport demand, despite COVID pandemic.

2 Description of privacy policy adopted for the collection and analysis of the data

For the preparation of the analysis, datasets collected from mobile phone operators were used, which are collected as information records in the air part of telecommunication traffic (traffic between the mobile device and the first stationary mobile network station) and as information records of data traffic in the core part of the mobile network infrastructure.

During the collection process, these information records were properly encrypted and anonymised to fully comply with all current legal regulations and guidelines related to the protection of personal data and comply with the GDPR Regulation. Several technical and organizational measures have been implemented to ensure a full privacy protection.

2.1 Data description

This chapter describes the datasets that will be used in the research.

Within mobile communication networks, due to the nature of the operation of the network itself, data can be used for analyses outside of the telecommunication environment and for other purposes. The normal purposes of analytics of these (big) datasets are related to services in marketing, public sector, retail, tourism, public safety, and transport. All datasets are anonymised according to the process defined in Chapter 3.2. The data shall be supplied from a mobile operator which has adequate technical and organisational capabilities for the collection and data anonymisation, and which has an adequate market share so that the data collected can be considered representative. It is recommended to select an operator with significant market share[2].

For the purposes of spatial analysis, information on topology and implemented technologies of the operator's mobile telecommunication network is necessary.

To collect data, a system is used that records events from the network, correlates the collected data, and stores it in a database.

The system is designed to collect metrics and events from the network, and by using complex event correlations, it generates session records of anonymised network users, and call records that contain key performance indicators (KPIs) for each session.

The architecture of the collection system consists of five layers, each of which has different components for data processing collected from the network – a layer of data collection (contains components that collect data from the network), a correlation layer (contains components that correlate the collected data), a layer of processing (contains components that process correlated data), a presentation layer (contains components that display processed data), and a service layer

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[2] Šoštarić, M.; Vidović, K.; Jakovljević, M.; Lale, O. Data-Driven Methodology for Sustainable Urban Mobility Assessment and Improvement. Sustainability 2021, 13, 7162. https://doi.org/10.3390/su13137162

(contains components that store data between processing steps and save the configuration for system applications).

The data owner, the telecommunications service operator, who is responsible for the anonymisation process and the delivery of the minimum subset of data necessary for the implementation of analytics, is responsible for collecting and pre-processing of data, including anonymisation.

2.2 Privacy and data protection

All personal data used within this project have been processed in accordance with the General Data Protection Regulation (EU) 2016/679 (GDPR), which regulates data protection and privacy in the European Union (EU) and the European Economic Area (EEA).

The privacy protection within this project consists of four key steps:

- The operator recorded records from mobile network nodes over a period of time defined by the project task in the area where the analysis is to be performed. Records from mobile telecommunications network nodes are automatically saved to the operations support system, and automatically transferred to record processing servers. All records are recorded in an encrypted, unreadable format.
- During data collection, sensitive data that could be used to connect individuals (IMSI and IMEI) is automatically encrypted and further anonymised. Each encrypted record was replaced by a randomly generated string after which all originally encrypted records were permanently deleted.
- The analysis required to perform a project task was performed using data containing only randomly generated replacement IMSI and IMEI sequences. The collection of the necessary dataset, pseudonymisation and replacement of encrypted IMSIs, IMEIs by random sequences was carried out sequentially and automatically. In this process, none of the employees of the Operator, Ericsson Nikola Tesla or any other person had the opportunity to view the data.
- After analysing and processing the entire dataset, upon delivery and acceptance of the delivery defined by the project task, all random strings that were used during the analysis will be permanently deleted, and groupings and / or separation of records will be performed. The final delivery of such aggregated results was delivered in tables and graphical statistical representations. In this way, it is impossible to directly or indirectly identify any person based on results that are thus considered completely anonymous.

For the purposes of this analysis, all appropriate technical and organisational measures have been implemented to comply with the data protection principle.

3 Description of the methodology for collecting and analysing data from the mobile telecommunications network

In the execution of analytics of the anonymised dataset, the scientifically validated SumBoost methodology[3] was used, consisting of a series of steps/actions, which are sequentially divided into five main logical units as shown in Figure 1:

1. project preparation,
2. project planning,
3. mobility analysis,
4. preparing solutions, and
5. final result: sustainable urban mobility measures.

The whole process involves approximately 150 interconnected activities/sub-processes. For information purposes, they are graphically represented in Annex of this document. Overall scheme is attached as Annex to this document. In addition to the definition and description of the activities to be carried out under the SumBoost tool, the process includes a high-level definition (description of the necessary inputs, definition of expected results data, definition of results) and information on expected validation steps. All activities are logically and sequentially linked, so that in general the outcome of the previous activity represents input data for the following activities.

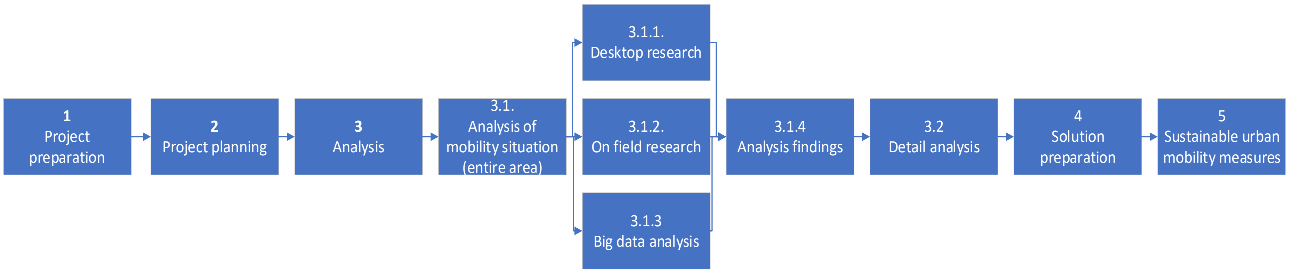
1
Project preparation
2
Project planning
3
Analysis
3.1.
Analysis of mobility situation (entire area)
3.1.1.
Desktop research
3.1.2.
On field research
3.1.3
Big data analysis
3.1.4
Analysis findings
3.2
Detail analysis
4
Solution preparation
5
Sustainable urban mobility measures

Figure 1 Logical units of the SumBoost tool

SumBoost methodology defines the essential structural framework for the realization of big dataset analytics. Executors of analytics may and must adapt the use of this essential framework to the requirements of their project. Therefore, the SumBoost methodology should be used as a process and should be seen as a guideline for the implementation of analytics in the target area and the required statistics, i.e. results of the analyses.

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[3] Šoštarić, M.; Vidović, K.; Jakovljević, M.; Lale, O. Data-Driven Methodology for Sustainable Urban Mobility Assessment and Improvement. Sustainability 2021, 13, 7162. https://doi.org/10.3390/su13137162

The following chapters explain the sections and steps of the mobility analysis used in the realization of the Mimosa project.

Mobility analyses begin with field research that collects data on travel habits, intensity and structure of traffic flows, and distribution of traffic flows for characteristic areas. Such defined characteristic areas are used as target geographic area for which a detailed analysis of the big dataset will be carried out.

The defined areas will be further analysed regarding their spatial content, mobility status, including infrastructure and mobility services, and the identification of traffic samples within target areas for target population groups. The result of the detailed analysis will answer a number of questions related to traffic flow patterns to regional destinations and consider what the possible needs and habits of residents of the Primorje-Gorski Kotar County and cross-border passengers are.

3.1 Collecting and analysing the existing documentation – desk research

The collection and analysis of existing traffic documentation consists of the identification of existing owners / data sources / online database (documentation, plans, GIS, etc.). The research includes demographic and economic data (influential socio-economic indicators).

The analysis includes spatial contents, strategic documents and data on traffic flows and transport infrastructures (road, rail, maritime, public transport, and non-motorised transport).

The analysis includes:

- Analysis of documentation that is important for spatial planning of the covered area. The focus of the analysis is on fostering sustainable modes of transport.
- The analysis of traffic flow data includes data on road, rail, maritime, and non-motorised transports.
- The analysis of transport infrastructure includes the analysis of road, rail, maritime, pedestrian, cycling and passenger public transport infrastructures.
- Analysis of European, national, regional, and local strategic documents. The analysis of transport documentation includes relevant strategies, plans, projects, research and studies crucial for understanding the current state of the transport system.
- Other relevant analyses.

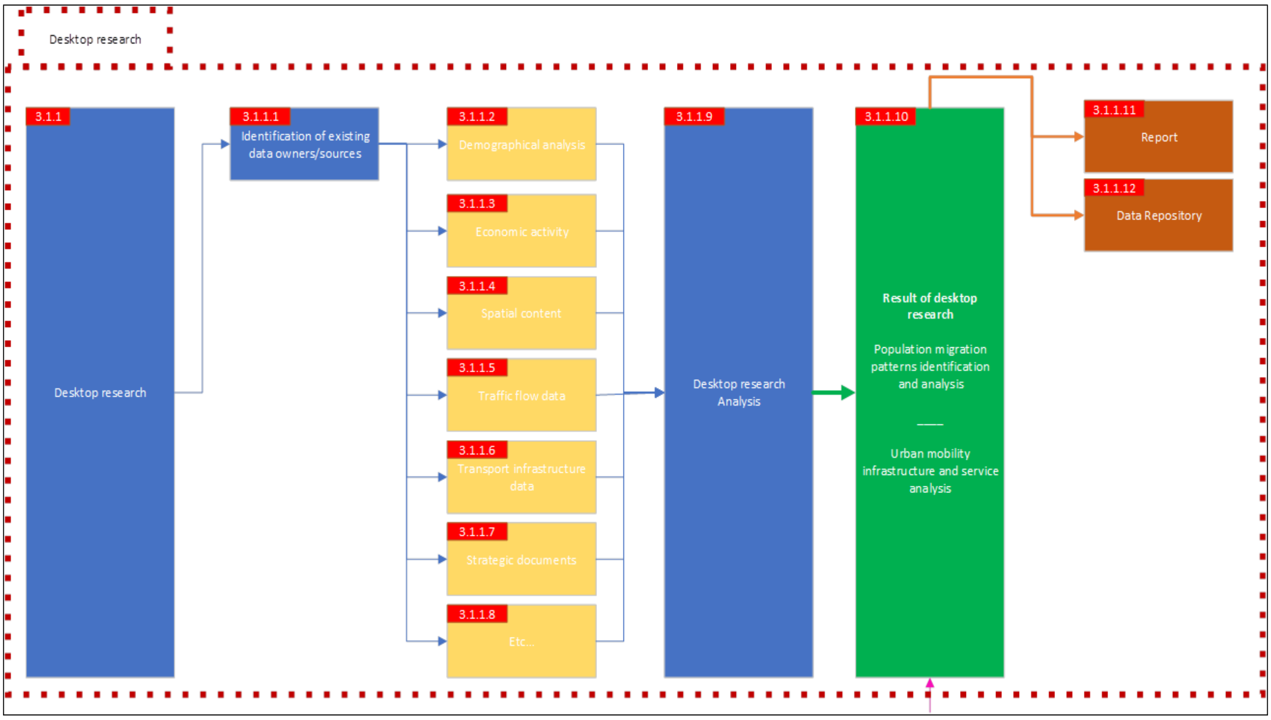
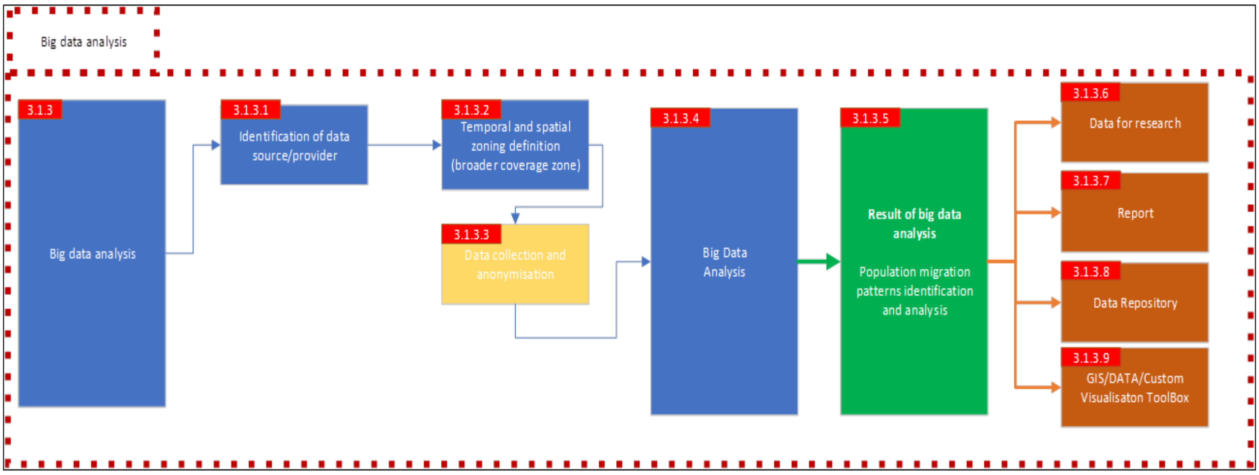

Desktop research
3.1.1
Desktop research
3.1.1.1
Identification of existing data owners/sources
3.1.1.2
Demographical analysis
3.1.1.3
Economic activity
3.1.1.4
Spatial content
3.1.1.5
Traffic flow data
3.1.1.6
Transport infrastructure data
3.1.1.7
Strategic documents
3.1.1.8
Etc...
3.1.1.9
Desktop research Analysis
3.1.1.10
Result of desktop research
Population migration patterns identification and analysis
Urban mobility infrastructure and service analysis
3.1.1.11
Report
3.1.1.12
Data Repository

Figure 2 Collecting and analysing existing traffic documentation

3.2 Analysis of the big data


Big data analysis
3.1.3
Big data analysis
3.1.3.1
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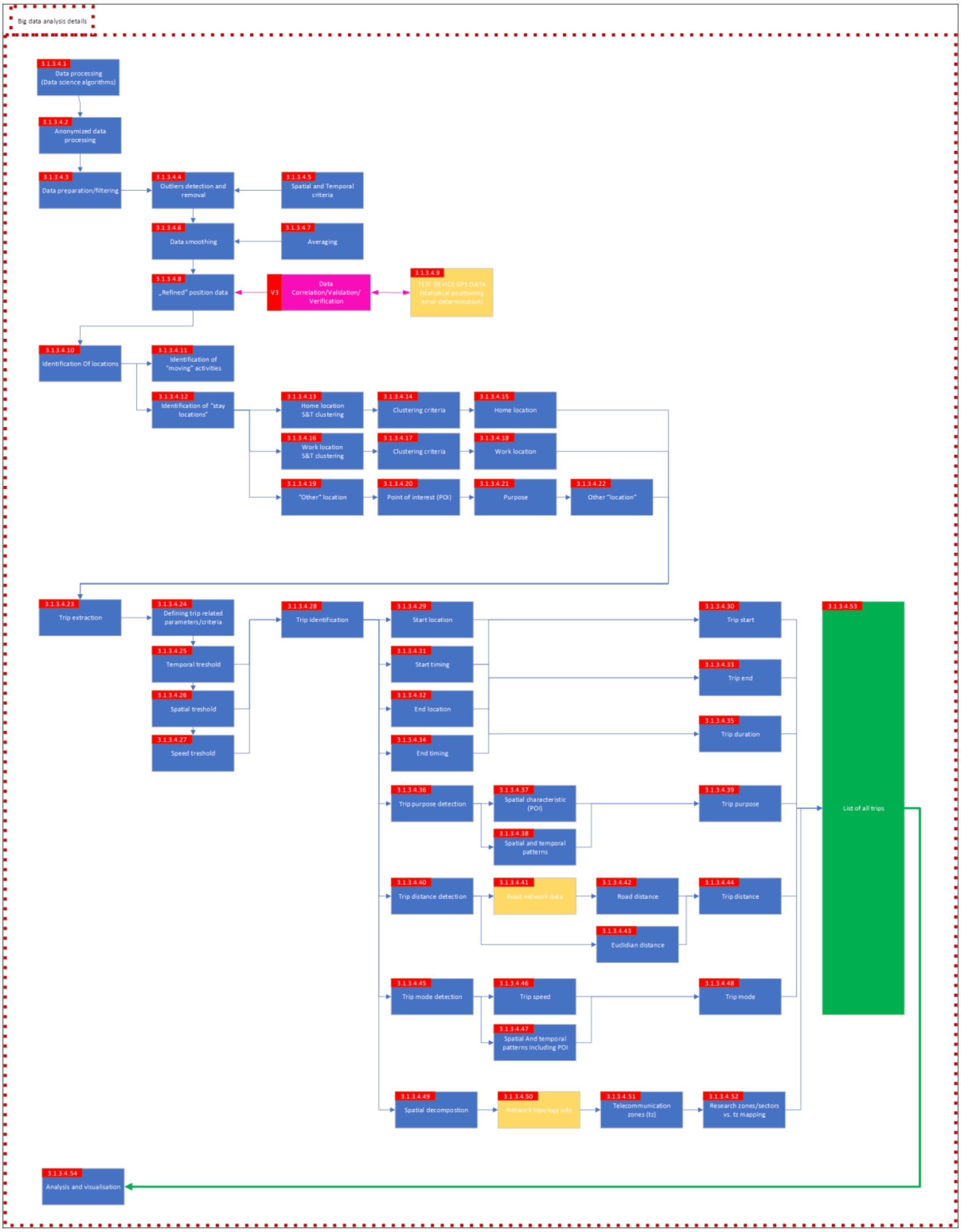
3.1.3.2
Temporal and spatial zoning definition (broader coverage zone)
3.1.3.3
Data collection and anonymisation
3.1.3.4
Big Data Analysis
3.1.3.5
Result of big data analysis
Population migration patterns identification and analysis
3.1.3.6
Data for research
3.1.3.7
Report
3.1.3.8
Data Repository
3.1.3.9
GIS/DATA/Custom Visualisaton ToolBox

Figure 3 Analysis of the big dataset


Big data analysis details
3.1.3.4.1
Data processing (Data science algorithms)
3.1.3.4.2
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3.1.3.4.3
Data preparation/filtering
3.1.3.4.4
Outliers detection and removal
3.1.3.4.5
Spatial and Temporal criteria
3.1.3.4.6
Data smoothing
3.1.3.4.7
Averaging
3.1.3.4.8
„Refined" position data
V3
Data Correlation/Validation/ Verification
3.1.3.4.9
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Clustering criteria
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Analysis and visualisation

Figure 4 Detailed steps of the analysis of big dataset from mobile telecommunication networks according to the SumBoost methodology.

Big data describe complex and big datasets that are difficult to collect, process, store, search, and analyse with conventional database systems. Big data analytics includes the process of collecting, organising, and analysing big dataset to detect useful information that can be used for urban mobility stakeholders. This project uses anonymised big datasets from the mobile telecommunications network that comply with GDPR regulations. The results of the analysis will enable mobility stakeholders to make quality and rapid decisions using up-to-date comprehensive data covering a very large statistical sample of the population throughout the observed area, and all neighbouring areas.

With a view to a quality data source, cooperation is necessary with a mobile network operator with a significant market share and capable, from the point of view of technical and operational capabilities, of meeting the needs of collecting anonymised data for a defined geographical (spatial) and temporal scope.

3.3 Area of analysis and zoning

It is desirable that the observed area over which the analysis is performed using big data sets be larger in scope than the initial scope of the project. The purpose of expanding the project coverage area is to identify transport corridors and transits from / to neighbouring areas according to the defined project coverage area. To obtain a representative / typical overview of traffic, data collection must 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). The observed area is segmented into smaller areas (spatial fragmentation) in accordance with traffic zoning and mobile network topology. Neighbouring areas are large segments along the border of the observed area.

3.4 Data preparation and pre-processing

After a successful process of collection and anonymization, the data are ready for processing.

The analysis uses advanced algorithms and techniques for data processing, as well as various techniques to reduce “noise” and improve the quality of data analysis.

The processing of anonymised data involves the prior processing of anonymised data (preparation, filtering, and cleaning) over which several algorithms are then applied to calculate positions in time and space by which a mobility pattern is identified (trip extraction).

Data preparation is the process of cleaning and converting raw data before processing and analysis. This is an important step before processing and involves customizing data, improving data, and removing deviating data.

Deviated data is data that differs significantly from other data from a coherent dataset. Deviation may occur due to measurement variability or may indicate experimental error and needs to be excluded from the dataset. The deviation may cause problems in statistical analyses. Deviations will be detected and removed after setting a set of spatial and time criteria that must be met to classify the point as deviating.

By alignment, i.e., consistency of the position, the spatial precision is improved by adjusting the location of each point according to the previous and following position within the selected time interval. Alignment by mitigating oscillations reduces noise levels in data. The fundamental assumption is that whenever a device quickly oscillates between several nearby antennas, its actual position is likely between oscillating cells.

The calculation of the average value is made by calculating the average position of the points at time intervals before and after the analysed point. When calculating the average, the weight factor is also included in the calculations. The result represents a new average point for the analysed location.

Initial anonymised data that can roughly determine positions have now been improved. The values that deviate and the remaining “noise” in the data have been removed, and the dataset is now ready for analysis. The data is now more accurate than the original dataset.

3.4.1 Identification of retention points

This is followed by the identification of retention points that can be identified if predefined sets of spatial and temporal stationary criteria are met. Based on the stationarity criteria, it is possible to determine longer and shorter locations of stay.

Stationary locations are determined depending on the places of stay that lasted more than 15 minutes. These places of stay are then grouped using hierarchical agglomerative clustering, which is a hierarchical approach where locations connect depending on the threshold distance. Points that have a greater distance than this will not connect. The total duration of points in each group is calculated and stationary locations are determined based on this duration.

The threshold distance is set by a parameter-defined spatial radius using a complete connection between the sets. Usually, the cluster with the highest total duration is named stationary location. Additional input datasets, the so-called POI (point of interest) data, are used to identify the purpose of stationarity.

POIs are information on geographical locations that may be important for mobility analysis. A set of point-of-interest data was introduced to identify the mode of transport, the purpose of the trip, and to identify the type of stationary location. 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. Based on the POI concentration, the analysed areas /zones may be assigned an appropriate designation (e.g. parks, residential areas, entertainment areas, etc.).

3.4.2 Trip identification

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. In order to use anonymous mobile network operator data to analyse travel patterns, after identifying the place of stay, the next steps include identifying the trip. Travel involves the movement of users between two locations with a specific purpose, where the prerequisites of travel distance, duration, and speed are met. These prerequisites are called travel-related parameters / criteria and will be defined in the following steps. In this step, travel is defined as movement between two locations, and all such trips are analysed for further processing. As the result, all trips will be identified within the observed area, including short, microscopic trips and macroscopic trips. Trips that are not part of the analysis (microscopic trips within the zone) will be discarded in following part of the process.

Based on the local characteristics of the observed area (coverage zone), it is necessary to define the criteria related to travel that will set the time, spatial and speed thresholds to be used to create the travel.

- The time threshold defines the time values that will be used to determine the travel. The minimum and maximum duration of travel will be defined to discard potential travels that take too long or too short and are therefore unlikely to have occurred. Minimum trip duration is 240 sec, and maximum trip duration is in this project is not set).
- The spatial threshold defines the spatial values that will be used to determine the travel. The minimum and maximum length of travel will be defined to discard potential travels for which the distance is too short or too long or cannot be determined and are therefore unlikely to occur. Minimum trip distance is 400 meters, and maximum trip distance in this project is not set).
- The speed threshold defines the speed values that will be used to determine the travel. The minimum and maximum speed of travel will be defined to discard potential travels for which the average value of speed is too low or too high and are therefore unlikely to occur. Minimum speed is 1 m/s, and maximum speed is 60 m/s).

As previously stated, all identified travels are analysed to determine whether they meet time, spatial and speed thresholds. All travels that do not meet the expected criteria are rejected. All remaining travels are classified as real travels that have actually occurred and will therefore be used in further steps to analyse mobility.

Each identified travel is defined by the following characteristics:

- The beginning of travel - based on previous findings, the location and timestamp of the start of travel are determined and saved for further processing.

- Start time - Determining timestamp for the start of travel
- End location - Determining the exact location of the end of travel (arrival at the destination).
- End time - Determining the timestamp of the end of travel (arrival at the destination).
- Duration of travel - Determining the duration of travel is calculated using data on the beginning and the end of travel.
- Purpose of travel - Travel is generated for all identified users. For each anonymous user, “stay locations” are marked as home, work, or other. Based on these markings and travel orientation, the purpose of travel is revealed.
- Distance travelled - In this step, the distance of travel will be determined (in the spatial sense). Each travel will be defined with two distances. The first is the Euclidean distance, and the second is the distance by road. The travel distance parameter will be used to define travel. It will also be used to calculate the speed of travel.
- Travel speed - The mode of travel is characterized by average speed. Therefore, one of the criteria for determining the way of travel will be to use speed criteria to identify or discard a possible travel mode.

As a result of the previous steps, a list of all identified and separated travels is generated. Each trip is described by the approximate place and time of the beginning and end of travel, the travel duration, the distance of travel (road and Euclidean distance) and the mode of travel. The place of start and end of travel was represented by an appropriate zone in accordance with the spatial decomposition resulting from the mapping of the research zones in relation to telecommunication zones.

3.4.3 Migrations patterns

The list of all travels can be used for different types of analysis and visualizations. The analysis may include the determination of 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.

Therefore, the result of this part of the project is the identification of population migration patterns collected through the analysis of an anonymous telecommunications big dataset.

3.4.4 Improvements in methodology – migration from SumBOOSt to SumBOOST v2 methodology

The SumBoost methodology is explained in detail in previous chapter, and this chapter will further clarify only additional modules that have been implemented as part of the extension.

The extension of the methodology is to improve the accuracy of the positioning of the mobile terminal and to improve the methodology for determining the means of transport used by the user during the trip. The process of improving positioning accuracy is shown in Figure 5.

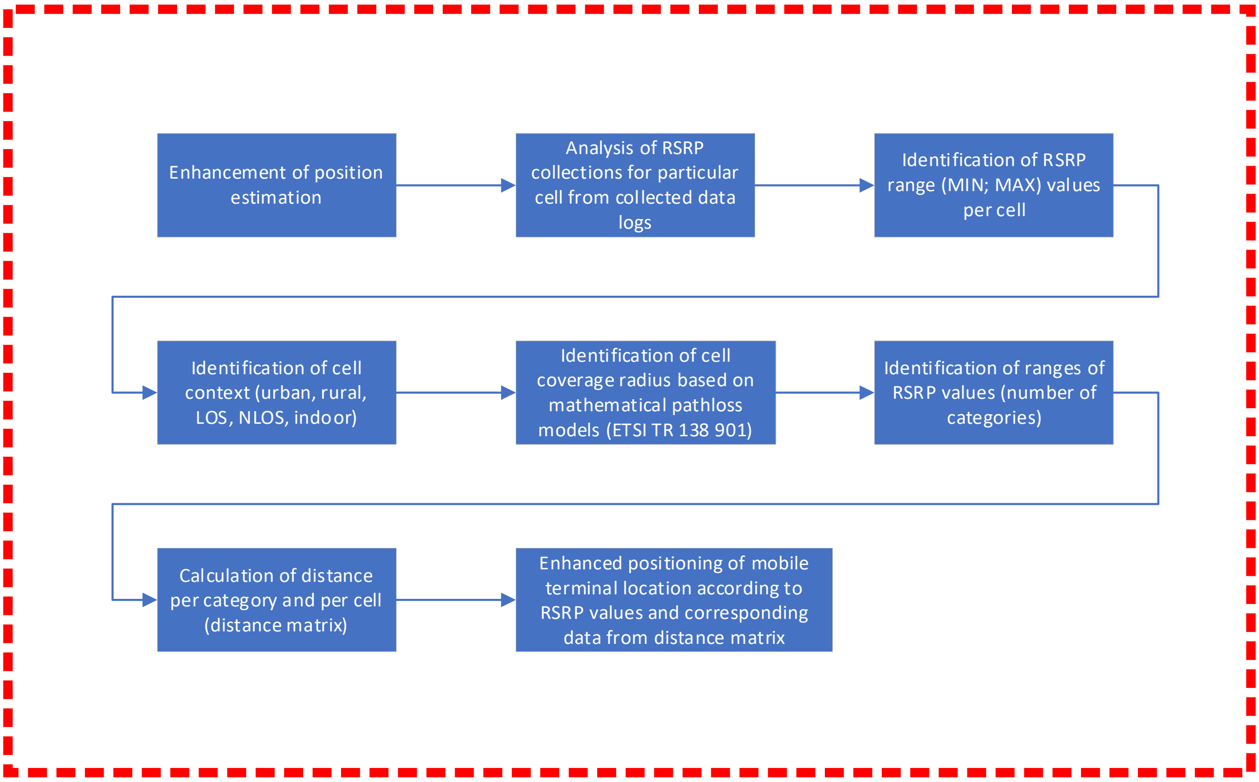

Enhancement of position estimation
Analysis of RSRP collections for particular cell from collected data logs
Identification of RSRP range (MIN; MAX) values per cell
Identification of cell context (urban, rural, LOS, NLOS, indoor)
Identification of cell coverage radius based on mathematical pathloss models (ETSI TR 138 901)
Identification of ranges of RSRP values (number of categories)
Calculation of distance per category and per cell (distance matrix)
Enhanced positioning of mobile terminal location according to RSRP values and corresponding data from distance matrix

Figure 5 The process of improving positioning accuracy.

In the original methodology, the initial user location is set on the azimuth field of the centre of the cell and at a predefined distance from the cell towards the nominal cell coverage radius.

In this step, the improvement was achieved by using additional statistics on the value of “RSRP - Reference Signal Received Power”, which allows a more precise determination of cell coverage, and according to the measured values of the RSRP, a more precise determination of the location of the user based on the statistical value of the RSRP. The result is a more accurate initial user location, which will then be further processed according to the SumBoost tool process.

Improving the detection of modes of travel (the means of transport used by the user) is based on the application of statistical modelling to improve the detection of the mode of travel. The approach used in this tool is based on Bayesian statistics and the Bayesian model. Bayesian statistics is a theory in the field of statistics based on the Bayesian interpretation of probability where probability expresses a degree of belief in an event. The Bayesian model is a statistical model in which you use the probability to present all the uncertainty within the model, both uncertainty about the output, and uncertainty about the input (known as parameters) into the model. Therefore, this group of steps will be positioned in “Detecting the mode of transportation” part of the process of the original Sumboost toolbox. The process consists of 8 steps, and the result will be an improved approximation of the mode of travel for travel accomplished by public transportation. The process is visualized in Figure 6.

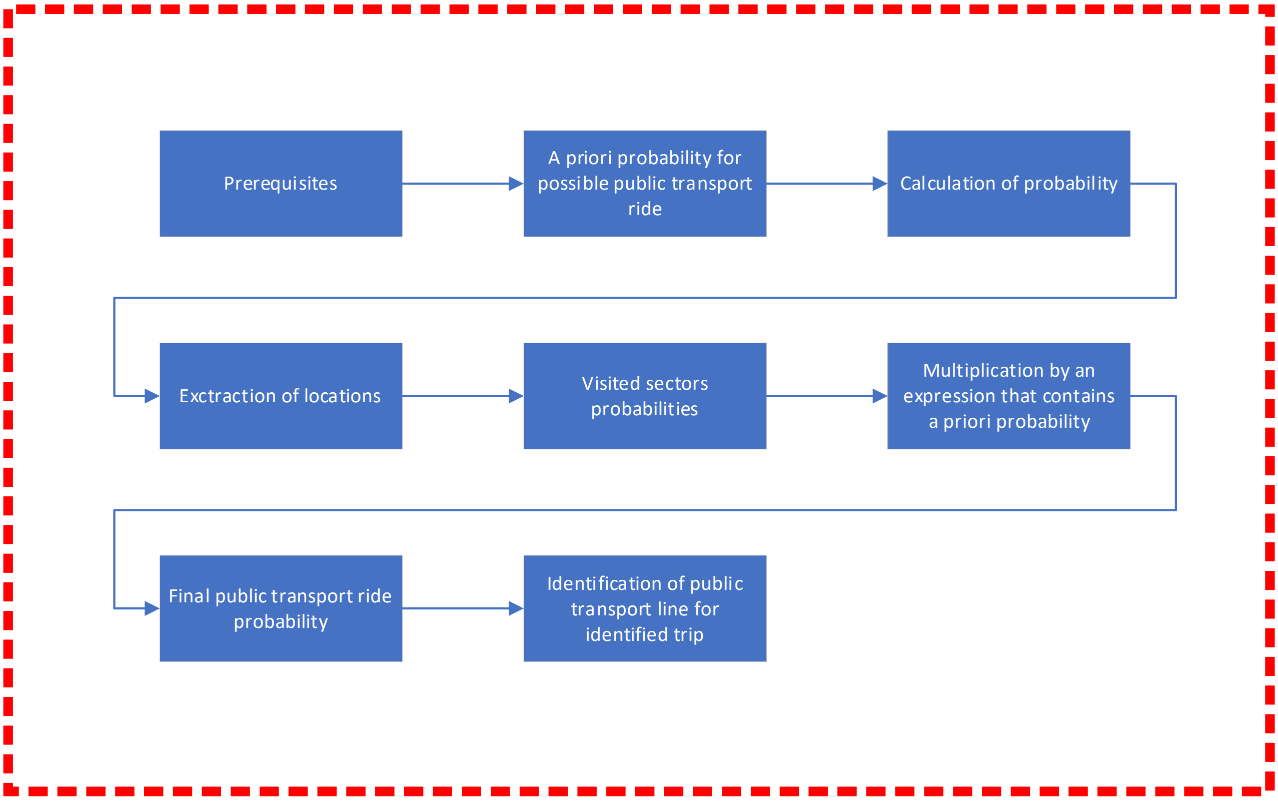

Prerequisites
A priori probability for possible public transport ride
Calculation of probability
Exctraction of locations
Visited sectors probabilities
Multiplication by an expression that contains a priori probability
Final public transport ride probability
Identification of public transport line for identified trip

Figure 6 The process of improving the determination of the means of transport

The improvements applied have improved the overall process of processing anonymised mass data sets based on the SumBOOST V2 methodology.

4 Analysis of historical data

This chapter presents the results of the analysis carried out in the identified area, considering based on the results of desk research, which task was to identify the characteristic points of the transport system, define cross-border corridors by individual mode of transport, and identify existing knowledge from cross-border mobility and travel habits. These data represent an input parameter

for the analysis of big datasets, as they show which areas of interest need to be focused on to carry out an appropriate migration analysis.
After that, an analysis of travels from mass datasets was made for two days in 2020 (characteristic working day, characteristic weekend day outside the peak tourist season).

4.1 Characteristic points of the transport system

The determination of key terminals is of paramount importance to monitor people's travel. Key road, rail, air, and sea transport terminals, as well as border crossings with Slovenia, have been considered. Graphical representation of key terminals is visible in Figure 7.

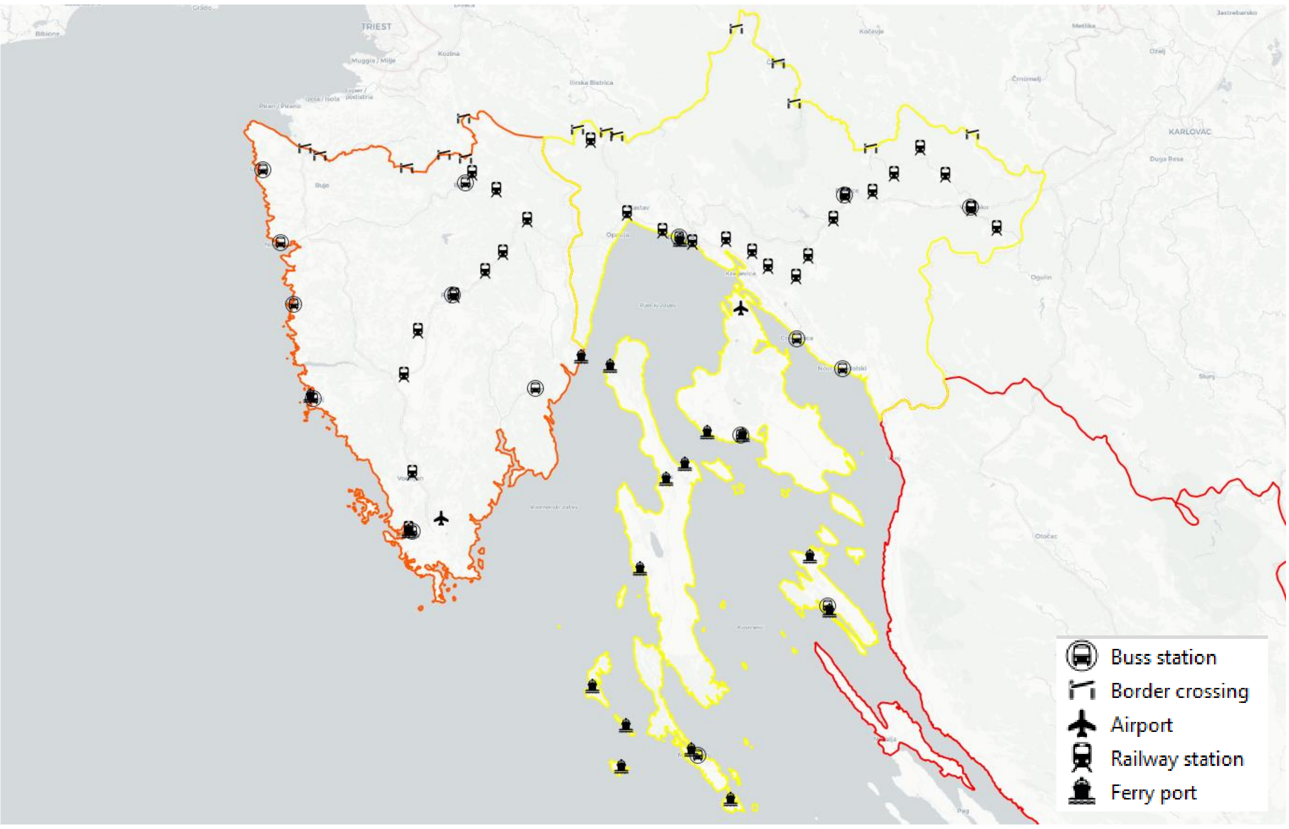


Figure 7 Terminals

In total, there are 76 key terminals in the observed area, of which 48 are in the Primorje-Gorski Kotar County, while 28 are in Istria County. The division of key terminals is as follows:

- 16 bus terminals
- 14 border crossings
- 2 airports

- 27 railway stations
- 17 ferry ports

It is important to note that in the analysed area there are different types of border crossing points according to their characteristics, which are presented in more detail in Table 1.

Table 1 Information on border crossing points

Name	County	Border crossing type
Kaštel Border Crossing	Istria	Permanent international road border crossing of category I
Plovanija Border Crossing	Istria	Permanent international road border crossing of category I
Požane Border Crossing	Istria	Permanent international road border crossing of category I
Lucija Border Crossing	Istria	Permanent border crossing point for local border road transport
Slum Border Crossing	Istria	Permanent border crossing point for local border road transport
Jelovice Border Crossing	Istria	Permanent interstate border crossing of category II
Rupa Border Crossing	Primorje-Gorski Kotar	Permanent international road border crossing of category I
Pasjak Border Crossing	Primorje-Gorski Kotar	Permanent international road border crossing of category I
Prezid Border Crossing	Primorje-Gorski Kotar	Permanent international road border crossing of category II
Brod na Kupi Border Crossing	Primorje-Gorski Kotar	Permanent international road border crossing of category II
Čabar Border Crossing	Primorje-Gorski Kotar	Permanent border crossing point for local border road transport

Lipa Border Crossing	Primorje-Gorski Kotar	Permanent border crossing point for local border road transport
Zamost Border Crossing	Primorje-Gorski Kotar	Permanent border crossing point for local border road transport
Blaževci Border Crossing	Primorje-Gorski Kotar	Permanent border crossing point for local border road transport

4.2 Cross-border mobility and corridors

To be able to analyse the movement of transport demand and the needs and habits of residents of the Primorje-Gorski Kotar County and cross-border passengers to regional destinations, transport corridors for road, rail, air, and sea transport have been established. The transport corridors in question extend across three counties: Primorje-Gorski Kotar, Istria, and Lika-Senj. In this regard, Istria and Lika-Senj counties are transit counties.

A detailed description of the transport corridors for each of these modes of transport is provided below.

4.2.1 Road transport corridors

Several transport corridors have been identified for road transport for cross-border travel from the Primorje-Gorski Kotar County, depending on the destination area. In view of the existence of a larger number of road corridors for the purposes of this research, the most common ones were identified, from the point of view of speed and distance of travel.

Accordingly, the first transport corridor is Rijeka - Ljubljana, for which 3 different routes have been established. A view of possible routes is given in Figure 8, while a more detailed description is given in Table 2.

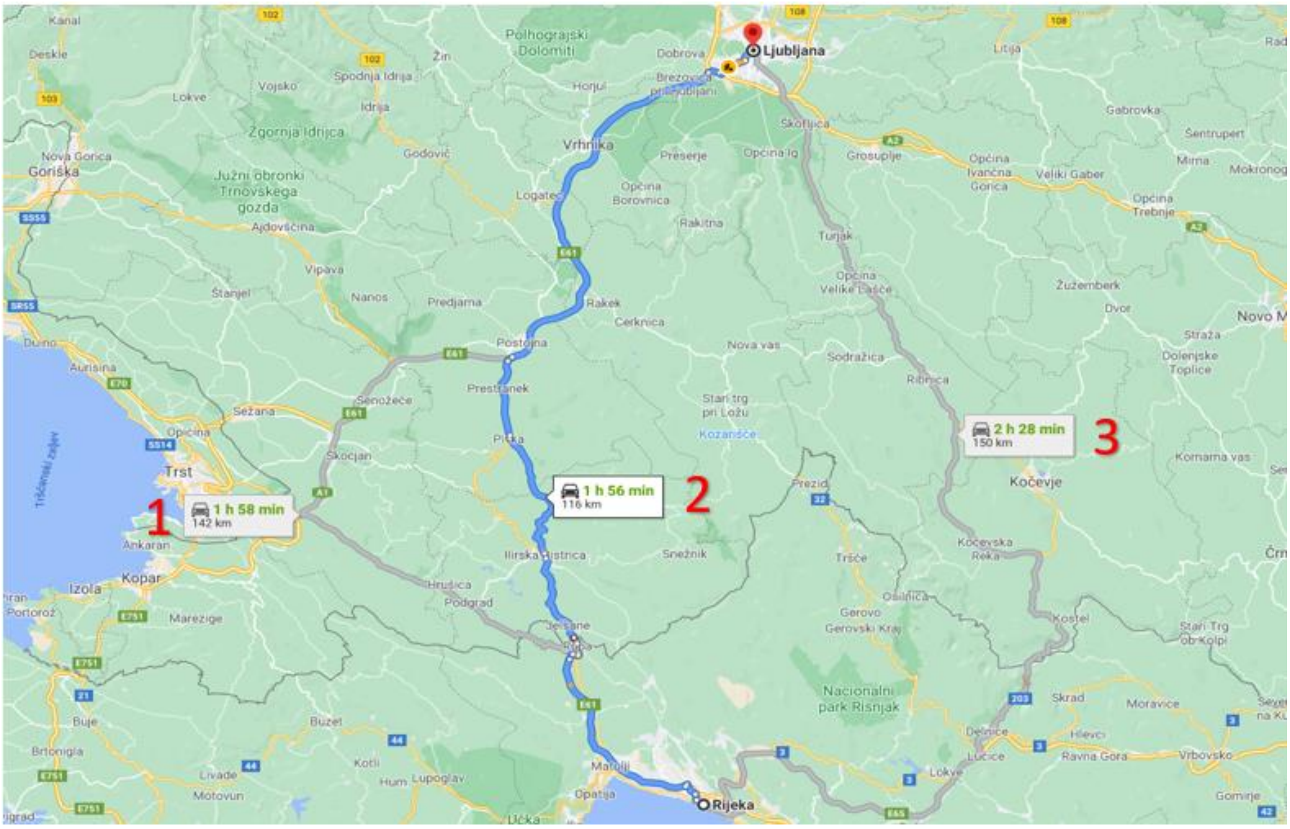

Ljubljana
Vrhnika
Postojna
Prestranek
Pivka
Ilirska Bistrica
Trst
Koper
Izola
Kočevje
Rijeka
Opatija
1
1 h 58 min
142 km
2
1 h 56 min
116 km
3
2 h 28 min
150 km
E61
A1

Figure 8 Display of routes between Rijeka and Ljubljana

Table 2 Information on possible routes between Rijeka and Ljubljana2

Name	Distance	Travel time	Roads used	Border crossing
Route 1	142 kilometres	1 hour and 58 minutes	E61 and A1	Pasjak
Route 2	116 kilometres	1 hour and 56 minutes	A1	Rupa
Route 3	150 kilometres	2 hour and 28 minutes	E65 and State Road 106	Brod na Kupi

The second corridor is Rijeka - Maribor. A view of possible routes is given in Figure 9, while a more detailed description is given in Table 3.

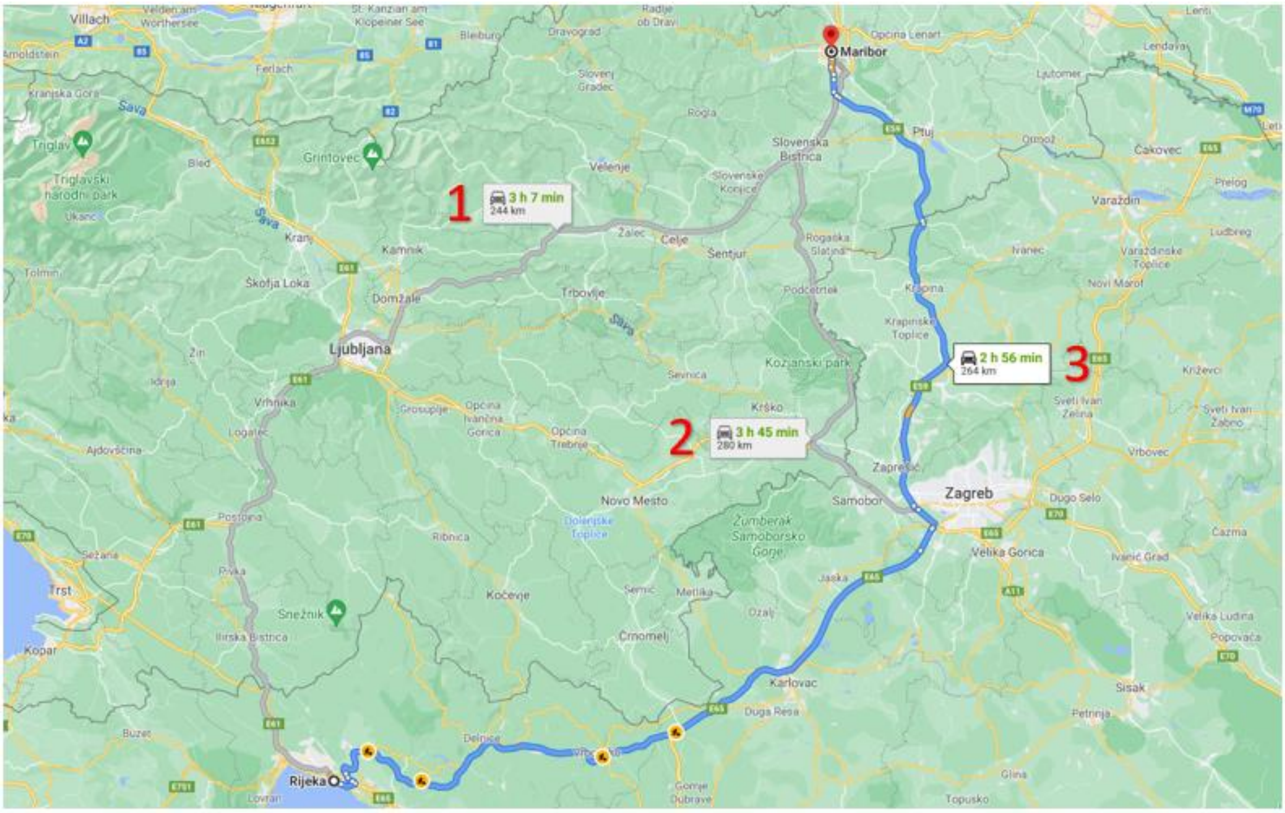

1
3 h 7 min
244 km
2
3 h 45 min
280 km
3
2 h 56 min
264 km
Maribor
Rijeka
Ljubljana
Zagreb

Figure 9 Display of routes between Rijeka and Maribor

Table 3 Information on possible routes between Rijeka and Maribor

Name	Distance	Travel time	Roads used	Border crossing
Route 1	244 kilometres	3 hours and 7 minutes	A1/E57	Rupa
Route 2	280 kilometres	3 hours and 45 minutes	E65 and E70	Bregana
Route 3	264 kilometres	2 hours and 56 minutes	E65	Macelj

The third transport corridor is Rijeka - Trieste. A view of possible routes is given in Figure 10, while a more detailed description is given in Table 4.

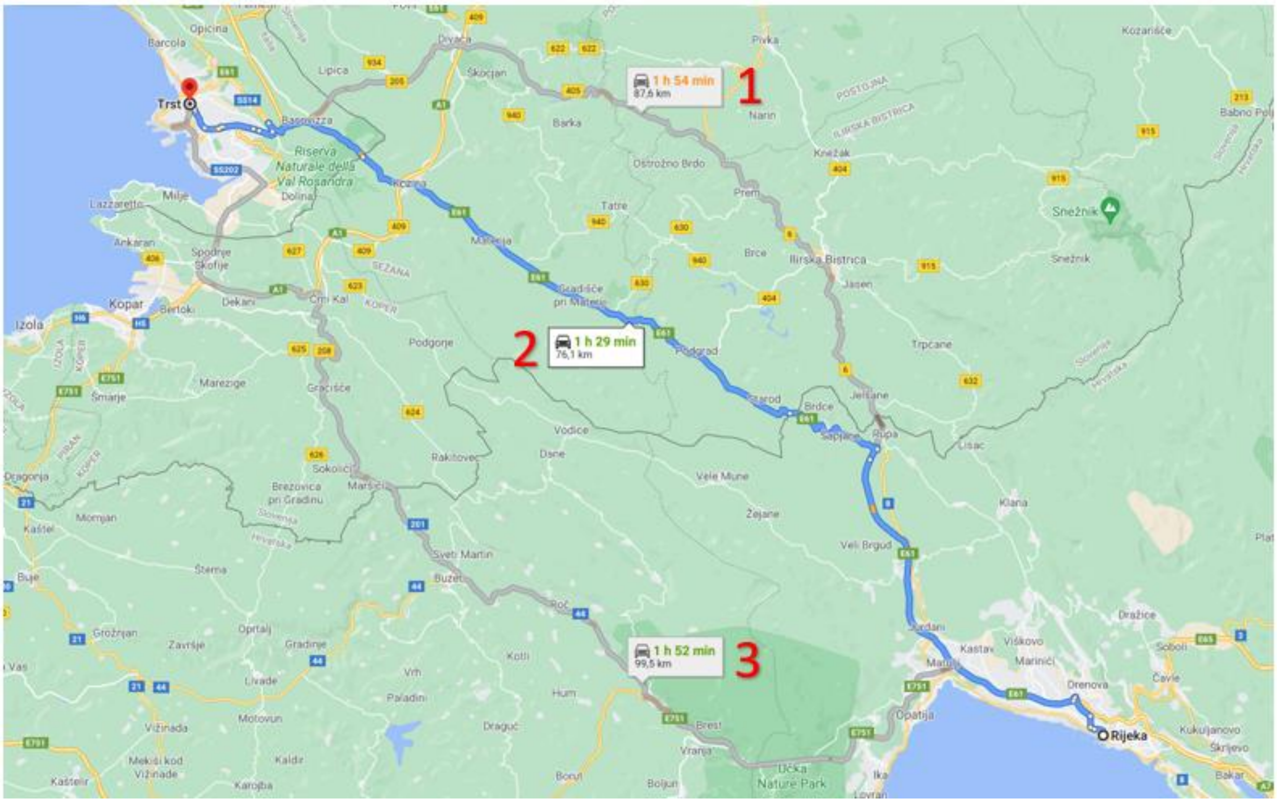


Figure 10 Display of routes between Rijeka and Trieste

Table 4 Information on possible routes between Rijeka and Trieste

Name	Distance	Travel time	Roads used	Border crossing
Route 1	87.6 kilometres	1 hour and 54 minutes	E61	Rupa
Route 2	76.1 kilometres	1 hour and 29 minutes	E61 and State Road 6	Pasjak
Route 3	99.5 kilometres	1 hour and 52 minutes	E751	Požane

As bus transport uses road infrastructure as part of road transport, the possibility of cross-border bus travels has also been analysed. Observing public bus transports, it was determined that from the Žabica bus terminal in Rijeka one can travel to Ljubljana, Maribor, Trieste, and Venice. Towards Ljubljana, Trieste and Venice transportation takes place daily, while to Maribor transport takes place five times a week (Wednesday to Sunday). According to the timetable, the most daily departures are to Venice. Graphical representation of public bus services is given in Figure 11.

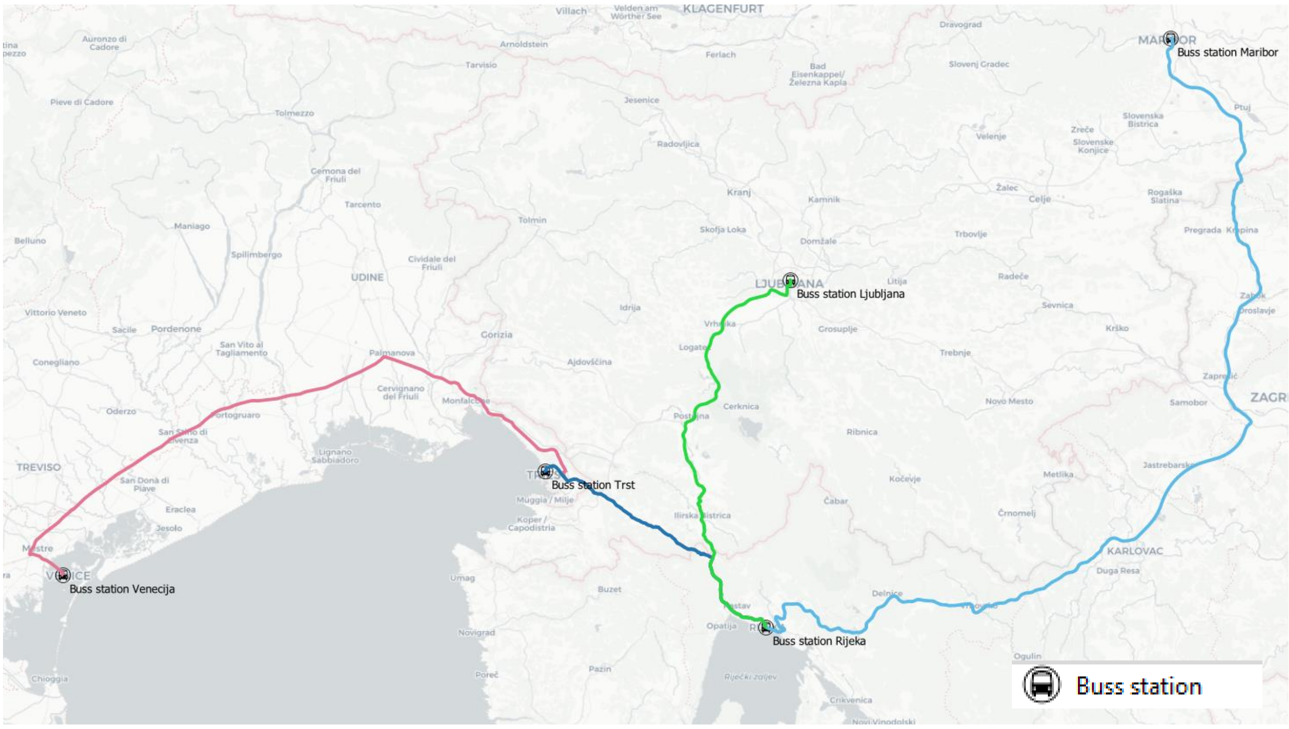

Buss station Maribor
Buss station Ljubljana
Buss station Trst
Buss station Venecija
Buss station Rijeka
Buss station

Figure 11 Public bus services from the Rijeka bus terminal.

4.2.2 Rail transport corridors

Given the less developed rail infrastructure for cross-border travel from Primorje-Gorski Kotar County, it is easier to identify rail travels. Namely, from the county in question there is one train line that runs to Slovenia on the route between Rijeka and Ljubljana. Figure 12 shows the railway network of Croatia, Slovenia, and Italy.

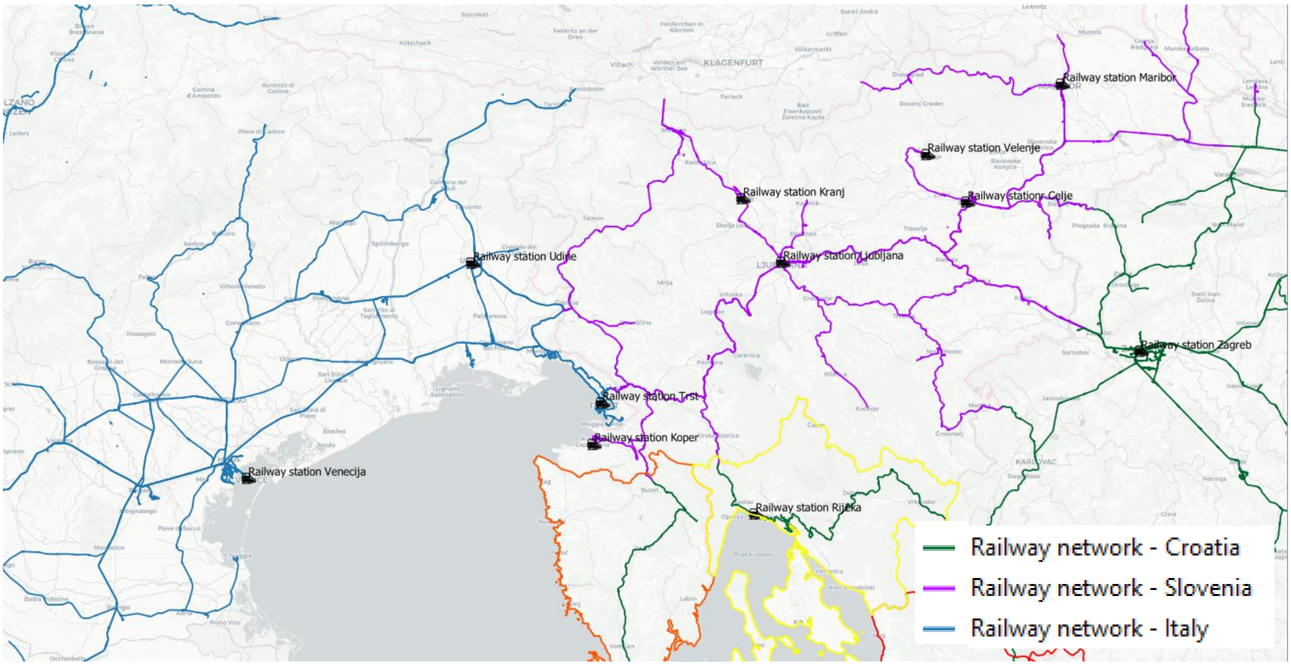

Railway station Maribor
Railway station Velenje
Railway station Kranj
Railway station Celje
Railway station Udine
Railway station Ljubljana
Railway station Zagreb
Railway station Trst
Railway station Koper
Railway station Venecija
Railway station Rijeka
Railway network - Croatia
Railway network - Slovenia
Railway network - Italy

Figure 12 Railway network of Croatia, Slovenia, and Italy

For public rail travel from Rijeka, the first important railway station is Pivka, where the network separates to Italy and Ljubljana. Another of the most important railway station is Zidani Most where the network separates towards Zagreb and Maribor. A list of all railway stations is given in Table 5.

Table 5 Details of railway stations

Railway station name	Rail separation	Location
Celje	towards Velenje and Maribor	Slovenia
Cervignano del Friuli	towards Venice and Udine	Italy
Divača	towards Koper and Trieste	Slovenia
Grobelno	towards Maribor and Croatia	Slovenia
Ljubljana	towards Kranj and Celje	Slovenia
Pivka	towards Italy and Ljubljana	Slovenia
Pragersko	towards Maribor and Croatia	Slovenia

Villa Opicina / Opčine	towards Trieste and Udine	Italy
Zidani Most	towards Celje and Croatia	Slovenia

4.2.3 Air transport corridors

Air transport in the area of Primorje-Gorski Kotar County takes place from Rijeka Airport located on the island of Krk, 25 kilometres northwest of Rijeka. From Rijeka Airport it is possible to travel to domestic and foreign destinations. Among national destination, transport to Split, Dubrovnik, and Osijek is offered, while some of the international destinations are Frankfurt, Berlin, Köln, Warsaw and Eindhoven. A view of all destinations is given in Figure 13.

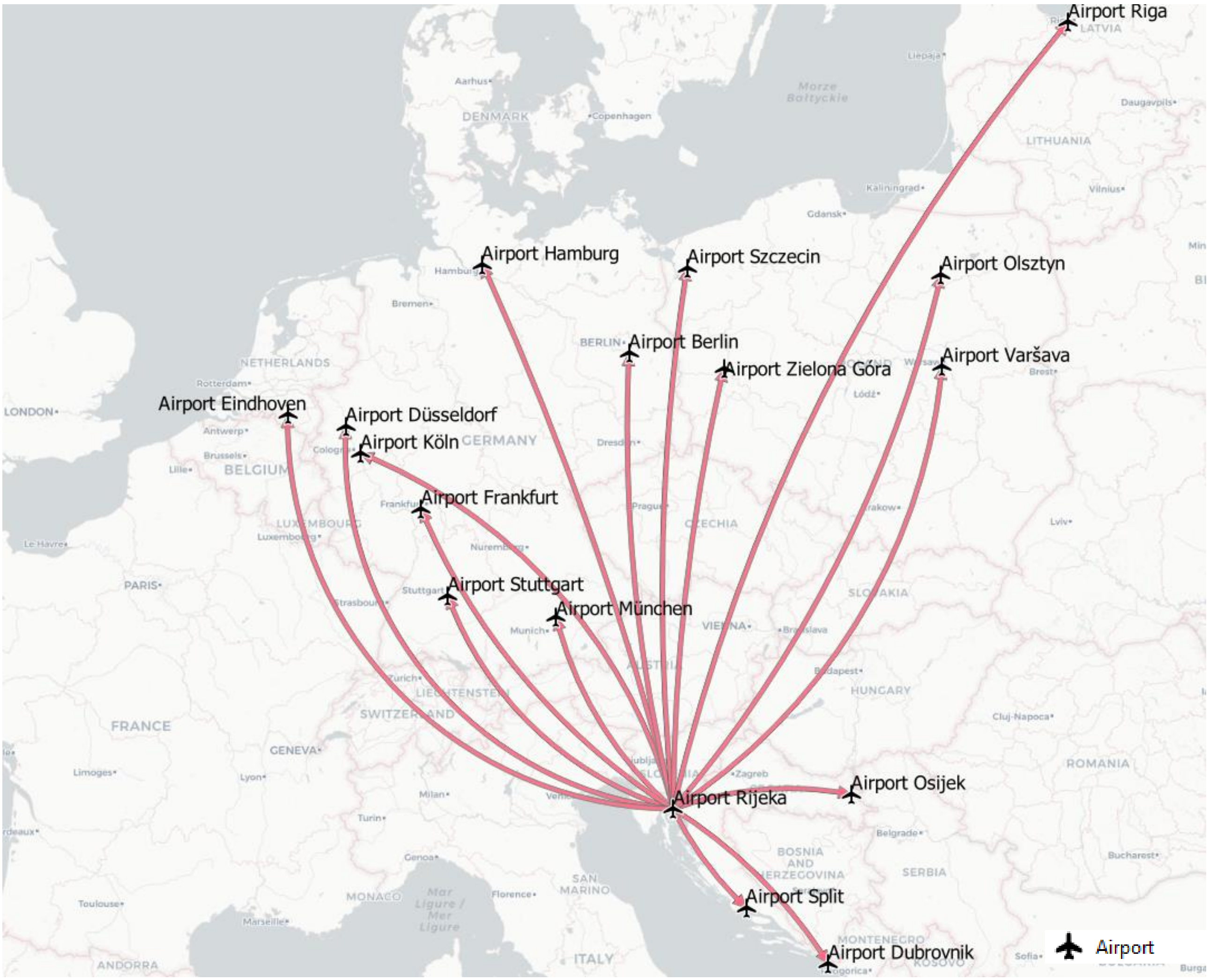

Airport Riga
Airport Hamburg
Airport Szczecin
Airport Olsztyn
Airport Berlin
Airport Zielona Góra
Airport Varšava
Airport Eindhoven
Airport Düsseldorf
Airport Köln
Airport Frankfurt
Airport Stuttgart
Airport München
Airport Rijeka
Airport Osijek
Airport Split
Airport Dubrovnik
Airport

Figure 13 Destinations from Rijeka Airport

4.2.4 Maritime transport corridors

Although the coverage area is the Primorje-Gorski Kotar County, for the purpose of a complete description of maritime transport, it is necessary to consider the neighbouring counties, as well as the Zadar ferry port, as it is the closest maritime traffic line to Italy that allows the transportation of motor vehicles. The reason is that from the Rijeka ferry port Rijeka it is not possible to travel to ferry ports in Italy. The only ferry port in the Primorje-Gorski Kotar County that is connected to Italy by sea is Mali Lošinj. Neighbouring counties, most notably Istria County, which have maritime connections with cities in Italy and the Primorje-Gorski Kotar County, become apparent here. Accordingly, Figure 14 shows ferry ports and maritime lines in the wider coverage area.

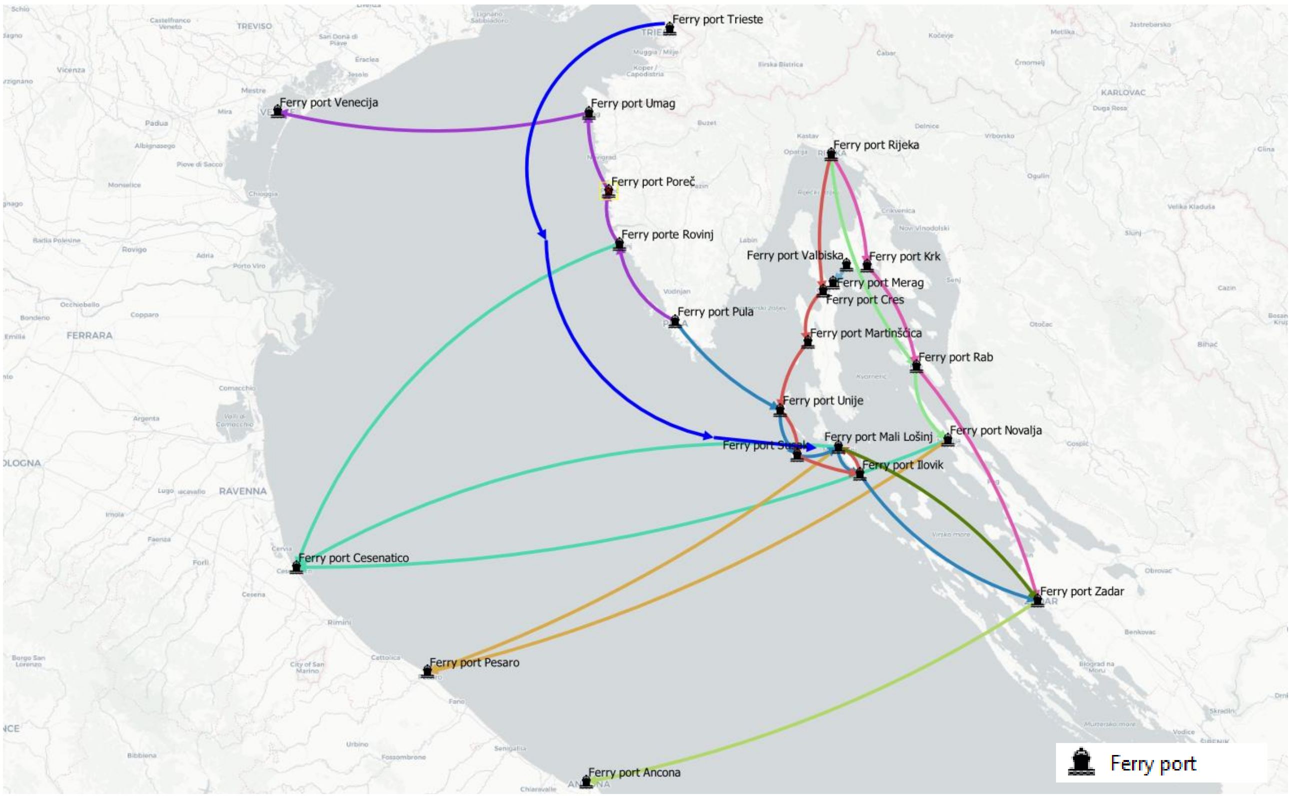

Ferry port Trieste
Ferry port Venecija
Ferry port Umag
Ferry port Poreč
Ferry porte Rovinj
Ferry port Pula
Ferry port Rijeka
Ferry port Valbiska
Ferry port Krk
Ferry port Merag
Ferry port Cres
Ferry port Martinšćica
Ferry port Rab
Ferry port Unije
Ferry port Susak
Ferry port Mali Lošinj
Ferry port Novalja
Ferry port Ilovik
Ferry port Cesenatico
Ferry port Zadar
Ferry port Pesaro
Ferry port Ancona
Ferry port

Figure 14 Maritime connections in a wider coverage area

As already stated, Rijeka is not connected by sea with cities in the region but serves as a link for the realization of the travel of users from the Primorje-Gorski Kotar County. Three catamaran lines run from Rijeka: Rijeka – Cres – Martinšćica – Unije – Susak – Ilovik – Mali Lošinj, Rijeka – Rab – Novalja, and Rijeka – Krk – Rab – Silba - Zadar. The most important ferry port for travel to regional destinations on the front line is Mali Lošinj, on the second Novalja, while on the last-mentioned line it is Zadar. The Mali Lošinj ferry port is directly connected to Cesenatico and Pesaro in Italy and is one of the stops on the line Pula – Unije – Susak – Mali Lošinj – Ilovik – Silba – Zadar. The line in question is important because it provides the connection of Primorje-Gorski Kotar County with the Istria County and Zadar. The line Pula – Rovinj – Poreč – Umag – Venice starts from the Pula ferry port, while Rovinj is directly connected to Cesenatico. All of the above lines provide only passenger transport, and for motor vehicle travel to Italy it is necessary to reach Zadar where the nearest maritime line is located that allows such travel (ferry line Zadar – Ancona). The only maritime line from the Primorje-Gorski Kotar County towards Zadar that has the possibility to transport motor vehicles is the ferry line Mali Lošinj – Premuda – Silba – Olib – Ist – Zadar. For the realization of this journey from Rijeka, the Valbiska – Merag ferry line connecting the islands of Krk and Cres is important, while the islands of Cres and Lošinj are connected by a bridge.

4.3 Cross-border mobility and travel habits

The survey regarding travel habits of cross-border mobility of Primorje-Gorski Kotar County is based on the results of mobility surveys in the county. The surveys were conducted in 2017 and 2018, as part of the development of the *Master plan for developing the traffic system of the functional region of Northern Adriatic.*

For the purposes of this project, a household survey, and surveys on travel habits in key road crossing points and public transport terminals were carried out. The results of the surveys carried out are presented below in the chapter.

The household survey was conducted by the Institute of Social Sciences Ivo Pilar in 2018. The survey was conducted on a probabilistic multi-stage stratified probability sample covering a total of **1500 respondents** in the entire North Adriatic region. According to the share of the population in the Primorje-Gorski Kotar County, a total of **810 respondents** participated in the survey, i.e. 810 households.

The survey included 52% of male respondents, and approximately 48% of female respondents. About 54% of respondents are between 30 and 64 years of age, approximately 38% are between 7 and 29 years old, and about 9% have more than 65 years old. 45% of respondents are employed, about 22% are students, and about 12 % are retired. If the level of education of respondents is analysed, about 59% have graduated from secondary school, about 29% have higher education, and approximately 11% have completed the elementary education.

The key results are given in Chart 1 to Chart 4.

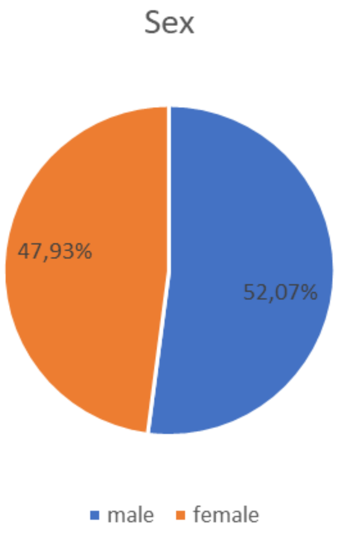


Chart 1 Share of respondents by sex

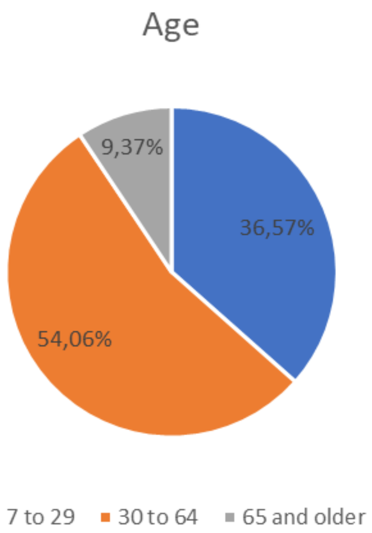


Chart 2 Share of respondents by age

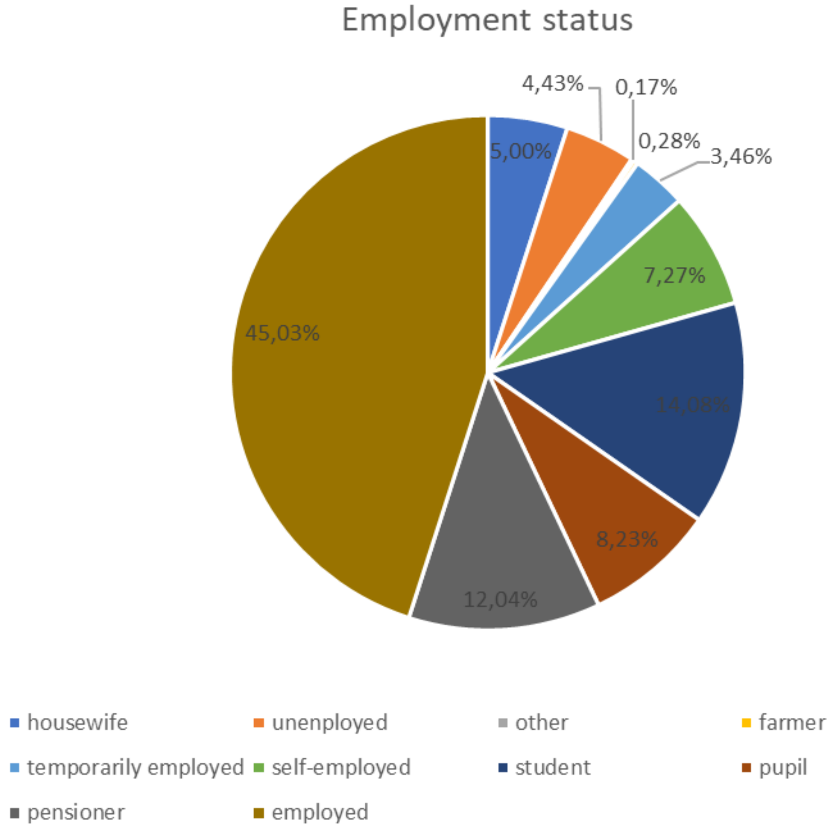


Chart 3 Share of respondents by employment status

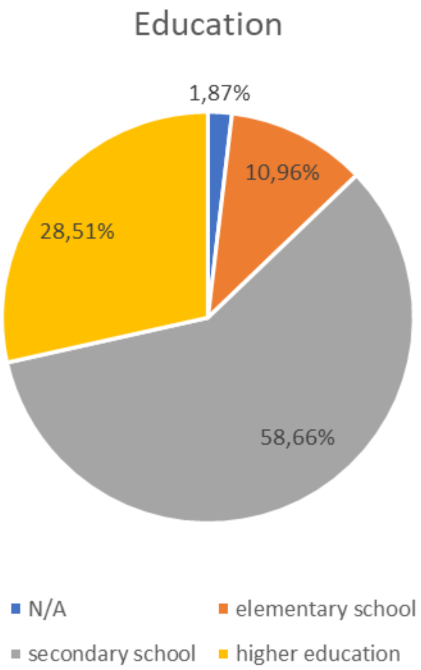


Chart 4 Share of respondents by level of education

By analysing travel purpose habits, it was established that a little more than 25% of travels refer to commuting to and from work, then approximately 15% concerns trips from home to shop and return, while travel with educational purpose and return home refers to approximately 10% of travel. The view of the travel share by type is given in Chart 5.

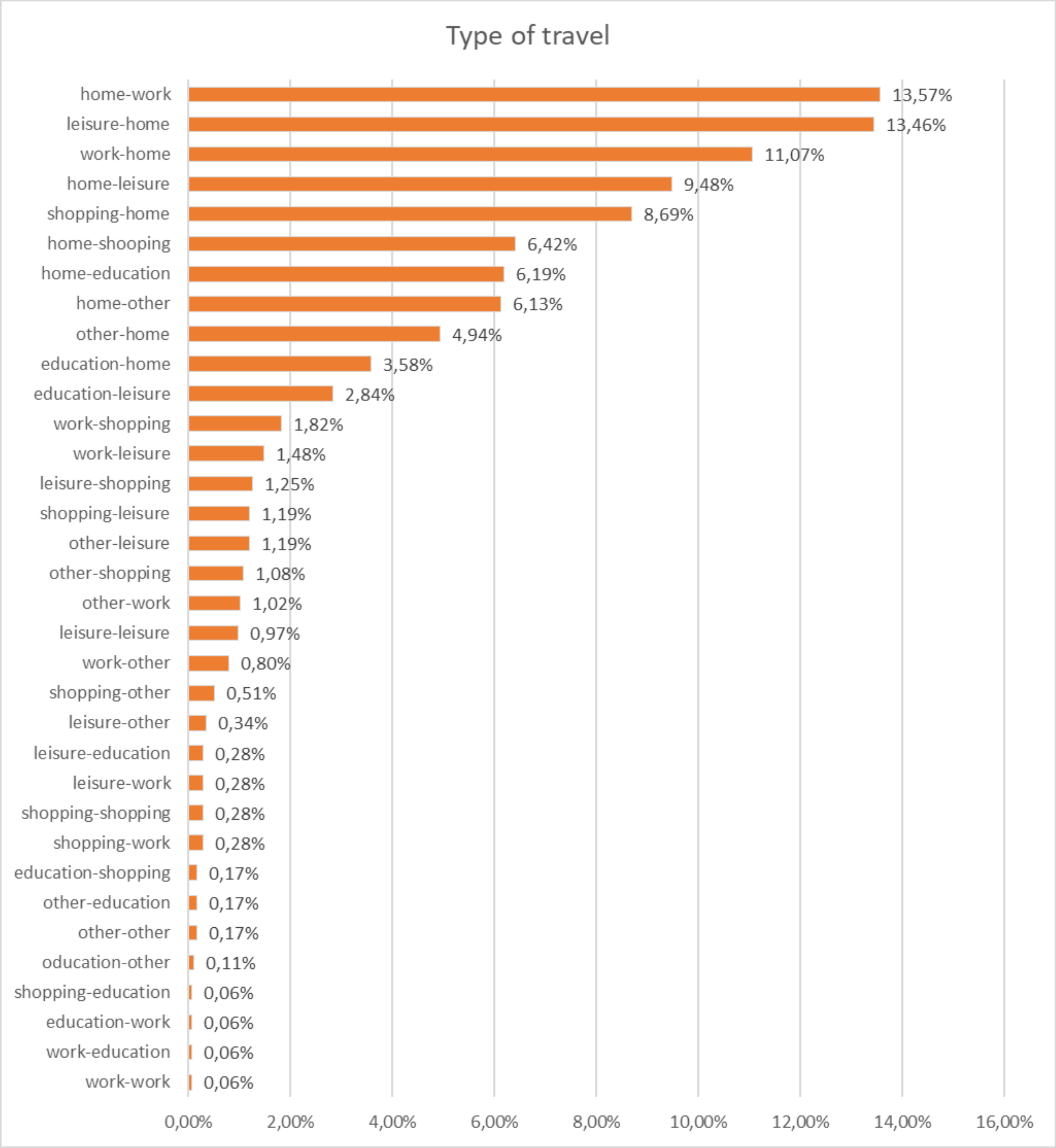


Chart 5 Share of travel according to the type

The analysis of the mode of travel has shown that almost 52% of travel are done by passenger cars as drivers, and if the use of a personal car is analysed regardless of the role of the passenger, then this share rises to almost 63%. Walking includes a little over 21% of travels, and public transport covers about 13% of travels. The main results on travel modes are given in Chart 6.

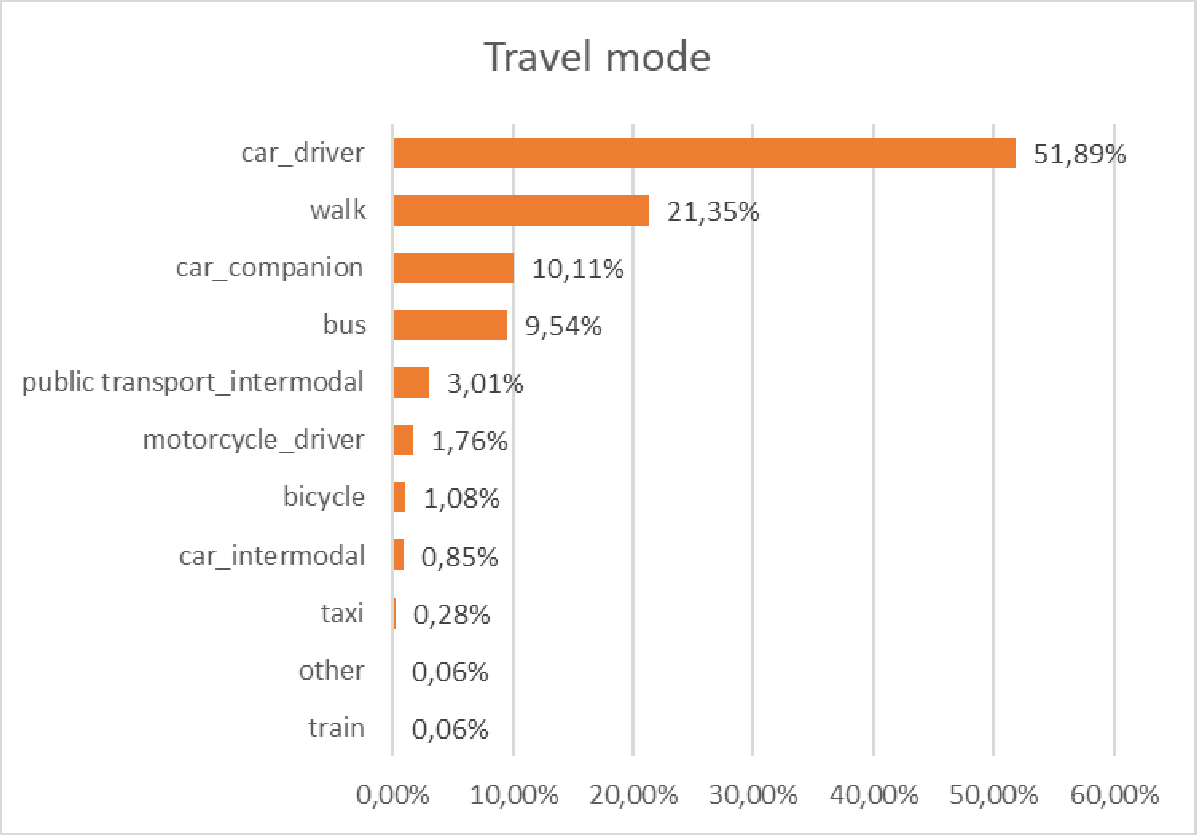


Chart 6 Share of travel according to the means of transport

The analysis of the spatial distribution of travels according to the location of the destination has shown that approximately 99.43% of travel refers to the Republic of Croatia, about 0.12% to travel to Italy and Slovenia, and about 0.45% of travel refers to other countries. If the results in question are weighted on the population, it can be assumed that about 330 passengers (residents of the Primorje-Gorski Kotar County) travel daily from the Primorje-Gorski Kotar County to Italy and Slovenia, 1,320 passengers to other countries, and about 288,930 passengers to the rest of the county and the Republic of Croatia. The spatial distribution view of travel is given in Chart 7.

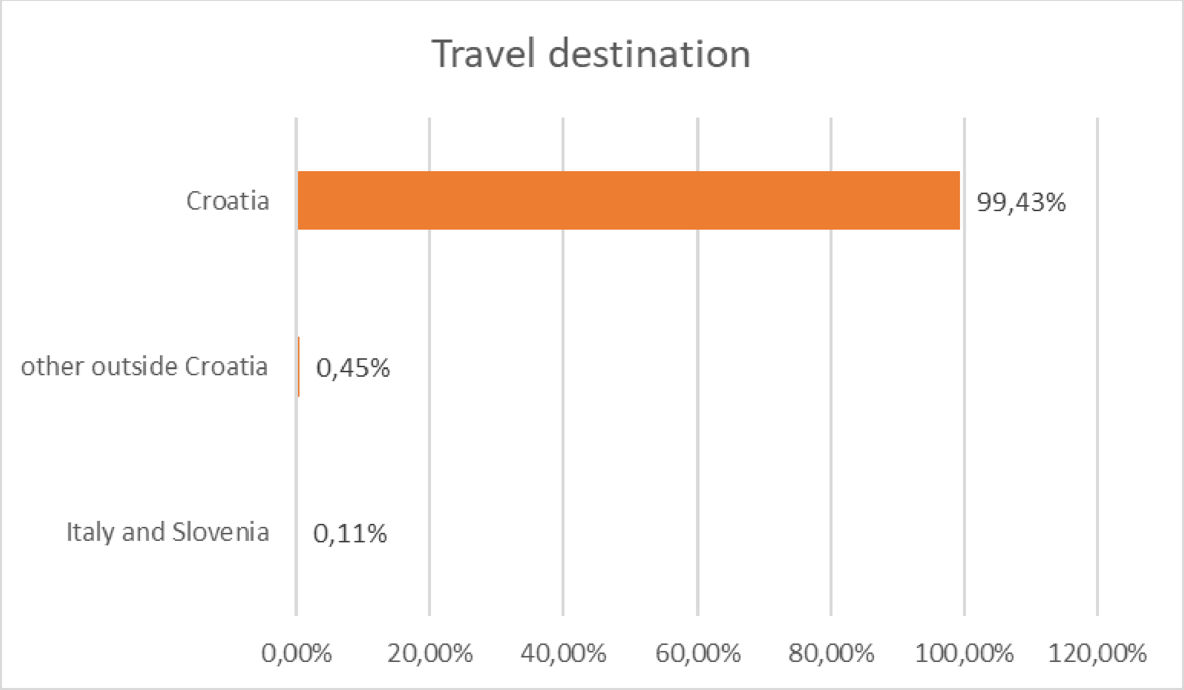


Chart 7 Share of travel according to the destination

In order to analyse the spatial distribution of travel to cross-border countries, surveys carried out at key road crossing points characteristic of such travel (e.g. border crossing points), as well as surveys conducted at major public transport terminals were also analysed. The surveys in question were conducted by the Faculty of Transport and Traffic Sciences of the University of Zagreb in 2018, and for the purpose of developing the *Master plan for developing the traffic system of the functional region of Northern Adriatic.*

The following locations are selected as characteristic road crossing points:

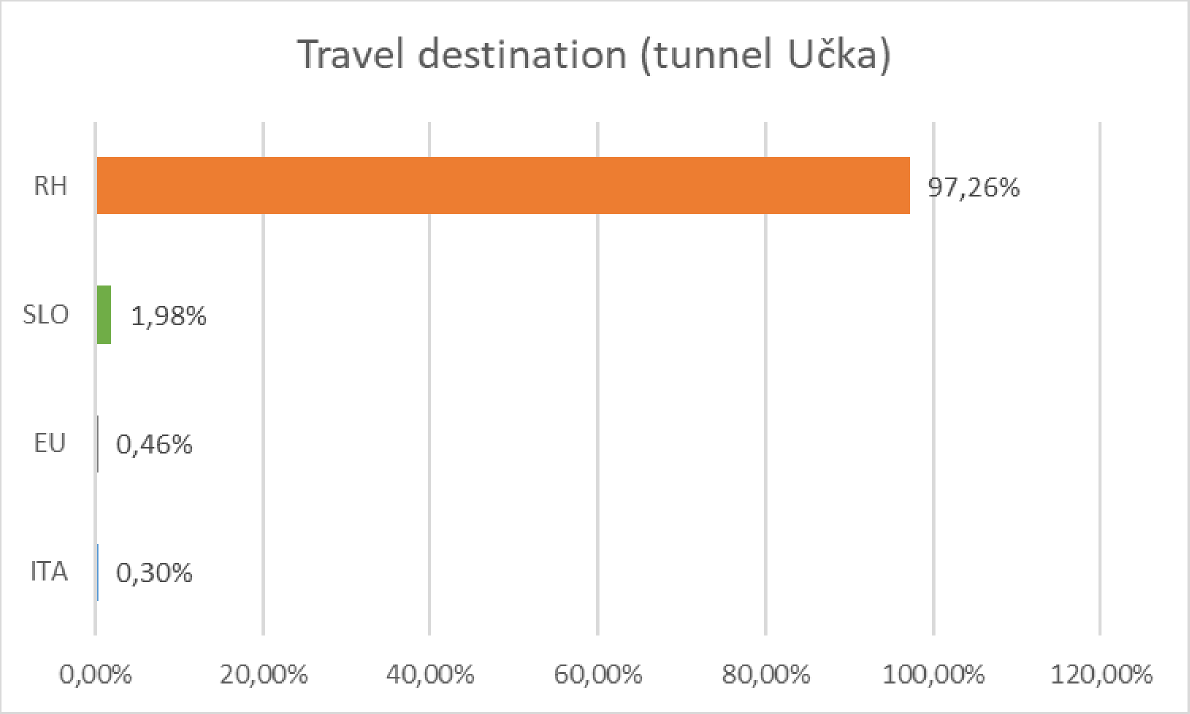
- Rupa border crossing (Rupa BC) - characteristic location for travel to Slovenia
- Pasjak border crossing (Pasjak BC) - characteristic location for travel to Slovenia and partly to Italy
- Učka tunnel - a characteristic location for travel to Italy.

A total of 3,177 respondents were asked at these locations, considering that one respondent represents one vehicle, the following can be concluded:

- Rupa border crossing (Rupa BC) -1,104 respondents (approx. 27 % AADT)
- Pasjak border crossing (Pasjak BC) - 514 respondents (approx. 22 % AADT)
- Učka tunnel - 1,559 respondents (approx. 18 % AADT).

With the aim of avoiding double values, it is important to note that for the purposes of this analysis, only respondents surveyed at the exit from Croatia, and those who were moving toward the west (Italy) when it came to the Učka tunnel were processed.

According to the results obtained at the Pasjak and Rupa border crossings, on average, during the working day, about 80% of respondents gravitate towards Slovenia or Italy, about 19% towards other countries, and about 1% towards Croatia. The 1% of passengers who gravitate towards Croatia are mostly border population whose travel to Istria is shorter through Slovenia than if they were going through the Učka tunnel. Considering that the survey also covered foreign nationals (tourist season), it can be concluded that the results obtained are in line with the household survey. As regards the Učka tunnel, it was noted that most of the travel is related to travel within Croatia, in the amount of about 97 %. About 2 % of travel in that location have the destination in Slovenia, and only 0.30 % in Italy. The view of the results obtained is given in Chart 8.



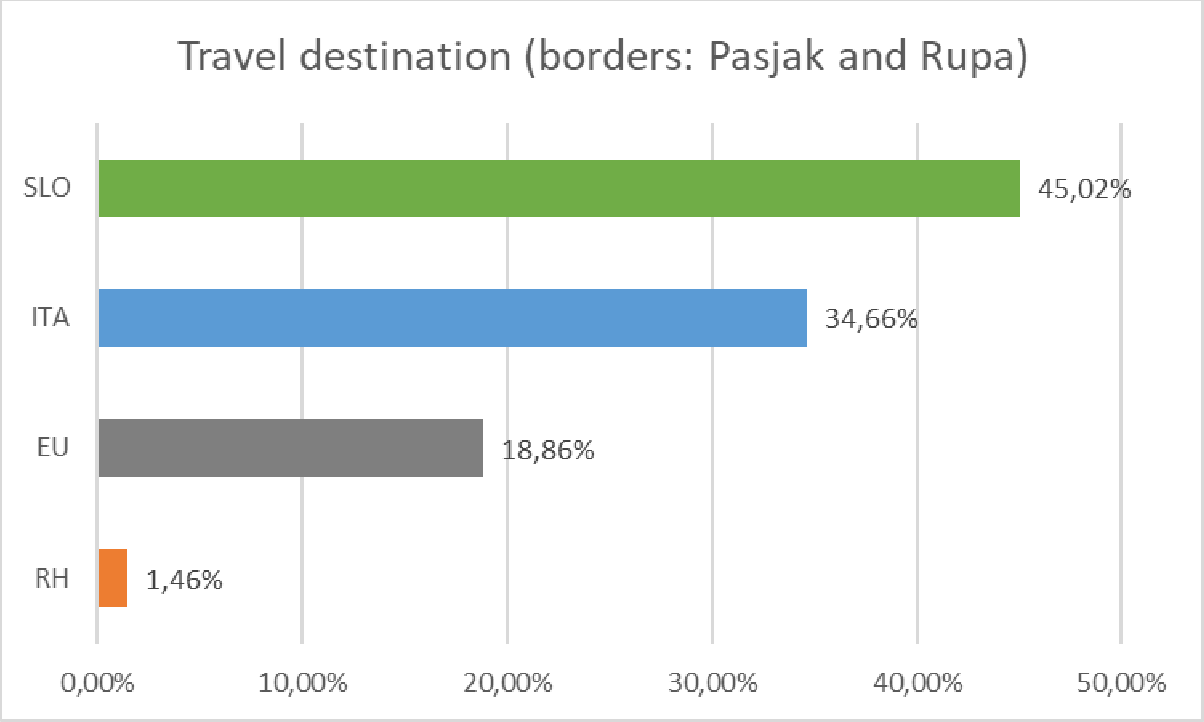


Chart 8 Share of travel according to the destination

According to the results obtained, it can be concluded that border crossings in the Primorje-Gorski Kotar County can be considered as key points in the road transport network where it is best possible to determine the distribution of road cross-border travel. It was also found that around 80% of traffic at these crossings gravitates towards Slovenia and Italy. As regards the period of the tourist season, according to the results of surveys from border crossings, it was found that the share of trips to Slovenia and Italy was then slightly lower than the average (about 71%), which is expected given the increased tourist activity and the number of travels to other countries. Outside the peak tourist season, this share is about 87%, i.e. slightly higher than the average.

Of the public transport surveys for international transport, only rail transport surveys are available, which found one of the 134 respondents who travelled by train from the Primorje-Gorski Kotar County to Slovenia.

4.4 Big dataset analysis report for 2020

This paragraph contains summary results of the analysis of mass data sets for selected days in 2020, and all analytical possibilities of the collected data, including the visualisation, will be available through the online WebGIS tool upon its delivery in the final phase of the project.

According to the defined methodology described in Chapter 2.2. Analysis of big dataset, analysis of big dataset consists of a series of steps that were realised during this research, and the results are presented in this chapter.

Identification of mobile network operators with significant market share and technical and operational capabilities to provide the necessary anonymous data for a defined geographical (spatial) and temporal scope has been carried out. The operator A1 was selected, with a significant market share of 34.7 %, according to HAKOM (Croatian Regulatory Authority for Network Industries) data for the year which is the subject matter of the analysis[4].

Subsequently the initial and wider coverage area was identified. The purpose of expanding the project coverage area is to properly identify transport and transit samples from / to neighbouring areas according to the defined narrower project coverage area. The initial areas (Figure 15) as areas of the local self-government units of the Primorje-Gorski Kotar County and the wider coverage area (Figure 16) were identified, followed by key points of interest (transport terminals, border crossings) shown in Figure 17, and key corridors shown in Figure 18.

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[4] https://www.hakom.hr/UserDocsImages/2021/e-trziste/GOD%20HRV%202020%20Udio%20operatora%20pokretnih%20mre%C5%BEa%20obzirom%20na%20broj%20korisnika.pdf?vel=494876

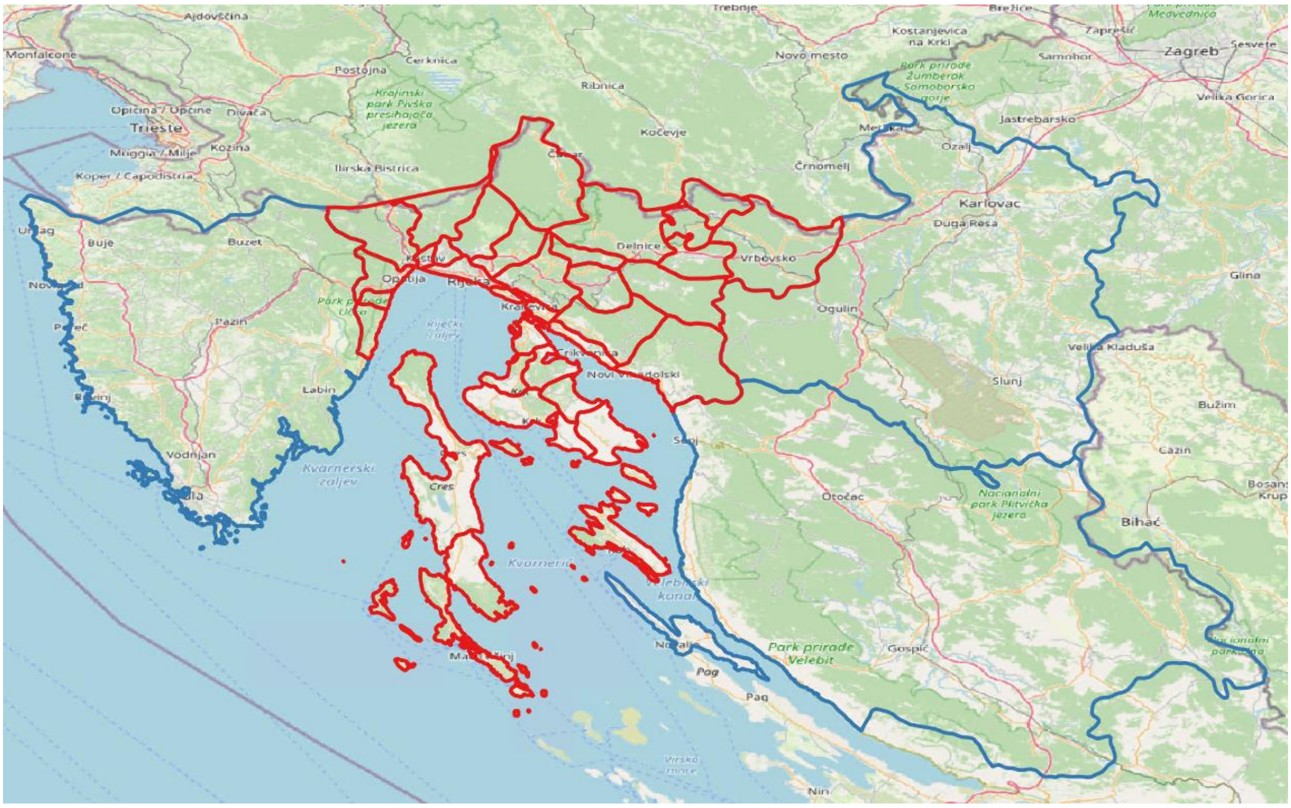

Ajdovščina
Trebnje
Brežice
Monfalcone
Postojna
Cerknica
Novo mesto
Kostanjevica na Krki
Samobor
Zaprešić
Zagreb
Sesvete
Ribnica
Trieste
Divača
Kočevje
Jastrebarsko
Velika Gorica
Koper / Capodistria
Ilirska Bistrica
Čabar
Črnomelj
Metlika
Ozalj
Karlovac
Duga Resa
Umag
Buje
Buzet
Delnice
Vrbovsko
Glina
Opatija
Rijeka
Kastav
Kraljevica
Ogulin
Pazin
Poreč
Crikvenica
Novi Vinodolski
Velika Kladuša
Slunj
Labin
Rovinj
Vodnjan
Pula
Kvarnerski zaljev
Cres
Senj
Otočac
Bužim
Cazin
Bihać
Kvarnerić
Novalja
Pag
Park prirode Velebit
Gospić
Mali Lošinj
Nin

Figure 15 Coverage area – local self-government units of the Primorje-Gorski Kotar County (marked in red) and the neighbouring counties (marked in blue)

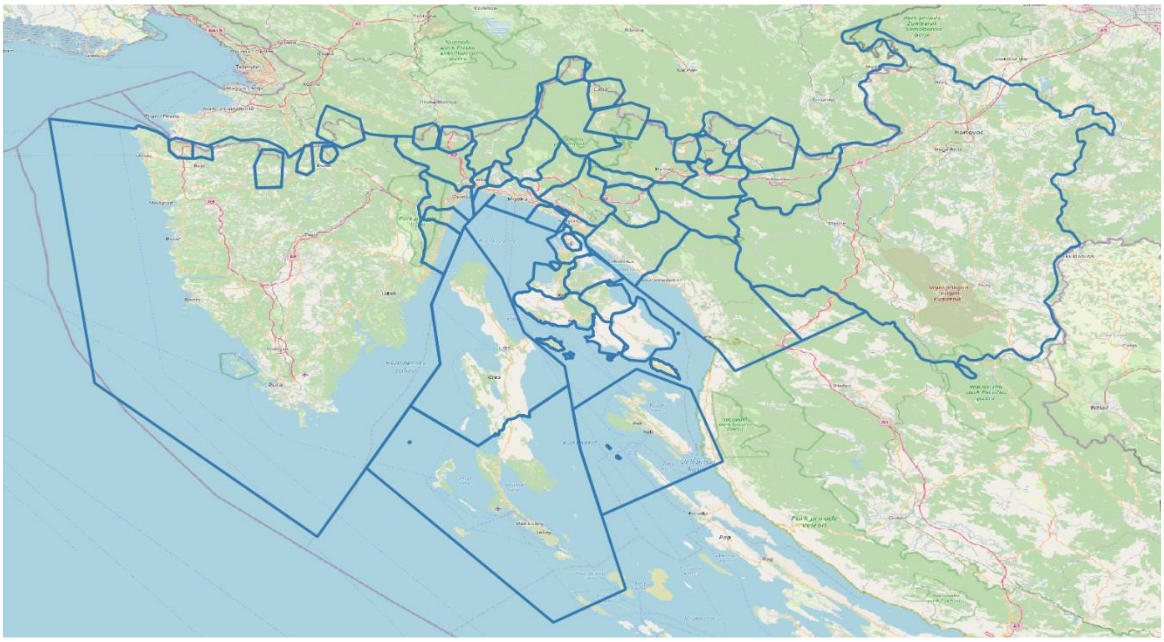


Figure 16 A wider coverage area

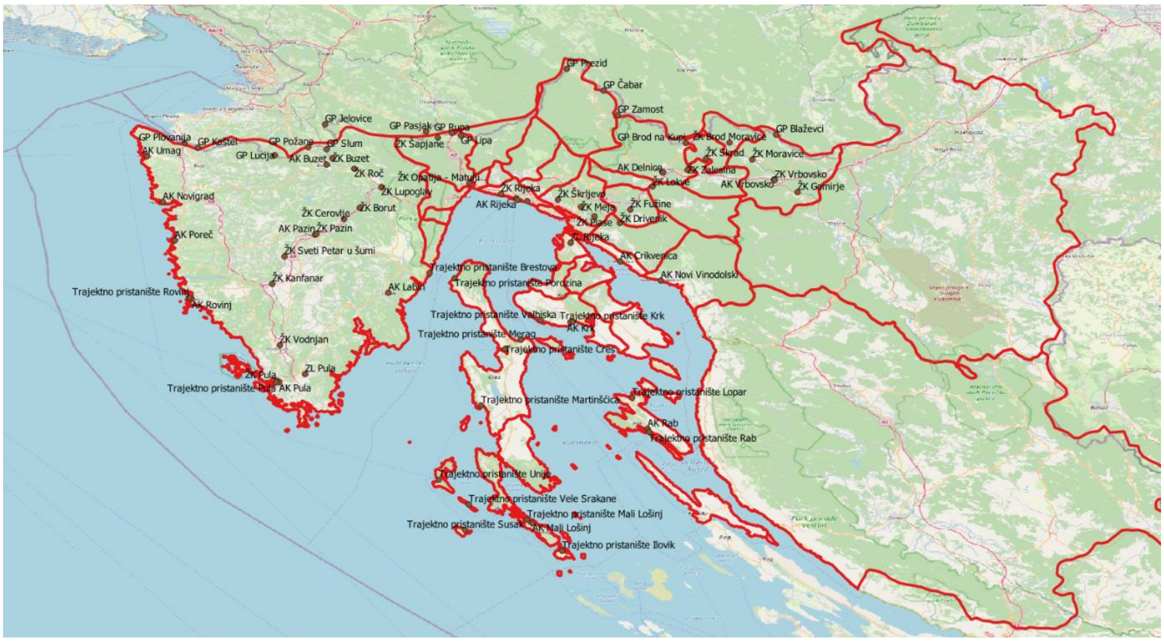
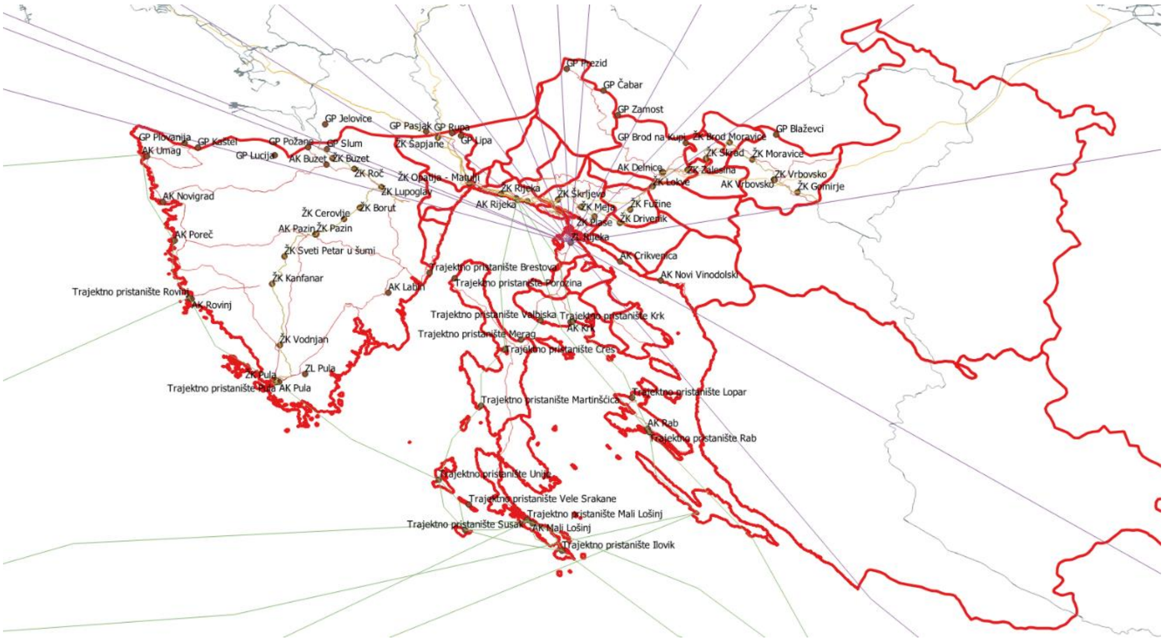

GP Prezid
GP Čabar
GP Zamost
GP Jelovice
GP Pasjak
GP Rupa
GP Lipa
ŽK Šapjane
GP Plovanija
GP Kaštel
GP Požane
GP Slum
AK Umag
GP Lucija
AK Buzet
ŽK Buzet
ŽK Roč
ŽK Opatija - Matulji
ŽK Lupoglav
ŽK Rijeka
AK Rijeka
ŽK Škrljevo
ŽK Meja
ŽK Plase
ŽK Fužine
ŽK Drivenik
ZL Rijeka
GP Brod na Kupi
ŽK Brod Moravice
GP Blaževci
ŽK Skrad
ŽK Moravice
AK Delnice
ŽK Zalesina
ŽK Lokve
AK Vrbovsko
ŽK Vrbovsko
ŽK Gomirje
AK Novigrad
ŽK Cerovlje
ŽK Borut
AK Pazin
ŽK Pazin
AK Poreč
ŽK Sveti Petar u šumi
ŽK Kanfanar
AK Labin
AK Crikvenica
AK Novi Vinodolski
Trajektno pristanište Brestova
Trajektno pristanište Porozina
Trajektno pristanište Rovinj
AK Rovinj
Trajektno pristanište Valbiska
Trajektno pristanište Krk
AK Krk
Trajektno pristanište Merag
Trajektno pristanište Cres
ŽK Vodnjan
ZL Pula
ŽK Pula
Trajektno pristanište Pula
AK Pula
Trajektno pristanište Martinšćica
Trajektno pristanište Lopar
AK Rab
Trajektno pristanište Rab
Trajektno pristanište Unije
Trajektno pristanište Vele Srakane
Trajektno pristanište Mali Lošinj
Trajektno pristanište Susak
AK Mali Lošinj
Trajektno pristanište Ilovik

Figure 17 Key points of interest


GP Prezid
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GP Zamost
GP Jelovice
GP Pasjak
GP Rupa
GP Lipa
GP Brod na Kupi
ŽK Brod Moravice
GP Blaževci
GP Plovanija
GP Kaštel
GP Požane
GP Slum
ŽK Šapjane
AK Umag
GP Lucija
AK Buzet
ŽK Buzet
ŽK Skrad
ŽK Moravice
ŽK Roč
ŽK Opatija - Matulji
AK Delnice
ŽK Delnice
ŽK Vrbovsko
ŽK Lupoglav
ŽK Rijeka
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ŽK Fužine
ŽK Cerovlje
ŽK Drivenik
AK Pazin
ŽK Pazin
ŽK Plase
AK Poreč
ŽK Rijeka
ŽK Sveti Petar u šumi
AK Crikvenica
Trajektno pristanište Brestova
ŽK Kanfanar
AK Novi Vinodolski
AK Labin
Trajektno pristanište Porozina
Trajektno pristanište Rovinj
AK Rovinj
Trajektno pristanište Valbiska
Trajektno pristanište Krk
AK Krk
Trajektno pristanište Merag
ŽK Vodnjan
Trajektno pristanište Cres
ZL Pula
ŽK Pula
Trajektno pristanište Pula
AK Pula
Trajektno pristanište Lopar
Trajektno pristanište Martinšćica
AK Rab
Trajektno pristanište Rab
Trajektno pristanište Unije
Trajektno pristanište Vele Srakane
Trajektno pristanište Mali Lošinj
Trajektno pristanište Susak
AK Mali Lošinj
Trajektno pristanište Ilovik

Figure 18 Key points of interest and key corridors

All key zones are accompanied by identification marks used in the travel matrix. The zones with associated identification codes, and including some key POIs, are shown in Figure 19.

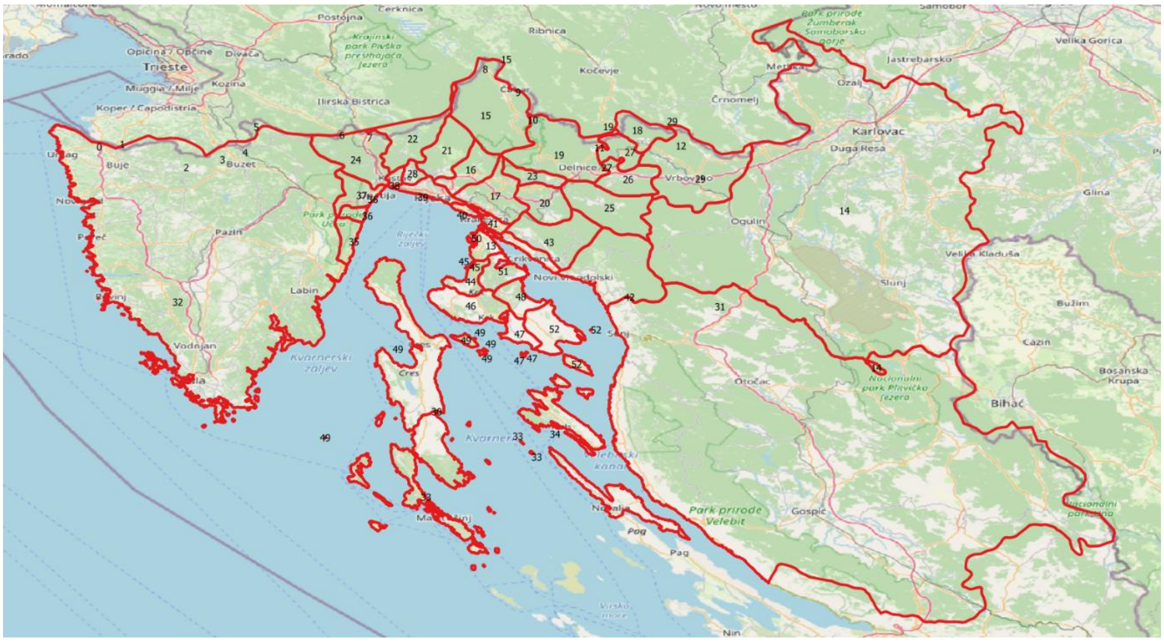
Postojna
Cerknica
Ribnica
Kočevje
Črnomelj
Park prirode Žumberak Samoborsko gorje
Samobor
Jastrebarsko
Velika Gorica
Metlika
Ozalj
Karlovac
Duga Resa
Trieste
Muggia / Milje
Koper / Capodistria
Ilirska Bistrica
Umag
Buje
Buzet
Novigrad
Poreč
Pazin
Labin
Rovinj
Vodnjan
Pula
Kvarnerski zaljev
Cres
Kvarner
Mali Lošinj
Delnice
Vrbovsko
Novi Vinodolski
Senj
Ogulin
Otočac
Slunj
Velika Kladuša
Nacionalni park Plitvička jezera
Bihać
Cazin
Bužim
Glina
Bosanska Krupa
Gospić
Park prirode Velebit
Novalja
Pag
Nacionalni park
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Figure 19 Zones with associated identification codes

Following the successful identification of the coverage area, data collection and anonymisation were carried out on the premises of the mobile operator. For the purposes of the analysis, records collected from **14 to 23 September 2020** were used. In addition to telecommunication records, information about the topology of the network used for spatial segmentation and adaptation to predefined transport and administrative zones was collected. The total amount of telecommunications records collected during this period was 2,900 GB (compressed). Sensitive data records were automatically encrypted, merged, and anonymised on the premises of the mobile operator. Such an anonymous GDPR-compliant data set was transferred to Ericsson Nikola Tesla for further processing and analysis of big data.

During the analysis period, the number of anonymous users (on a sample basis of 34.7%) was analysed. The number of users making at least one trip over a 7-day period in the wider coverage area was **236,720**. In total, more than **7,000,000 trips** were analysed in the area.

All further data provided in this report are weighted so that the 34.7% sample on which data were collected is scaled to 100% of the population.

Data pre-processing consisting of data preparation and filtering was performed, including the following steps:

- detection and removal of outliers - outliers were detected and removed after setting a set of spatial and time criteria that must be met in order to classify the point as outlier.
- setting spatial and time criteria - the median of the point is calculated based on the value of points in the time interval before and after the test point. The test point had to be distant more than the spatial threshold from the calculated median to be stated as an outlier
- fine-tuning of data - re-adjusting each point of the location in relation to the previous and following position within the predefined time frame. A step of reducing noise was also implemented by removing oscillations. The fundamental assumption is that whenever a device quickly oscillates between several nearby antennas, its actual position is likely between oscillating cells.
- Averaging - calculating the average of points in the time interval before and after the analysed point. When calculating the average, the weight factor is also included in the calculations. The result represents a new average point for the analysed location.

The result of all these steps was the improved position data for all anonymous user locations.

The following steps (parallel step) include mapping the improved user position in the identified zones. As a reminder, the area of project coverage is divided into zones as defined in the previous steps (local self-government units for the Primorje-Gorski Kotar County, POI, neighbouring counties). These zones are defined by administrative areas or census areas, and identified as core zones for urban mobility analysis. Therefore, the beginning and end of each trip must be mapped in these zones.

Travel identification as part of big data analysis is based on different spatial decomposition. This spatial decomposition is based on the area covered by antennas (cells) that are part of the telecommunication system (telecommunication zones). Usually in urban areas these coverage zones are significantly smaller than traffic zones. Unlike traffic zones, zones defined by antenna coverage usually overlap. Therefore, telecommunication zones must be mapped in transport zones. This requires data about the topology of the network given by the mobile phone operator. This database includes a list of base stations and corresponding antennas with their characteristics and configuration required to determine the coverage areas. The data includes information about the type of antenna, type of technology, antenna location, azimuth, beam width, distance, etc. Based on the data from the previous set, the coverage area of each antenna is calculated and is considered a telecommunication zone. Using spatial analysis tools and processes, telecommunications zones are mapped in the research zone, and these research zones are used to present travel and calculate statistics in the final output. It is worth noting that all trips are calculated on the basis of telecommunication zones. Mapping zones will not affect any travel characteristic (such as distance, speed, etc.).

In parallel, GPS data from the test device for checking the reliability of mobile network positioning was obtained. Up to 12 mobile terminals were used during the recording of telecommunications records in the coverage area. They were carried by volunteers and driven by public transport vehicles to collect as much data as possible. A third-party GPS logger was used with a frequency of recording of < 5 seconds. The analysis was conducted on 23,397 pairs of data. A pair of data consists of location data obtained from the GPS unit of the mobile phone and refined data on the position of the mobile network for the same terminal and for the same timestamp. Statistical analysis showed that the average position error for a more precise position of the user compared to GPS data is 393 m. The minimum average positioning error is 6 m, the maximum average positioning error is 5,179 m, the mean value is 341 m, and the standard deviation is 323 m. The analysis confirmed the fact that more precise user location data can be used for large mobility analyses, as this positioning uncertainty is acceptable for such analysis.

Refined user locations are used in further parts of the process to determine user locations. The location may be identified as the location of the stay if a predefined set of spatial and temporal criteria are met indicating that the user has spent predefined time in a predefined geographical area, which will lead to the conclusion that the user is stationed there.

In order to use anonymous mobile network operator data to analyse travel patterns, after identifying the place of stay, the next steps include identifying the trip. Travel is defined as the movement of users between two locations with a specific purpose, where the prerequisites of travel distance, duration, and speed are met. These prerequisites are called travel-related parameters / criteria and will be defined in the following steps. In this step, travel is defined as movement between two locations, and all such trips are analysed for further processing.

All identified trips are filtered to identify false migrations (trips that didn’t actually happen but could be identified as travel as a result of telecommunications network oscillations). Based on the local characteristics of the observed area (coverage area), the criteria related to travel are defined, which will set the next threshold to be used to identify travel:

- The time threshold defines the time values that will be used to determine the travel. The minimum and maximum duration of travel will be defined to discard potential travels that take too long or too short and are therefore unlikely to have occurred.
- The spatial threshold defines the spatial values that will be used to determine the travel. The minimum and maximum length of travel will be defined to discard potential travels for which the distance is too short or too long or cannot be determined and are therefore unlikely to occur.
- The speed threshold defines the speed values that will be used to determine the travel. The minimum and maximum speed of travel will be defined to discard potential travels for which the average value of speed is too low or too high and are therefore unlikely to occur.

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.

As two characteristic days, a characteristic working day in the off-season was chosen, Monday 21 September 2020 and Saturday 19 September 2020.

Table 6 shows the number of trips by different types of users (only domestic users, only foreign users, only Italian users) during the characteristic days that are the subject of the analysis. It is important to note that this is data that is scaled to 100% of the population, and that these figures only apply to travel between defined traffic zones. Travel within a particular zone, e.g. all trips of domestic users during a characteristic day within the City of Rijeka, are not shown.

Table 6 Number of travels by type of user

Date	Type of user	Number of trips made
19/09/2020	All Users	623,838
21/09/2020	All Users	580,260
19/09/2020	Foreign users	103,029
21/09/2020	Foreign users	69,894
19/09/2020	Italian users only	6,984
21/09/2020	Italian users only	4,675

The distribution of the number of trips per user is shown in Table 7. In the area of coverage, during all days of conducting the analysis, more than 85% of all travels are travelled by Croatian users, followed according to the share by Germany, Slovenia, Austria, and Poland. Users from Italy are in the fifth place of all foreign users and have made about 0.87% of all trips.

Table 7 Share in total amount of travel according to the type of user

Country	**Share in the total number of trips**
Croatia	85.65 %
Germany	6.78 %
Slovenia	1.87 %
Austria	1.29 %
Poland	1.10 %
Italy	0.87 %
Czech Republic	0.65 %
Bosnia and Herzegovina	0.22 %
Serbia	0.20 %
UK	0.16 %
France	0.15 %
Romania	0.13 %
The Netherlands	0.11 %
Switzerland	0.10 %
Sweden	0.09 %

The OD travel matrix for the specified days, for all users, for foreign users, and only for Italian users are shown in Figure 20 to Figure 25.

The trips arriving from the external zones are encountered in the first zones (border crossing) where they enter the analysed area.

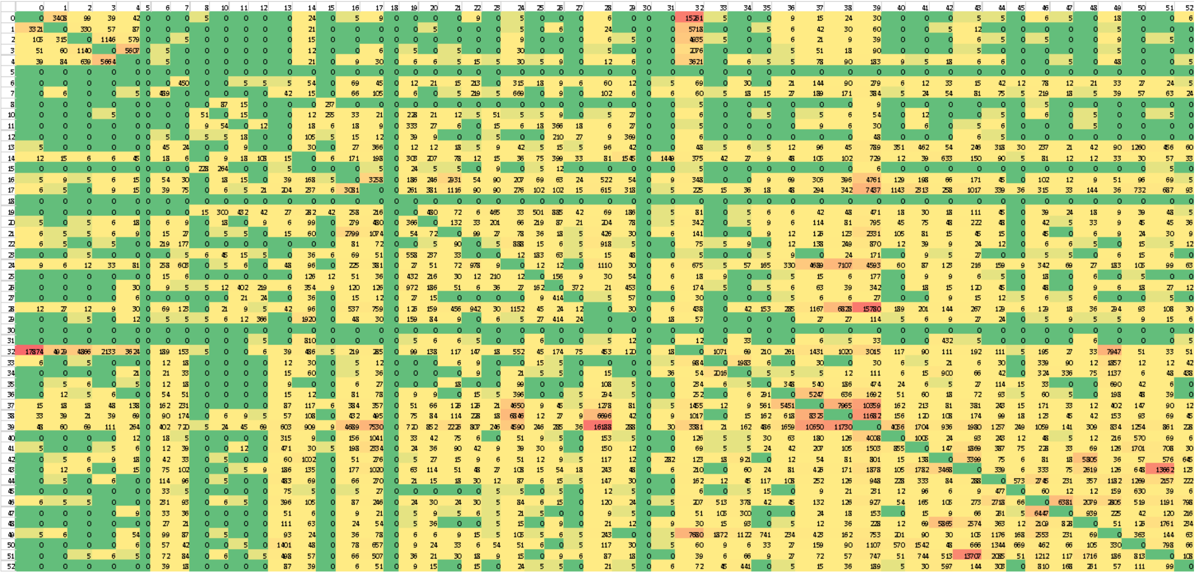


Figure 20 OD travel matrix for all users (19/09/2020)

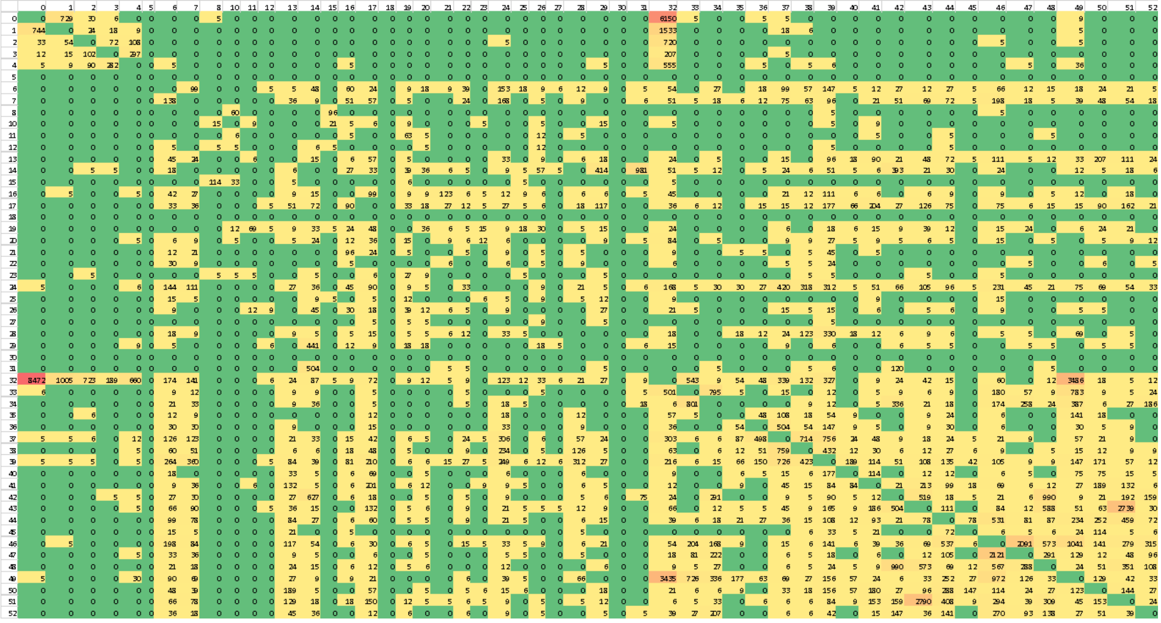
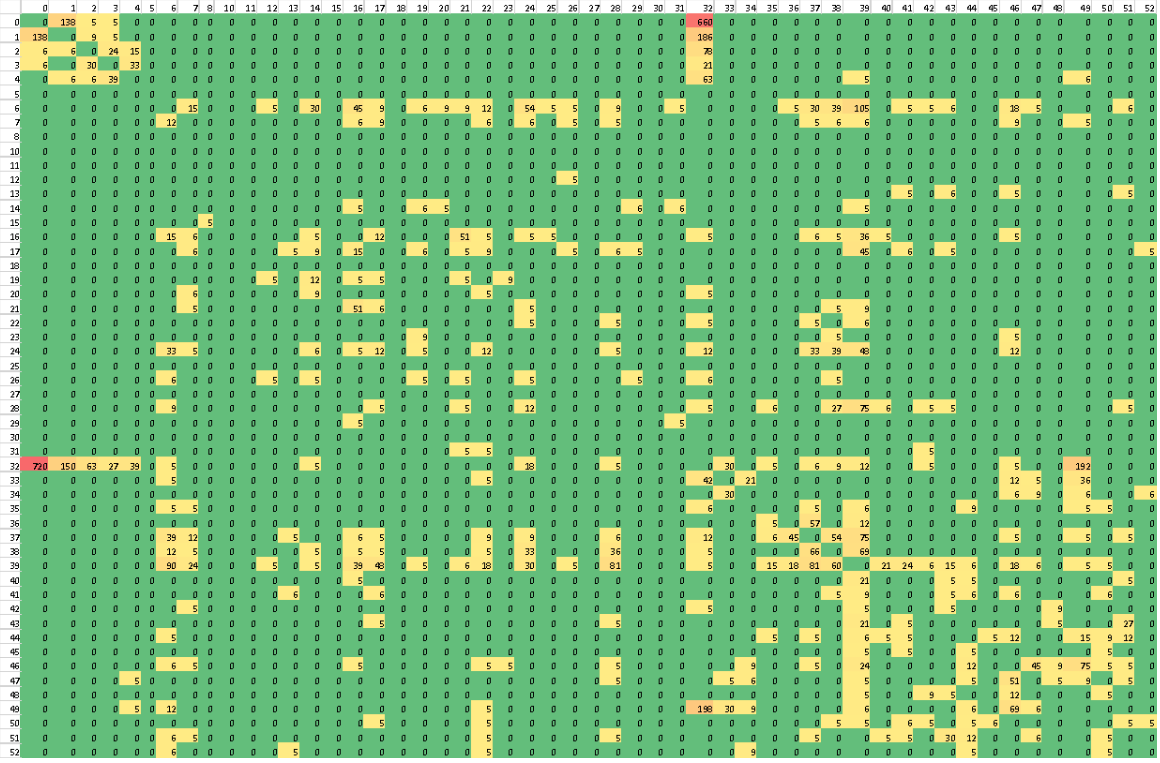


Figure 21 OD travel matrix for foreign users (19/09/2020)



	0	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0	0	138	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	660	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	138	0	9	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	6	6	0	24	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	6	0	30	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	6	6	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	6	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	15	0	0	0	5	0	30	0	45	9	0	6	9	9	12	0	54	5	5	0	9	0	0	5	0	0	0	0	5	30	39	105	0	5	5	6	0	0	18	5	0	0	0	6	0
7	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	6	9	0	0	0	0	6	0	6	0	5	0	5	0	0	0	0	0	0	0	0	5	6	6	0	0	0	0	0	0	9	0	0	5	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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17	0	0	0	0	0	0	0	6	0	0	0	0	5	9	0	15	0	0	6	0	5	9	0	0	0	5	0	6	5	0	0	0	0	0	0	0	0	0	45	0	6	0	5	0	0	0	0	0	0	0	0	5
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	5	0	12	0	5	5	0	0	0	5	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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21	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	51	6	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	9	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5	0	0	0	5	0	0	0	0	5	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	5	0	0	0	0	0	0
24	0	0	0	0	0	0	33	5	0	0	0	0	0	6	0	5	12	0	5	0	0	12	0	0	0	0	0	5	0	0	0	12	0	0	0	0	33	39	48	0	0	0	0	0	0	12	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
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37	0	0	0	0	0	0	39	12	0	0	0	0	5	0	0	6	5	0	0	0	0	9	0	9	0	0	0	6	0	0	0	12	0	0	6	45	0	54	75	0	0	0	0	0	0	5	0	0	5	0	5	0
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50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0	6	5	0	5	6	0	0	0	0	0	5	5
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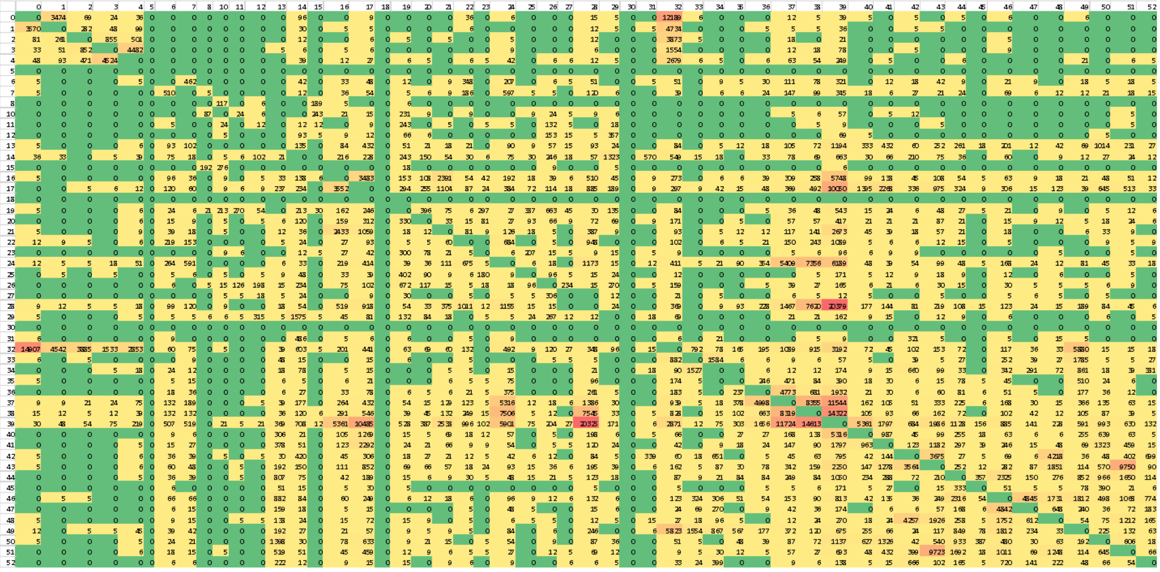
52	0	0	0	0	0	0	6	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	5	0	0

Figure 22 OD travel matrix for Italian users (19/09/2020)



	0	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
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2	81	261	0	855	501	0	0	0	0	0	0	0	0	12	0	0	6	0	5	0	5	0	0	5	0	0	0	12	0	0	0	3873	5	0	0	0	18	0	21	0	0	0	0	0	0	5	0	0	0	0	0	0
3	33	51	852	0	4482	0	0	0	0	0	0	0	5	6	0	5	6	0	0	0	0	0	0	9	0	0	0	6	0	0	0	1554	0	0	0	0	12	18	78	0	0	5	0	0	0	9	0	0	0	0	0	0
4	48	93	471	4524	0	0	0	0	0	0	0	0	0	39	0	12	27	0	6	5	0	6	5	42	0	6	6	12	5	0	0	2679	6	5	0	6	63	54	249	0	5	0	0	6	0	0	0	0	21	0	6	5
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7	5	0	0	0	0	0	510	0	5	0	0	0	0	12	0	36	54	0	5	6	9	186	0	597	5	5	0	120	6	0	0	39	0	6	6	24	147	99	345	18	6	27	21	24	0	69	6	12	12	21	18	15
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13	5	0	0	0	6	0	93	102	0	0	0	0	0	135	0	84	432	0	51	21	18	21	0	90	9	57	15	93	24	0	0	84	0	5	12	18	105	72	1194	333	432	60	252	261	18	201	12	42	69	1014	231	27
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50	5	0	0	0	5	0	24	21	0	0	0	0	1398	30	0	78	633	0	9	21	15	0	5	54	0	9	0	87	36	0	0	51	5	0	48	39	87	72	1137	627	1326	42	540	933	387	480	30	63	192	0	606	18
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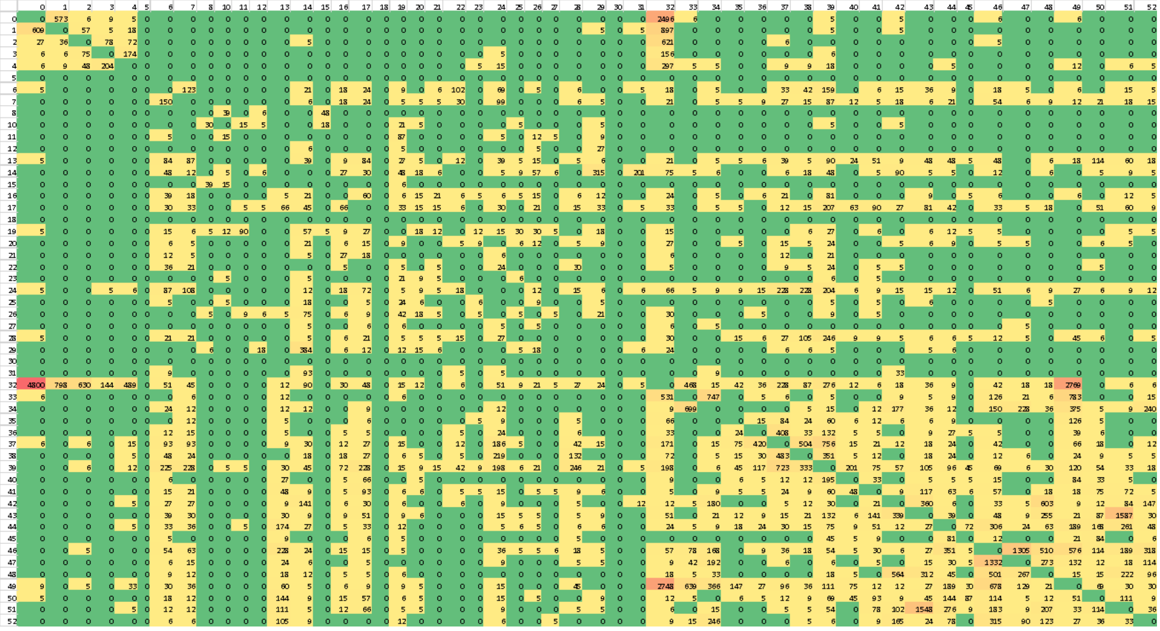
52	0	0	0	0	0	0	6	6	0	0	0	0	222	12	0	9	15	0	15	0	9	6	0	9	0	0	6	6	5	0	0	33	24	399	0	0	9	6	138	5	15	666	102	165	5	720	141	222	48	66	54	0

Figure 23 OD travel matrix for all users (21/09/2020)



	0	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0	0	573	6	9	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2496	6	0	0	0	0	0	5	0	0	5	0	0	0	6	0	0	6	0	0	0
1	609	0	57	5	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5	897	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	0	0	0	0	0
2	27	36	0	78	72	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	621	0	0	0	0	6	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
3	6	6	75	0	174	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	156	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
4	6	9	48	204	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	15	0	0	0	0	0	0	0	297	5	5	0	0	9	9	18	0	0	0	0	5	0	0	0	0	12	0	6	5
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	5	0	0	0	0	0	0	123	0	0	0	0	0	21	0	18	24	0	9	0	6	102	0	69	0	5	0	6	0	0	5	18	0	5	0	0	33	42	159	0	6	15	36	9	0	18	5	0	6	0	15	5
7	0	0	0	0	0	0	150	0	0	0	0	0	0	6	0	18	24	0	5	5	5	30	0	99	0	0	0	6	5	0	0	21	0	5	5	9	27	15	87	12	5	18	6	21	0	54	6	9	12	21	18	15
8	0	0	0	0	0	0	0	0	0	39	0	6	0	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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20	0	0	0	0	0	0	6	5	0	0	0	0	0	21	0	6	15	0	9	0	0	5	9	0	6	12	0	5	9	0	0	27	0	0	5	0	15	5	24	0	0	5	6	9	0	5	5	0	0	6	5	0
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40	0	0	0	0	0	0	6	0	0	0	0	0	27	0	0	5	66	0	0	5	0	0	0	0	0	0	0	0	0	0	0	9	0	0	6	5	12	12	195	0	33	0	5	5	5	15	0	0	84	33	5	0
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42	0	0	0	0	5	0	27	27	0	0	0	0	9	141	0	6	30	0	6	0	0	6	0	9	0	0	0	5	0	0	12	12	5	180	0	0	5	12	30	0	21	0	360	6	0	33	5	603	9	12	84	147
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45	0	0	0	0	0	0	5	0	0	0	0	0	9	0	0	0	6	0	5	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	45	5	9	0	0	81	0	12	0	0	21	84	0	6
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48	0	0	0	0	0	0	9	12	0	0	0	0	18	12	0	5	5	0	6	0	0	0	0	0	0	0	0	0	0	0	0	18	5	33	0	0	0	0	18	5	0	564	312	45	0	501	267	0	15	15	222	96
49	9	0	5	0	33	0	30	36	0	0	0	0	60	5	0	6	9	0	9	5	0	0	0	15	0	0	0	45	0	0	0	2748	639	366	147	27	96	36	111	75	12	12	27	189	30	678	129	21	0	69	30	30
50	5	0	0	0	0	0	18	12	0	0	0	0	144	9	0	15	57	0	6	5	0	0	0	15	0	5	0	0	9	0	0	12	5	0	6	5	12	9	69	45	93	9	45	144	87	114	5	12	51	0	111	9
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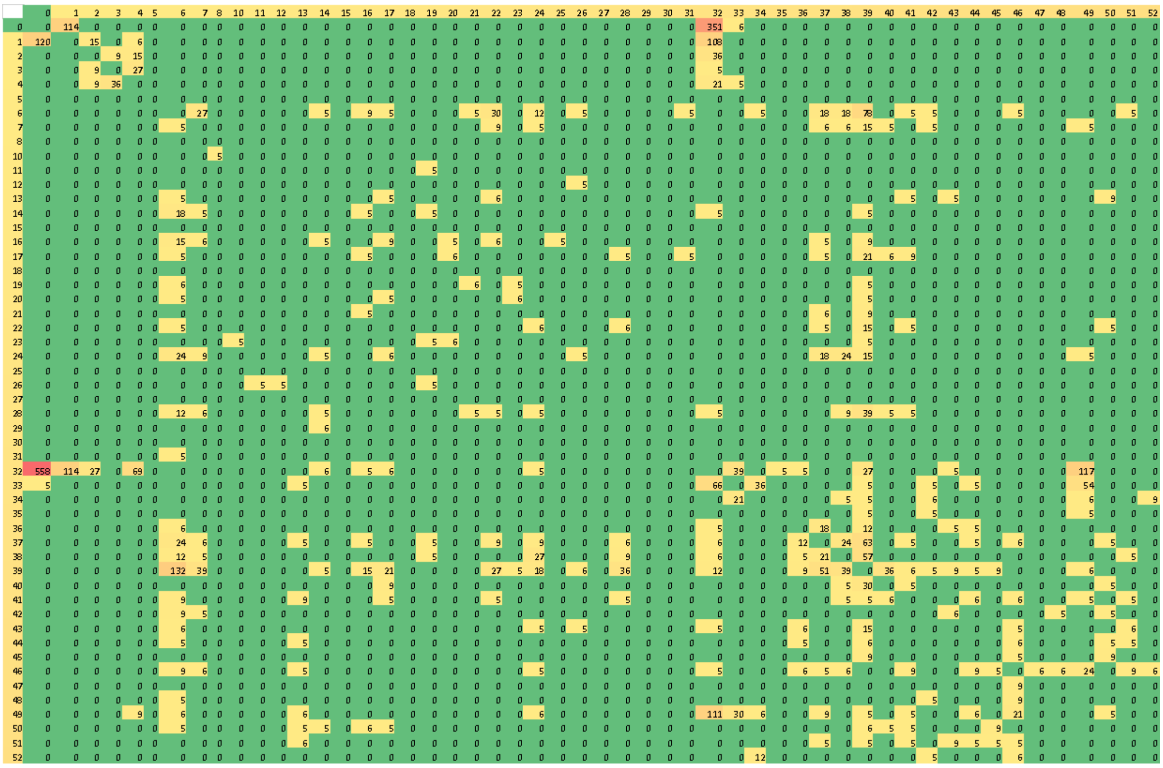
52	0	0	0	0	0	0	6	6	0	0	0	0	105	9	0	0	0	0	12	0	0	0	0	6	0	0	5	0	0	0	0	9	15	246	0	0	0	5	6	0	9	165	24	78	0	315	90	123	27	36	33	0

Figure 24 OD travel matrix for foreign users (21/09/2020)



	0	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0	0	114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	351	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	120	0	15	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	9	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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7	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	5	0	0	0	0	0	0	0	0	0	0	0	0	6	6	15	5	0	5	0	0	0	0	0	0	5	0	0	0
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18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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20	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
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22	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	6	0	0	0	0	0	0	0	0	5	0	15	0	5	0	0	0	0	0	0	0	0	5	0	0
23	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	24	9	0	0	0	0	0	5	0	0	6	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	18	24	15	0	0	0	0	0	0	0	0	0	5	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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29	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	558	114	27	0	69	0	0	0	0	0	0	0	0	6	0	5	6	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	39	0	5	5	0	0	27	0	0	0	5	0	0	0	0	0	117	0	0	0
33	5	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66	0	36	0	0	0	0	5	0	0	5	0	5	0	0	0	0	54	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0	5	5	0	0	6	0	0	0	0	0	0	6	0	0	9
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36	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	18	0	12	0	0	0	5	5	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	24	6	0	0	0	0	5	0	0	5	0	0	5	0	0	9	0	9	0	0	0	6	0	0	0	6	0	0	0	12	0	24	63	0	5	0	0	5	0	6	0	0	0	5	0	0
38	0	0	0	0	0	0	12	5	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	27	0	0	0	9	0	0	0	6	0	0	0	5	21	0	57	0	0	0	0	0	0	0	0	0	0	0	5	0
39	0	0	0	0	0	0	132	39	0	0	0	0	0	5	0	15	21	0	0	0	0	27	5	18	0	6	0	36	0	0	0	12	0	0	0	9	51	39	0	36	6	5	9	5	9	0	0	0	6	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	30	0	5	0	0	0	0	0	0	0	0	5	0	0
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42	0	0	0	0	0	0	9	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	5	0	5	0	0
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45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	5	0	0	0	9	0	0
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47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0
48	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	9	0	0	0	0	0	0
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51	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5	0	5	0	9	5	5	5	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	5	0	0	0	6	0	0	0	0	0	0

Figure 25 OD travel matrix for Italian users (21/09/2020)

In addition to the OD travel matrix, it has been prepared, as an illustration and visualization of the retention of users in space, a heat map for all users. Since the heat map shows the concentration of users in space, it cannot be created aggregated, but is made for illustration purposes in this report for a time period of 08:30. An example of a heat map is shown in Figure 26.

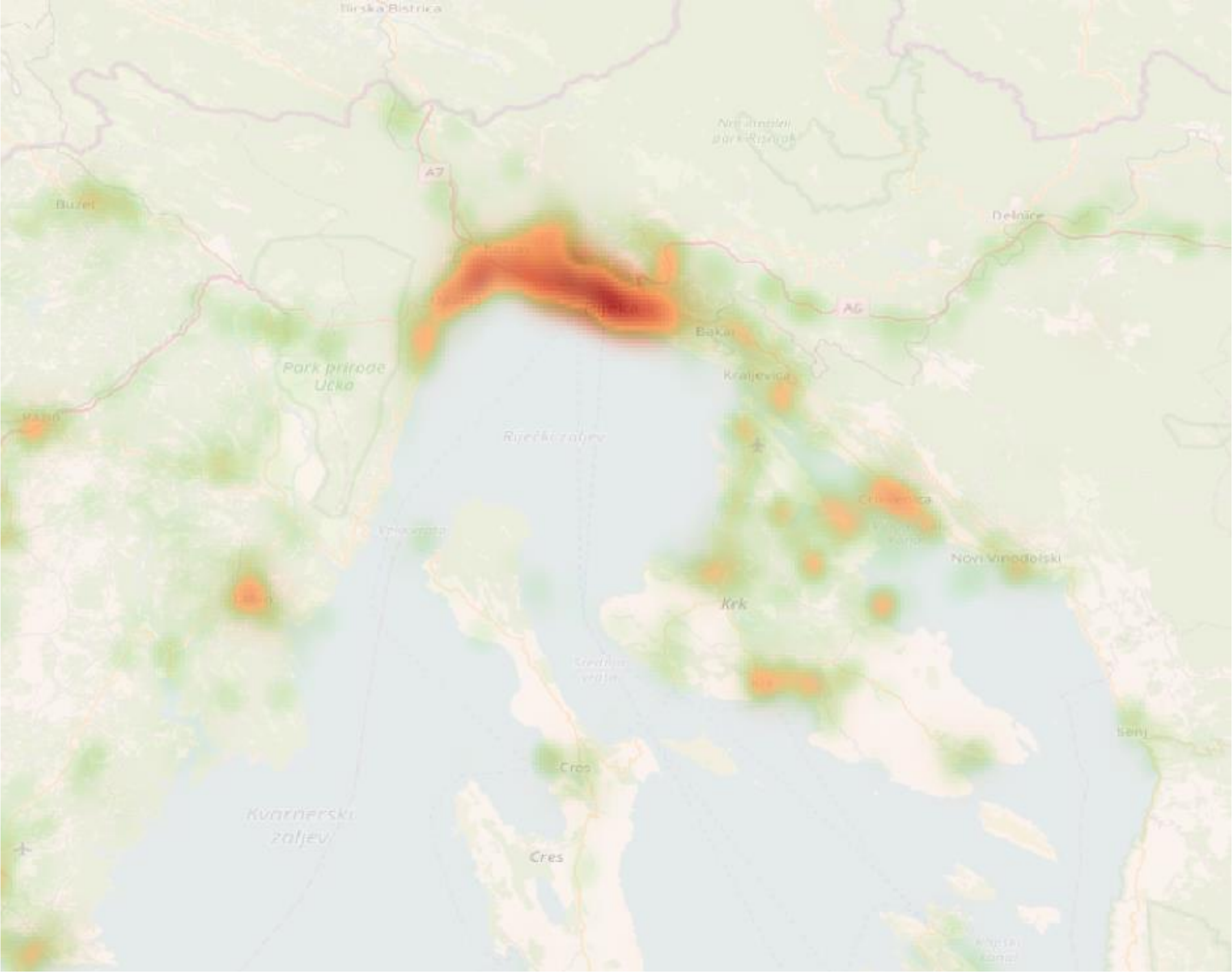

Ilirska Bistrica
A7
Buzet
Delnice
Rijeka
A6
Bakar
Park prirode Učka
Kraljevica
Riječki zaljev
Novi Vinodolski
Krk
Senj
Cres
Kvarnerski zaljev
Cres

Figure 26 Heatmap of population concentration in space - all users (19/09/2020, 08:30 am)

The attached image contains actual data and serves as an illustration of possibilities of analytics. The WebGIS tool with related data will enable the conduct of various analyses and combinations of views (in accordance with the defined functional requirements in Chapter 5) in accordance with the actual analytical needs.

4.5 Analysis of the first data set (June 2021)

The days 3 June (public holiday - Thursday), 4 June (working day - Friday), and 6 June (weekend day, Sunday) were chosen as characteristic days.
During the entire data collection period (3 to 6 June), just over 1.3 million unique users were registered in the area of coverage, as shown in Table 8. The number of users shown in the table refers to the total number of unique users who were recorded at least once in the coverage area during the recording period. Of these, 61% of the users are domestic users, and 39% are foreign users. Of all foreign users, 9% refers to the users from Italy.

Table 8 Number of identified users and shares for the entire data collection period

Type of user	Number of users	Share*
All Users	1,331,712	
Domestic users	818,883	61%
Foreign users	512,829	39%
Italian users only	47,658	9%

* The share of domestic users and foreign users is calculated in relation to all users, while the share of Italian users is calculated in relation to foreign users.
The number of identified users by characteristic days is shown in Table 9.

Table 9 Number of identified users by characteristic days

Type of user	Number of users	Share*	Number of users	Share*	Number of users	Share*
	3 June		4 June		6 June	
All Users	708,945		741,111		719,565	
Domestic users	514,671	73%	520,515	70%	502,620	70%
Foreign users	194,274	27%	220,596	30%	216,945	30%
Italian users only	13,113	7%	18,588	8%	17,049	8%

* The share of domestic users and foreign users is calculated in relation to all users, while the share of Italian users is calculated in relation to foreign users.
Table number 3 shows the number of trips by different types of users (only domestic users, only foreign users, only Italian users) during the characteristic days that are the subject of the analysis. It is important to note that this is data that is scaled to 100% of the population, and that these figures only apply to travel between defined traffic zones. Travel within a particular zone, e.g. all trips of domestic users during a characteristic day within the City of Rijeka, are not shown.

For all recording days, a total of just over 12 million trips were detected in the coverage area, as shown in Table 10 and Table 11, out of which 75% refers to travel by domestic users, 25% to travel by foreign users, and 8% to travel by Italian users compared to all foreign users.

Table 10 Number of trips per type of user for the entire recording period

Type of user	Number of users	Share*
All Users	12,608,532	
Domestic users	9,484,242	75%
Foreign users	3,124,290	25%
Italian users only	263,778	8%

Table 11 Number of identified trips by characteristic days

Type of user	Number of users	Share*	Number of users	Share*	Number of users	Share*
	3 June		4 June		6 June	
All Users	2,403,555		2,850,201		2,138,922	
Domestic users	1,790,145	74%	2,139,075	75%	1,567,071	73%
Foreign users	613,410	26%	711,126	25%	571,851	27%
Italian users only	40,812	7%	51,762	7%	50,619	9%

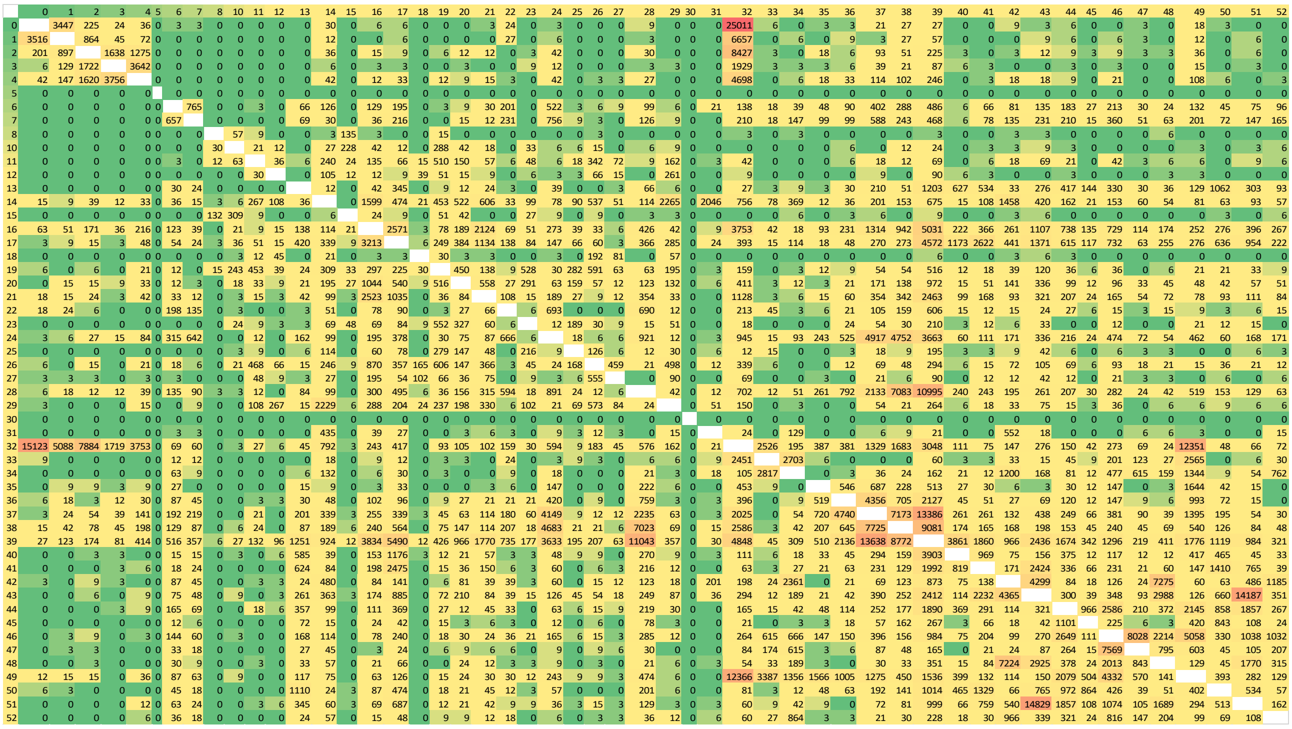
* The share of travel of domestic users and foreign users is calculated in relation to travel by all users, while the share of travel of Italian users is calculated in relation to travel by foreign users.
The distribution of the number of trips per user is shown in Table 12. In the coverage area, during all days of conducting the analysis, more than 75 % of all travel is travel by Croatian users, followed according to the share by Germany, Slovenia, Austria and Poland. Users from Italy are in the fifth place of all foreign users and have made about 2.1 % of all trips.

Table 12 Share in total amount of travel according to the type of user

Country	Share in the total number of trips
Croatia	75.56%
Germany	7.64%
Austria	7.35%
Slovenia	3.66%
Italy	2.10%
Poland	0.92%
Czech Republic	0.52%
Bosnia and Herzegovina	0.38%

Country	Share in the total number of trips
Hungary	0.30%
Switzerland	0.28%
Serbia	0.27%
Slovakia	0.25%
Great Britain	0.14%
France	0.14%

The OD travel matrix for the specified days, for all users, for foreign users, and only for Italian users is shown in Figure 27 to Figure 35. Since the subject of the analysis is not migration within the zone, as mentioned above, the matrix diagonal does not contain data.



	0	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0		3447	225	24	36	0	3	3	0	0	0	0	0	30	0	6	6	0	0	0	3	24	0	3	0	0	0	9	0	0	0	25011	6	0	3	3	21	27	27	0	0	9	3	6	0	0	3	0	18	3	0	0
1	3516		864	45	72	0	0	0	0	0	0	0	0	12	0	0	6	0	0	0	0	27	0	6	0	0	0	3	0	0	0	6657	0	6	0	9	3	27	57	0	0	0	9	6	0	6	3	0	12	0	6	0
2	201	897		1638	1275	0	0	0	0	0	0	0	0	36	0	15	9	0	6	12	12	0	3	42	0	0	0	30	0	0	0	8427	3	0	18	6	93	51	225	3	0	3	12	9	3	9	3	3	36	0	6	0
3	6	129	1722		3642	0	0	0	0	0	0	0	0	6	0	3	3	0	0	3	0	0	9	12	0	0	0	3	3	0	0	1929	3	3	3	6	39	21	87	6	3	0	0	3	0	3	0	0	15	0	3	0
4	42	147	1620	3756		0	0	0	0	0	0	0	0	42	0	12	33	0	12	9	15	3	0	42	0	3	3	27	0	0	0	4698	0	6	18	33	114	102	246	0	3	18	18	9	0	21	0	0	108	6	0	3
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6	0	0	0	0	0	0		765	0	0	3	0	66	126	0	129	195	0	3	9	30	201	0	522	3	6	9	99	6	0	21	138	18	39	48	90	402	288	486	6	66	81	135	183	27	213	30	24	132	45	75	96
7	0	0	0	0	0	0	657		0	0	0	0	69	30	0	36	216	0	0	15	12	231	0	756	9	3	0	126	9	0	0	210	18	147	99	99	588	243	468	6	78	135	231	210	15	360	51	63	201	72	147	165
8	0	0	0	0	0	0	0	0		57	9	0	0	3	135	3	0	0	15	0	0	0	0	0	0	3	0	0	0	0	0	3	0	3	0	0	0	0	3	0	0	3	3	0	0	0	0	6	0	0	0	0
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12	0	0	0	0	0	0	0	0	0	0	30		0	105	12	12	9	39	51	15	9	0	6	3	3	66	15	0	261	0	0	9	0	0	0	0	9	0	90	6	3	0	0	3	0	0	0	3	3	0	0	0
13	0	0	0	0	0	0	30	24	0	0	0	0		12	0	42	345	0	9	12	24	3	0	39	0	0	3	66	6	0	0	27	3	9	3	30	210	51	1203	627	534	33	276	417	144	330	30	36	129	1062	303	93
14	15	9	39	12	33	0	36	15	3	6	267	108	36		0	1599	474	21	453	522	606	33	99	78	90	537	51	114	2265	0	2046	756	78	369	12	36	201	153	675	15	108	1458	420	162	21	153	60	54	81	63	93	57
15	0	0	0	0	0	0	0	0	132	309	9	0	0	6		24	9	0	51	42	0	0	27	9	0	9	0	3	3	0	0	0	0	6	0	3	6	0	9	0	0	3	6	0	0	0	0	0	0	3	0	6
16	63	51	171	36	216	0	123	39	0	21	9	15	138	114	21		2571	3	78	189	2124	69	51	273	39	33	6	426	42	0	9	3753	42	18	93	231	1314	942	5031	222	366	261	1107	738	135	729	114	174	252	276	396	267
17	3	9	15	3	48	0	54	24	3	36	51	15	420	339	9	3213		6	249	384	1134	138	84	147	66	60	3	366	285	0	24	393	15	114	18	48	270	273	4572	1173	2622	441	1371	615	117	732	63	255	276	636	954	222
18	0	0	0	0	0	0	0	0	0	3	12	45	0	21	0	3	3		30	3	3	0	0	3	0	192	81	0	57	0	0	0	0	0	0	0	0	0	6	0	0	3	6	3	0	0	0	0	0	0	0	0
19	6	0	6	0	21	0	12	0	15	243	453	39	24	309	33	297	225	30		450	138	9	528	30	282	591	63	63	195	0	3	159	0	3	12	9	54	54	516	12	18	39	120	36	6	36	0	6	21	21	33	9
20	0	15	15	9	33	0	12	3	0	18	33	9	21	195	27	1044	540	9	516		558	27	291	63	159	57	12	123	132	0	6	411	3	12	3	21	171	138	972	15	51	141	336	99	12	96	33	45	48	42	57	51
21	18	15	24	3	42	0	33	12	0	3	15	3	42	99	3	2523	1035	0	36	84		108	15	189	27	9	12	354	33	0	0	1128	3	6	15	60	354	342	2463	99	168	93	321	207	24	165	54	72	78	93	111	84
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49	12	15	15	0	36	0	87	63	0	9	0	0	117	75	0	63	126	0	15	24	30	30	12	243	9	9	3	474	6	0	0	12366	3387	1356	1566	1005	1275	450	1536	399	132	114	150	2079	504	4332	570	141		393	282	129
50	6	3	0	0	0	0	45	18	0	0	0	0	1110	24	3	87	474	0	18	21	45	12	3	57	0	0	0	201	6	0	0	81	3	12	48	63	192	141	1014	465	1329	66	765	972	864	426	39	51	402		534	57
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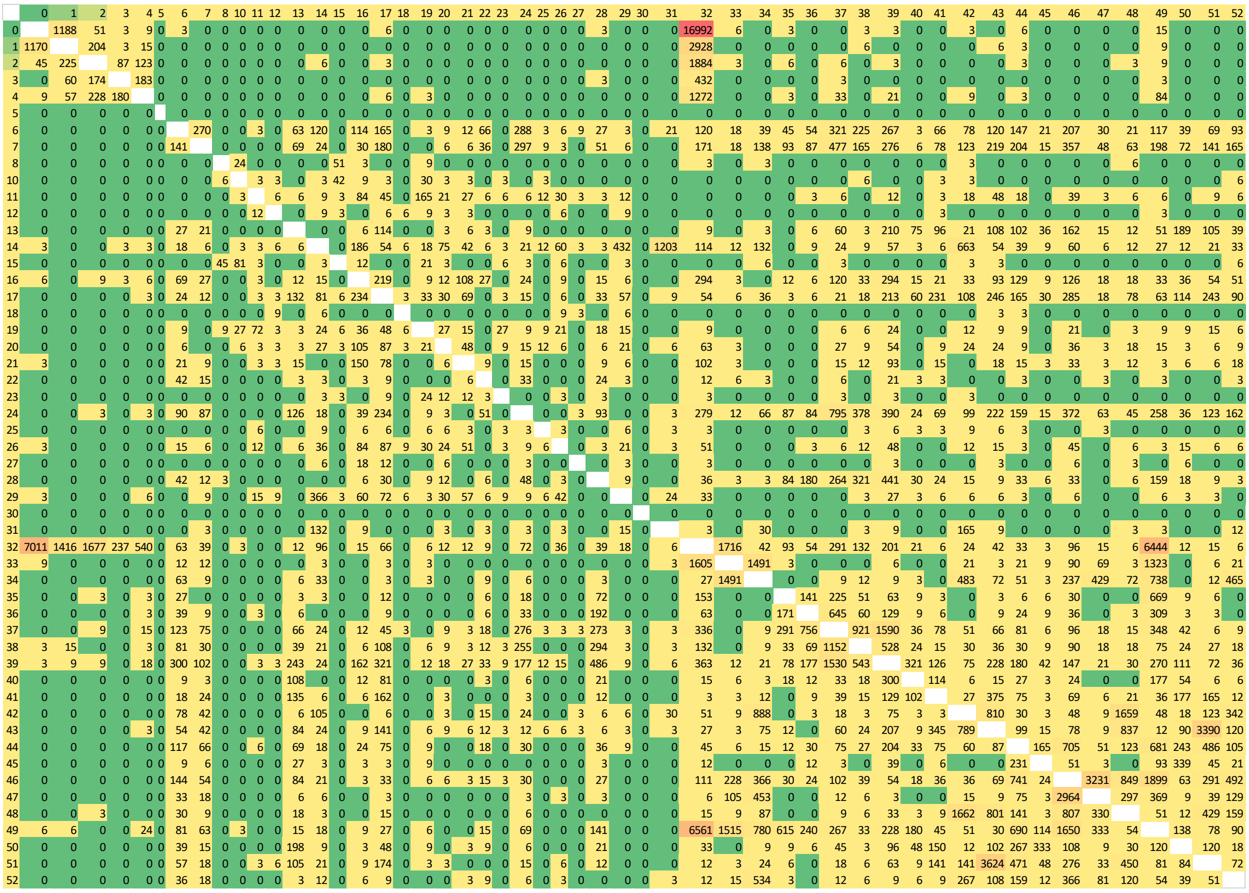
52	0	0	0	0	6	0	36	18	0	0	0	0	24	57	0	15	48	0	9	9	12	18	0	6	0	3	3	36	12	0	6	60	27	864	3	3	21	30	228	18	30	966	339	321	24	816	147	204	99	69	108	

Figure 27 OD travel matrix for all users (03/06/2021)



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0		1188	51	3	9	0	3	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	3	0	0	0	16992	6	0	3	0	0	3	3	0	0	3	0	6	0	0	0	0	15	0	0	0
1	1170		204	3	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2928	0	0	0	0	0	6	0	0	0	0	6	3	0	0	0	0	9	0	0	0
2	45	225		87	123	0	0	0	0	0	0	0	0	6	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1884	3	0	6	0	6	0	3	0	0	0	0	3	0	0	0	3	9	0	0	0
3	0	60	174		183	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	432	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
4	9	57	228	180		0	0	0	0	0	0	0	0	0	0	0	6	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1272	0	0	3	0	33	0	21	0	0	9	0	3	0	0	0	0	84	0	0	0
5	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0		270	0	0	3	0	63	120	0	114	165	0	3	9	12	66	0	288	3	6	9	27	3	0	21	120	18	39	45	54	321	225	267	3	66	78	120	147	21	207	30	21	117	39	69	93
7	0	0	0	0	0	0	141		0	0	0	0	69	24	0	30	180	0	0	6	6	36	0	297	9	3	0	51	6	0	0	171	18	138	93	87	477	165	276	6	78	123	219	204	15	357	48	63	198	72	141	165
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10	0	0	0	0	0	0	0	0	6		3	3	0	3	42	9	3	0	30	3	3	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	3	3	0	0	0	0	0	0	0	0	0	6
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13	0	0	0	0	0	0	27	21	0	0	0	0		0	0	6	114	0	0	3	6	3	0	9	0	0	0	0	0	0	0	9	0	3	0	6	60	3	210	75	96	21	108	102	36	162	15	12	51	189	105	39
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18	0	0	0	0	0	0	0	0	0	0	0	9	0	6	0	0	0		0	0	0	0	0	0	0	9	3	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0
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23	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	9	0	24	12	12	3		0	0	3	0	3	0	0	0	3	0	0	0	0	3	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0
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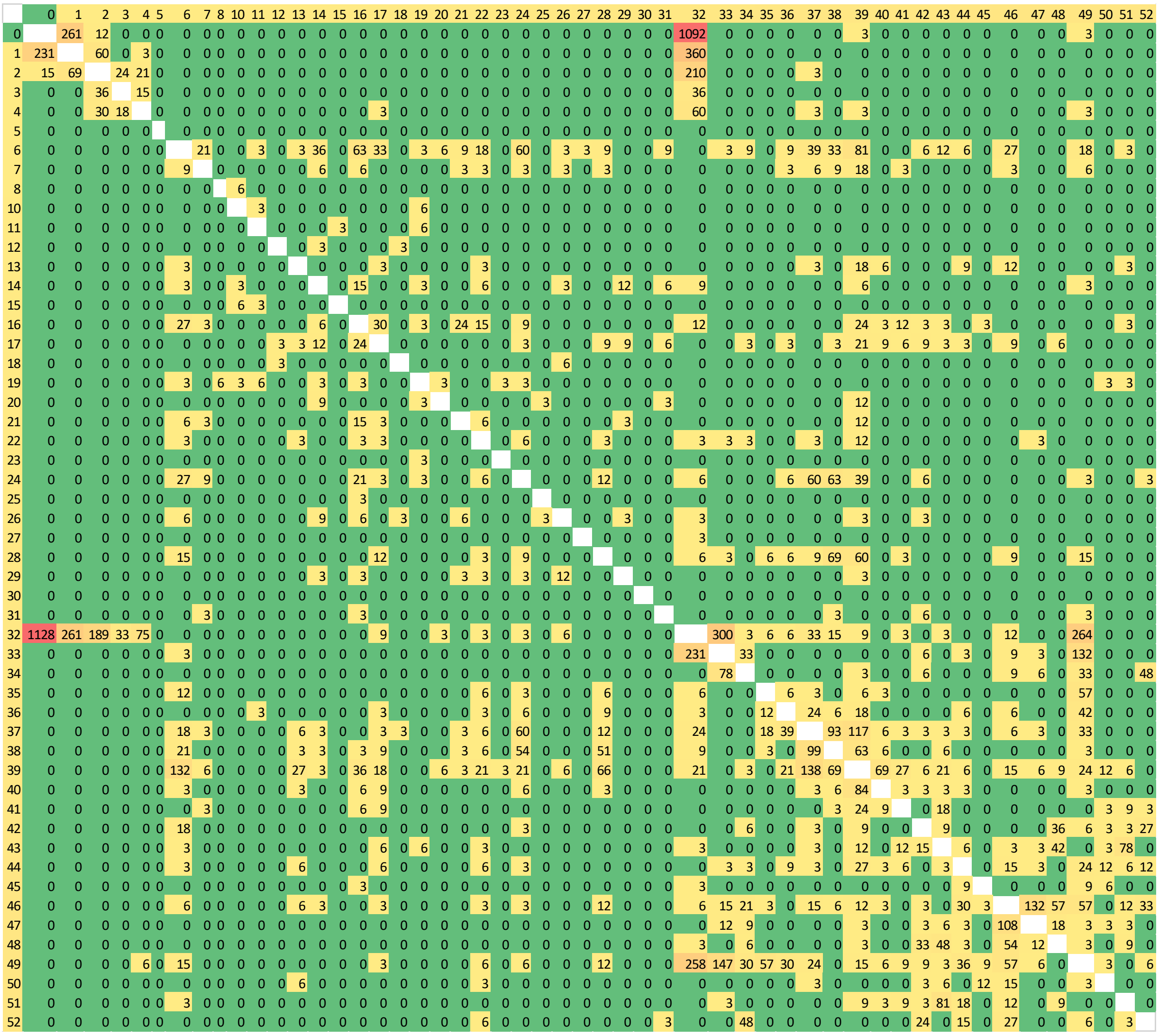
39	3	9	9	0	18	0	300	102	0	0	3	3	243	24	0	162	321	0	12	18	27	33	9	177	12	15	0	486	9	0	6	363	12	21	78	177	1530	543		321	126	75	228	180	42	147	21	30	270	111	72	36
40	0	0	0	0	0	0	9	3	0	0	0	0	108	0	0	12	81	0	0	0	0	3	0	6	0	0	0	21	0	0	0	15	6	3	18	12	33	18	300		114	6	15	27	3	24	0	0	177	54	6	6
41	0	0	0	0	0	0	18	24	0	0	0	0	135	6	0	6	162	0	0	3	0	0	0	3	0	0	0	12	0	0	0	3	3	12	0	9	39	15	129	102		27	375	75	3	69	6	21	36	177	165	12
42	0	0	0	0	0	0	78	42	0	0	0	0	6	105	0	0	6	0	0	3	0	15	0	24	0	0	3	6	6	0	30	51	9	888	0	3	18	3	75	3	3		810	30	3	48	9	1659	48	18	123	342
43	0	0	0	0	3	0	54	42	0	0	0	0	84	24	0	9	141	0	6	9	6	12	3	12	6	6	3	6	3	0	3	27	3	75	12	0	60	24	207	9	345	789		99	15	78	9	837	12	90	3390	120
44	0	0	0	0	0	0	117	66	0	0	6	0	69	18	0	24	75	0	9	0	0	18	0	30	0	0	0	36	9	0	0	45	6	15	12	30	75	27	204	33	75	60	87		165	705	51	123	681	243	486	105
45	0	0	0	0	0	0	9	6	0	0	0	0	27	3	0	3	3	0	9	0	0	0	0	0	0	0	0	3	0	0	0	12	0	0	0	12	3	0	39	0	6	0	0	231		51	3	0	93	339	45	21
46	0	0	0	0	0	0	144	54	0	0	0	0	84	21	0	3	33	0	6	6	3	15	3	30	0	0	0	27	0	0	0	111	228	366	30	24	102	39	54	18	36	36	69	741	24		3231	849	1899	63	291	492
47	0	0	0	0	0	0	33	18	0	0	0	0	6	6	0	0	3	0	0	0	0	0	0	3	0	3	0	3	0	0	0	6	105	453	0	0	12	6	3	0	0	15	9	75	3	2964		297	369	9	39	129
48	0	0	3	0	0	0	30	9	0	0	0	0	18	3	0	0	15	0	0	0	0	0	0	6	0	0	0	0	0	0	0	15	9	87	0	0	9	6	33	3	9	1662	801	141	3	807	330		51	12	429	159
49	6	6	0	0	24	0	81	63	0	3	0	0	15	18	0	9	27	0	6	0	0	15	0	69	0	0	0	141	0	0	0	6561	1515	780	615	240	267	33	228	180	45	51	30	690	114	1650	333	54		138	78	90
50	0	0	0	0	0	0	39	15	0	0	0	0	198	9	0	3	48	0	9	0	3	9	0	6	0	0	0	21	0	0	0	33	0	9	9	6	45	3	96	48	150	12	102	267	333	108	9	30	120		120	18
51	0	0	0	0	0	0	57	18	0	0	3	6	105	21	0	9	174	0	3	3	0	0	0	15	0	6	0	12	0	0	0	12	3	24	6	0	18	6	63	9	141	141	3624	471	48	276	33	450	81	84		72
52	0	0	0	0	0	0	36	18	0	0	0	0	3	12	0	6	9	0	0	0	3	9	0	6	0	3	0	0	0	0	3	12	15	534	3	0	12	6	9	6	9	267	108	159	12	366	81	120	54	39	51	

Figure 28 OD travel matrix for foreign users (03/06/2021)



	0	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0		261	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1092	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0
1	231		60	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	360	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	15	69		24	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	210	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	36		15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	30	18		0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0
5	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0		21	0	0	3	0	3	36	0	63	33	0	3	6	9	18	0	60	0	3	3	9	0	0	9	0	3	9	0	9	39	33	81	0	0	6	12	6	0	27	0	0	18	0	3	0
7	0	0	0	0	0	0	9		0	0	0	0	0	6	0	6	0	0	0	0	3	3	0	3	0	3	0	3	0	0	0	0	0	0	0	3	6	9	18	0	3	0	0	0	0	3	0	0	6	0	0	0
8	0	0	0	0	0	0	0	0		6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0		3	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0		0	0	0	3	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0		0	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	3	0	0	0	0	0		0	0	0	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	18	6	0	0	0	9	0	12	0	0	0	0	3	0
14	0	0	0	0	0	0	3	0	0	3	0	0	0		0	15	0	0	3	0	0	6	0	0	0	3	0	0	12	0	6	9	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	3	0	0	0
15	0	0	0	0	0	0	0	0	0	6	3	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	27	3	0	0	0	0	0	6	0		30	0	3	0	24	15	0	9	0	0	0	0	0	0	0	12	0	0	0	0	0	0	24	3	12	3	3	0	3	0	0	0	0	0	3	0
17	0	0	0	0	0	0	0	0	0	0	0	3	3	12	0	24		0	0	0	0	0	0	3	0	0	0	9	9	0	6	0	0	3	0	3	0	3	21	9	6	9	3	3	0	9	0	6	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0		0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	3	0	6	3	6	0	0	3	0	3	0	0		3	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	3		0	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	6	3	0	0	0	0	0	0	0	15	3	0	0	0		6	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	3	0	0	0	0	0	3	0	0	3	3	0	0	0	0		0	6	0	0	0	3	0	0	0	3	3	3	0	0	3	0	12	0	0	0	0	0	0	0	3	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	27	9	0	0	0	0	0	0	0	21	3	0	3	0	0	6	0		0	0	0	12	0	0	0	6	0	0	0	6	60	63	39	0	0	6	0	0	0	0	0	0	3	0	0	3
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	6	0	0	0	0	0	0	9	0	6	0	3	0	0	6	0	0	0	3		0	0	3	0	0	3	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	12	0	0	0	0	3	0	9	0	0	0		0	0	0	6	3	0	6	6	9	69	60	0	3	0	0	0	0	9	0	0	15	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	3	3	0	3	0	12	0	0		0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	3	0	0	0	6	0	0	0	0	0	0	3	0	0	0
32	1128	261	189	33	75	0	0	0	0	0	0	0	0	0	0	0	9	0	0	3	0	3	0	3	0	6	0	0	0	0	0		300	3	6	6	33	15	9	0	3	0	3	0	0	12	0	0	264	0	0	0
33	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	231		33	0	0	0	0	0	0	0	6	0	3	0	9	3	0	132	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78		0	0	0	0	3	0	0	6	0	0	0	9	6	0	33	0	0	48
35	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	3	0	0	0	6	0	0	0	6	0	0		6	3	0	6	3	0	0	0	0	0	0	0	0	57	0	0	0
36	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	0	0	0	0	3	0	6	0	0	0	9	0	0	0	3	0	0	12		24	6	18	0	0	0	0	6	0	6	0	0	42	0	0	0
37	0	0	0	0	0	0	18	3	0	0	0	0	6	3	0	0	3	3	0	0	3	6	0	60	0	0	0	12	0	0	0	24	0	0	18	39		93	117	6	3	3	3	3	0	6	3	0	33	0	0	0
38	0	0	0	0	0	0	21	0	0	0	0	0	3	3	0	3	9	0	0	0	3	6	0	54	0	0	0	51	0	0	0	9	0	0	3	0	99		63	6	0	0	6	0	0	0	0	0	3	0	0	0
39	0	0	0	0	0	0	132	6	0	0	0	0	27	3	0	36	18	0	0	6	3	21	3	21	0	6	0	66	0	0	0	21	0	3	0	21	138	69		69	27	6	21	6	0	15	6	9	24	12	6	0
40	0	0	0	0	0	0	3	0	0	0	0	0	3	0	0	6	9	0	0	0	0	0	0	6	0	0	0	3	0	0	0	0	0	0	0	0	3	6	84		3	3	3	3	0	0	0	0	3	0	0	0
41	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	6	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	24	9		0	18	0	0	0	0	0	0	3	9	3
42	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	6	0	0	3	0	9	0	0		9	0	0	0	0	36	6	3	3	27
43	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	6	0	6	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	0	12	0	12	15		6	0	3	3	42	0	3	78	0
44	0	0	0	0	0	0	3	0	0	0	0	0	6	0	0	0	6	0	0	0	0	6	0	3	0	0	0	0	0	0	0	0	3	3	0	9	3	0	27	3	6	0	3		0	15	3	0	24	12	6	12
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	9		0	0	0	9	6	0	0
46	0	0	0	0	0	0	6	0	0	0	0	0	6	3	0	0	3	0	0	0	0	3	0	3	0	0	0	12	0	0	0	6	15	21	3	0	15	6	12	3	0	3	0	30	3		132	57	57	0	12	33
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	9	0	0	0	0	3	0	0	3	6	3	0	108		18	3	3	3	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	6	0	0	0	0	3	0	0	33	48	3	0	54	12		3	0	9	0
49	0	0	0	0	6	0	15	0	0	0	0	0	0	0	0	0	3	0	0	0	0	6	0	6	0	0	0	12	0	0	0	258	147	30	57	30	24	0	15	6	9	9	3	36	9	57	6	0		3	0	6
50	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	6	0	12	15	0	0	3		0	0
51	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	9	3	9	3	81	18	0	12	0	9	0	0		0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	3	0	0	48	0	0	0	0	0	0	0	24	0	15	0	27	0	0	6	0	3	

Figure 29 OD travel matrix for Italian users (03/06/2021)

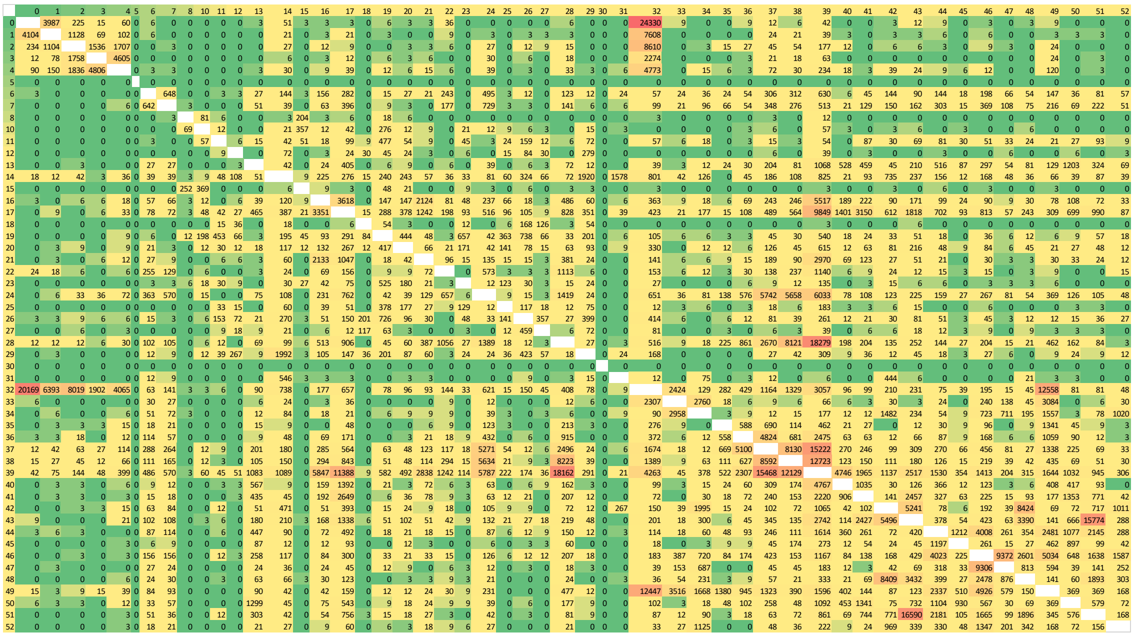


Figure 30 OD travel matrix for all users (04/06/2021)

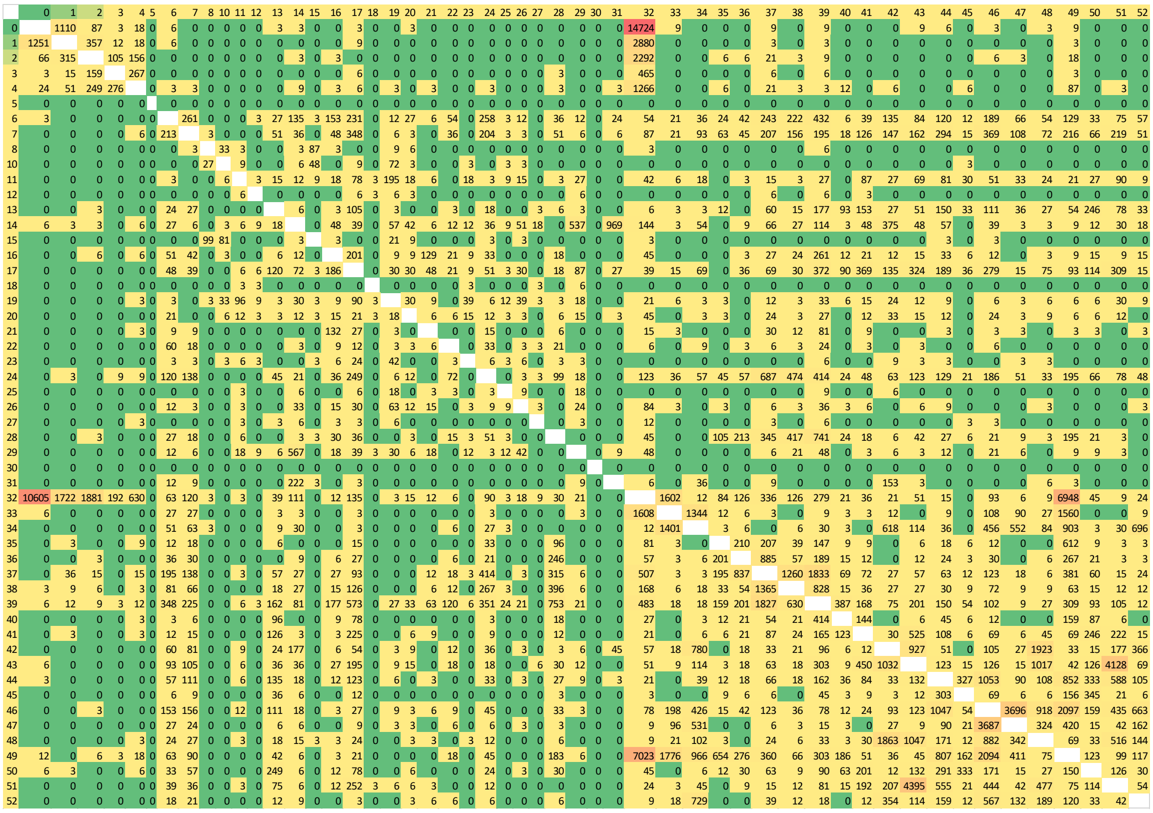
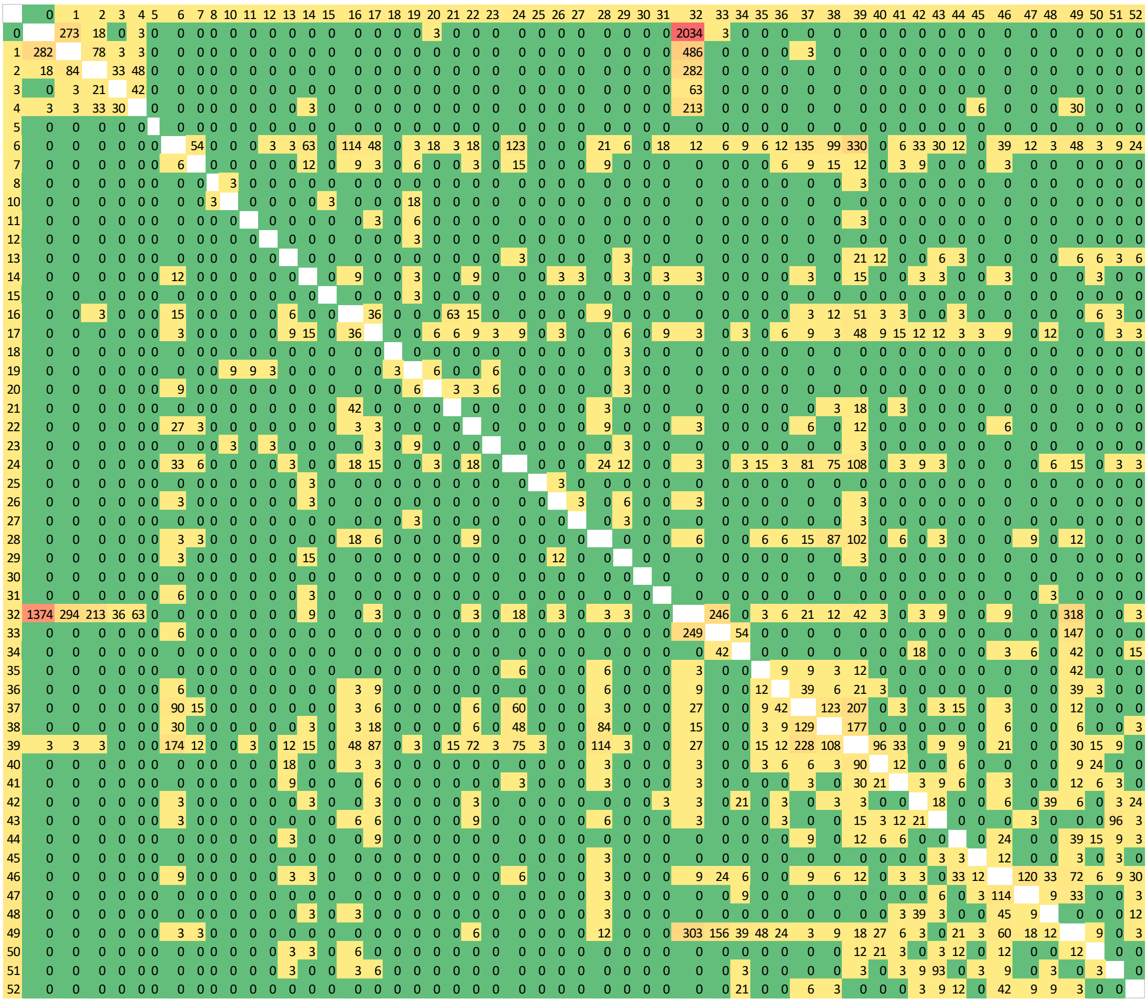


Figure 31 OD travel matrix for foreign users (04/06/2021)



	0	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0		273	18	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	2034	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	282		78	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	486	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	18	84		33	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	282	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	3	21		42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	3	3	33	30		0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	213	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	30	0	0	0
5	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0		54	0	0	0	3	3	63	0	114	48	0	3	18	3	18	0	123	0	0	0	21	6	0	18	12	6	9	6	12	135	99	330	0	6	33	30	12	0	39	12	3	48	3	9	24
7	0	0	0	0	0	0	6		0	0	0	0	0	12	0	9	3	0	6	0	0	3	0	15	0	0	0	9	0	0	0	0	0	0	0	6	9	15	12	0	3	9	0	0	0	3	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	3		0	0	0	0	3	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	3	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	21	12	0	0	6	3	0	0	0	0	6	6	3	6
14	0	0	0	0	0	0	12	0	0	0	0	0	0		0	9	0	0	3	0	0	9	0	0	0	3	3	0	3	0	3	3	0	0	0	0	3	0	15	0	0	3	3	0	0	3	0	0	0	3	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	3	0	0	0	15	0	0	0	0	0	6	0	0		36	0	0	0	63	15	0	0	0	0	0	9	0	0	0	0	0	0	0	0	3	12	51	3	3	0	0	3	0	0	0	0	0	6	3	0
17	0	0	0	0	0	0	3	0	0	0	0	0	9	15	0	36		0	0	6	6	9	3	9	0	3	0	0	6	0	9	3	0	3	0	6	9	3	48	9	15	12	12	3	3	9	0	12	0	0	3	3
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	9	9	3	0	0	0	0	0	3		6	0	0	6	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	6		3	3	6	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	0	0	0	0		0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	18	0	3	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	27	3	0	0	0	0	0	0	0	3	3	0	0	0	0		0	0	0	0	0	9	0	0	0	3	0	0	0	0	6	0	12	0	0	0	0	0	0	6	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	3	0	9	0	0	0		0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	33	6	0	0	0	0	3	0	0	18	15	0	0	3	0	18	0		0	0	0	24	12	0	0	3	0	3	15	3	81	75	108	0	3	9	3	0	0	0	0	6	15	0	3	3
25	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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28	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	18	6	0	0	0	0	9	0	0	0	0	0		0	0	0	6	0	0	6	6	15	87	102	0	6	0	3	0	0	0	9	0	12	0	0	0
29	0	0	0	0	0	0	3	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	12	0	0		0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	6	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
32	1374	294	213	36	63	0	0	0	0	0	0	0	0	9	0	0	3	0	0	0	0	3	0	18	0	3	0	3	3	0	0		246	0	3	6	21	12	42	3	0	3	9	0	0	9	0	0	318	0	0	3
33	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	249		54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	147	0	0	0
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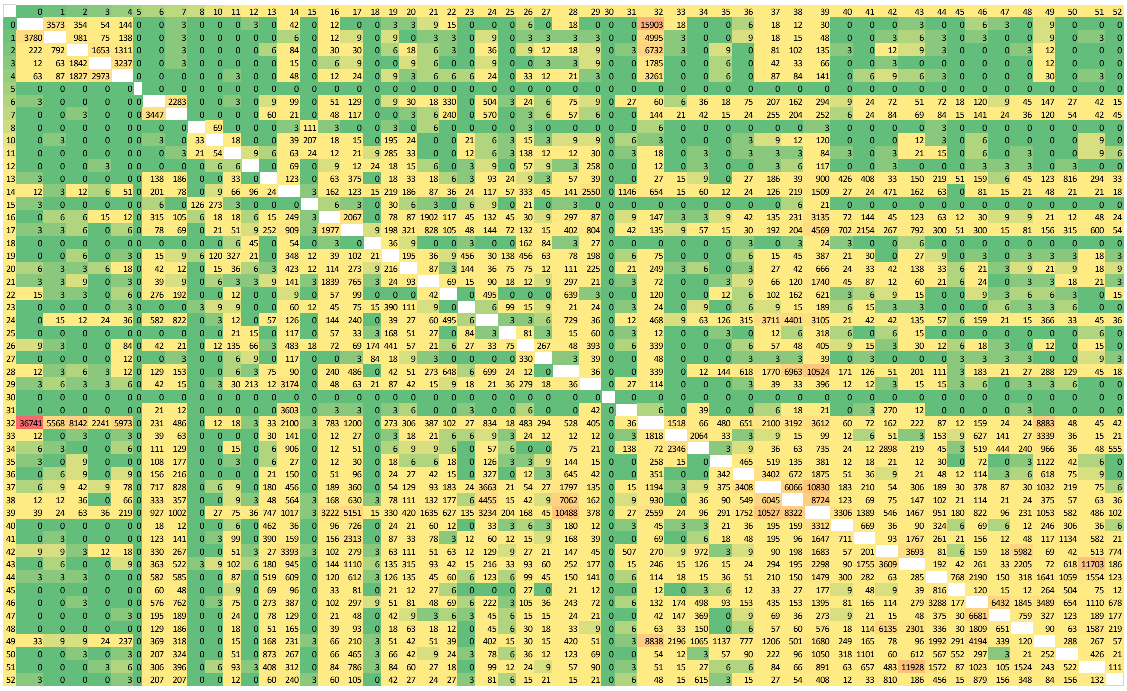
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	6	0	0	0	3	0	0		9	9	3	12	0	0	0	0	0	0	0	0	0	42	0	0	0
36	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	3	9	0	0	0	0	0	0	0	0	0	0	6	0	0	0	9	0	0	12		39	6	21	3	0	0	0	0	0	0	0	0	39	3	0	0
37	0	0	0	0	0	0	90	15	0	0	0	0	0	0	0	3	6	0	0	0	0	6	0	60	0	0	0	3	0	0	0	27	0	0	9	42		123	207	0	3	0	3	15	0	3	0	0	12	0	0	0
38	0	0	0	0	0	0	30	0	0	0	0	0	0	3	0	3	18	0	0	0	0	6	0	48	0	0	0	84	0	0	0	15	0	0	3	9	129		177	0	0	0	0	0	0	6	0	0	6	0	0	3
39	3	3	3	0	0	0	174	12	0	0	3	0	12	15	0	48	87	0	3	0	15	72	3	75	3	0	0	114	3	0	0	27	0	0	15	12	228	108		96	33	0	9	9	0	21	0	0	30	15	9	0
40	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	3	3	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0	3	6	6	3	90		12	0	0	6	0	0	0	0	9	24	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	6	0	0	0	0	0	0	3	0	0	0	3	0	0	0	3	0	0	0	0	3	0	30	21		3	9	6	0	3	0	0	12	6	3	0
42	0	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	3	0	0	0	0	3	0	0	0	0	0	0	0	0	3	3	0	21	0	3	0	3	3	0	0		18	0	0	6	0	39	6	0	3	24
43	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	6	6	0	0	0	0	9	0	0	0	0	0	6	0	0	0	3	0	0	0	3	0	0	15	3	12	21		0	0	0	3	0	0	0	96	3
44	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	12	6	6	0	0		0	24	0	0	39	15	9	3
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3		12	0	0	3	0	3	0
46	0	0	0	0	0	0	9	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	6	0	0	0	3	0	0	0	9	24	6	0	0	9	6	12	0	3	3	0	33	12		120	33	72	6	9	30
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	9	0	0	0	0	0	0	0	0	6	0	3	114		9	33	0	0	3
48	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3	39	3	0	0	45	9		0	0	0	12
49	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	12	0	0	0	303	156	39	48	24	3	9	18	27	6	3	0	21	3	60	18	12		9	0	3
50	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	21	3	0	3	12	0	12	0	0	12		0	0
51	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	0	3	9	93	0	3	9	0	3	0	3		0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	6	3	0	0	0	3	9	12	0	42	9	9	3	0	0	

Figure 32 OD travel matrix for Italian users (04/06/2021)



	0	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
0		3573	354	54	144	0	0	3	0	0	0	3	0	42	0	12	0	0	3	3	9	15	0	0	0	6	0	18
1	3780		981	75	138	0	0	3	0	0	0	0	0	6	0	12	9	0	9	0	3	3	0	9	0	3	3	3
2	222	792		1653	1311	0	0	3	0	0	0	0	6	84	0	30	30	0	6	18	6	3	0	36	0	9	12	18
3	12	63	1842		3237	0	0	3	0	0	0	0	0	15	0	6	9	0	0	9	6	0	0	9	0	0	3	3
4	63	87	1827	2973		0	0	0	0	0	3	0	0	48	0	12	24	0	9	3	6	6	6	24	0	33	12	21
5	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	3	0	0	0	0	0		2283	0	0	3	0	9	99	0	51	129	0	9	30	18	330	0	504	3	24	6	75
7	0	0	3	0	0	0	3447		0	0	0	0	60	21	0	48	117	0	0	3	6	240	0	570	0	3	6	57
8	0	0	0	0	0	0	0	0		69	0	0	0	3	111	3	0	0	3	0	6	0	0	0	0	3	0	0
10	0	3	0	0	0	0	3	0	33		18	0	0	39	207	18	15	0	195	24	0	0	21	6	3	15	3	9
11	0	0	0	0	0	0	0	3	21	54		9	6	63	24	12	21	9	285	33	0	0	12	6	3	138	12	12
12	0	0	0	3	0	0	0	0	0	6	6		0	69	0	9	12	24	18	15	6	0	3	9	0	57	9	3
13	3	0	0	0	0	0	138	186	0	0	33	0		123	0	63	375	0	18	33	18	6	3	93	24	9	3	57
14	12	3	12	6	51	0	201	78	0	9	66	96	24		3	162	123	15	219	186	87	36	24	117	57	333	45	141
15	3	0	0	0	0	0	6	0	126	273	3	0	0	0		6	3	0	30	6	3	0	6	9	0	21	0	3
16	0	6	6	15	12	0	315	105	6	18	18	6	15	249	3		2067	0	78	87	1902	117	45	132	45	30	9	297
17	3	3	6	0	6	0	78	69	0	21	51	9	252	909	3	1977		9	198	321	828	105	48	144	72	132	15	402
18	0	0	0	0	0	0	0	0	0	0	6	45	0	54	0	3	0		36	9	0	0	3	0	0	162	84	3
19	0	0	6	0	3	0	15	9	6	120	327	21	0	348	12	39	102	21		195	36	9	456	30	138	456	63	78
20	6	3	3	6	18	0	42	12	0	15	36	6	3	423	12	114	273	9	216		87	3	144	36	75	75	12	111
21	3	3	9	0	3	0	39	9	0	6	3	3	9	141	3	1839	765	3	24	93		69	15	90	18	12	9	297
22	15	3	3	0	6	0	276	192	0	0	12	0	0	9	0	57	99	0	0	0	42		0	495	0	0	0	639
23	0	0	0	0	3	0	0	0	3	9	9	0	0	60	12	45	75	15	390	111	9	0		6	99	15	9	21
24	0	15	12	24	36	0	582	822	0	3	12	0	57	126	0	144	240	0	39	27	60	495	6		3	3	6	729
25	0	0	0	0	0	0	0	0	0	0	21	15	0	117	0	57	33	3	168	51	27	0	84	3		81	3	15
26	9	3	0	0	84	0	42	21	0	12	135	66	3	483	18	72	69	174	441	57	21	6	27	33	75		267	48
27	0	0	0	0	12	0	0	3	0	0	6	9	0	117	0	0	3	84	18	9	3	0	0	0	0	330		3
28	12	3	6	3	12	0	129	153	0	0	6	3	75	90	0	240	486	0	42	51	273	648	6	699	24	12	0	
29	3	6	3	3	6	0	42	15	0	3	30	213	12	3174	0	48	63	21	87	42	15	9	18	21	36	279	18	36
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	21	12	0	0	0	0	0	3603	0	3	3	0	3	6	0	0	3	0	0	6	0	0
32	36741	5568	8142	2241	5973	0	231	486	0	12	18	3	33	2100	3	783	1200	0	273	306	387	102	27	834	18	483	294	528
33	12	0	3	0	3	0	39	63	0	0	0	0	30	141	0	12	27	0	3	18	21	6	6	9	3	24	12	12
34	6	3	0	0	6	0	111	129	0	0	15	0	6	906	0	12	51	0	6	9	9	6	0	57	6	0	0	75
35	3	0	9	0	0	0	108	177	0	0	3	0	6	27	0	12	30	0	18	6	6	18	0	126	3	3	9	144
36	0	6	9	0	9	0	156	216	0	0	0	0	21	150	0	51	96	0	24	27	42	15	0	327	0	12	3	645
37	6	9	42	9	78	0	717	828	0	6	9	0	180	456	0	189	360	0	54	129	93	183	24	3663	21	54	27	1797
38	12	12	36	0	66	0	333	357	0	0	9	3	48	564	3	168	630	3	78	111	132	177	6	4455	15	42	9	7062
39	39	24	63	36	219	0	927	1002	0	27	75	36	747	1017	3	3222	5151	15	330	420	1635	627	135	3234	204	168	45	10488
40	0	0	0	0	0	0	18	12	0	0	6	0	462	36	0	96	726	0	24	21	60	12	0	33	3	6	3	180
41	0	3	0	0	0	0	123	141	0	3	99	0	390	159	0	156	2313	0	87	33	78	3	12	60	12	15	9	168
42	9	9	3	12	18	0	330	267	0	0	51	3	27	3393	3	102	279	3	63	111	51	63	12	129	9	27	21	147
43	0	6	0	0	9	0	363	522	3	9	102	6	180	945	0	144	1110	6	135	315	93	42	15	216	33	93	60	252
44	3	3	3	0	0	0	582	585	0	0	87	0	519	609	0	120	612	3	126	135	45	60	6	123	6	99	45	150
45	0	0	0	0	0	0	60	48	0	0	9	0	69	96	0	33	81	0	21	12	27	6	0	0	0	27	0	21
46	0	0	3	0	0	0	576	762	0	3	75	0	273	387	0	102	297	9	51	81	48	69	6	222	3	105	36	243
47	0	0	0	0	3	0	195	189	0	0	24	0	78	129	0	21	48	0	42	9	3	6	3	45	6	15	15	24
48	0	0	0	0	0	0	129	186	0	0	18	0	51	165	0	39	93	0	18	63	18	12	0	45	6	30	18	33
49	33	9	9	24	237	0	369	318	0	0	15	0	168	231	3	66	210	3	51	42	51	39	0	402	15	30	15	420
50	0	0	3	0	3	0	207	324	0	0	51	0	873	267	0	66	465	3	66	42	9	24	3	78	6	36	12	123
51	0	0	0	3	6	0	306	396	0	6	93	3	408	312	0	84	786	3	84	60	27	18	0	99	12	24	9	57
52	3	0	0	0	3	0	207	207	0	0	12	0	60	240	3	60	105	0	42	27	24	27	3	81	6	15	21	15

	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0	0	0	0	15903	18	0	0	6	18	12	30	0	0	0	3	0	0	6	3	0	9	0	0	0
1	3	0	0	4995	3	0	0	9	18	15	48	0	0	3	6	3	0	3	0	0	9	0	3	0
2	9	0	3	6732	3	0	9	0	81	102	135	3	0	12	9	3	0	0	0	3	12	0	0	0
3	9	0	0	1785	0	0	6	0	42	33	66	0	0	3	0	0	0	0	0	0	12	0	0	0
4	3	0	0	3261	0	0	6	0	87	84	141	0	6	9	6	3	0	0	0	0	30	0	3	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	9	0	27	60	6	36	18	75	207	162	294	9	24	72	51	72	18	120	9	45	147	27	42	15
7	6	0	0	144	21	42	15	24	255	204	252	6	24	84	69	84	15	141	24	36	120	54	42	45
8	0	0	0	6	0	0	0	0	0	0	3	0	0	0	0	3	0	0	0	0	0	0	0	0
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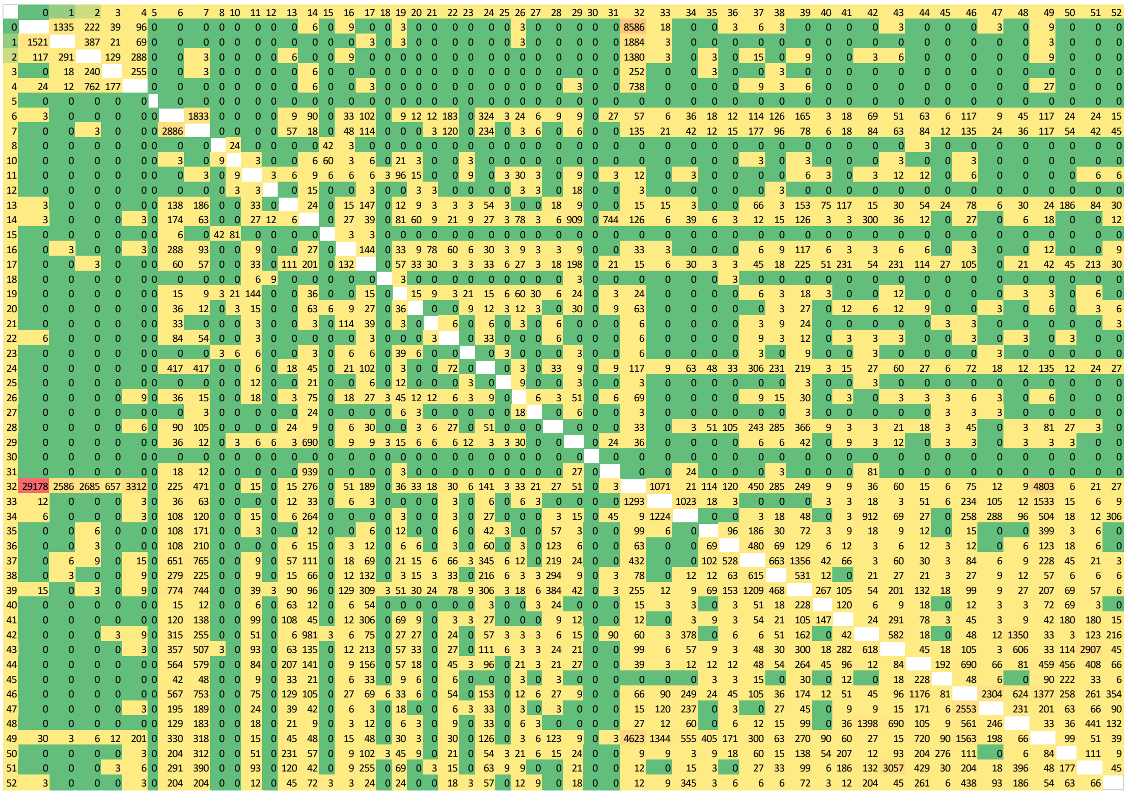
11	30	0	3	18	0	3	0	3	3	3	84	3	0	3	21	15	0	6	0	3	0	0	9	6
12	258	0	0	12	0	3	0	0	3	6	117	0	0	3	0	0	0	3	3	3	0	3	0	0
13	39	0	0	27	15	9	0	27	186	39	900	426	408	33	150	219	51	159	6	45	123	816	294	33
14	2550	0	1146	654	15	60	12	24	126	219	1509	27	24	471	162	63	0	81	15	21	48	21	21	18
15	0	0	0	0	0	0	0	0	0	6	21	0	0	0	0	0	0	0	0	0	0	0	0	0
16	87	0	9	147	3	3	9	42	135	231	3135	72	144	45	123	63	12	30	9	9	21	12	48	24
17	804	0	42	135	9	57	15	30	192	204	4569	702	2154	267	792	300	51	300	15	81	156	315	600	54
18	27	0	0	0	0	0	0	3	0	3	24	3	0	0	6	0	0	0	0	0	0	0	0	0
19	198	0	6	75	0	0	0	6	15	45	387	21	30	0	27	9	0	3	0	3	3	3	18	3
20	225	0	21	249	3	6	0	3	27	42	666	24	33	42	138	33	6	21	3	9	21	9	18	9
21	21	0	3	72	0	0	3	9	66	120	1740	45	87	12	60	21	6	24	0	3	3	18	21	3
22	3	0	0	120	0	0	12	6	102	162	621	3	6	9	15	0	0	9	3	6	6	3	0	15
23	24	0	3	24	0	9	0	6	9	15	189	6	15	3	3	0	0	0	6	3	3	6	0	0
24	36	0	12	468	9	63	126	315	3711	4401	3105	21	42	42	135	57	6	159	21	15	366	33	45	36
25	60	0	3	12	0	0	3	0	12	6	318	6	0	6	15	0	0	0	0	0	0	0	6	0
26	393	0	6	339	0	0	0	6	57	48	405	9	15	3	30	12	6	18	3	0	12	0	15	0
27	39	0	0	48	0	0	0	3	3	3	39	0	3	0	0	0	3	3	3	3	0	0	9	3
28	36	0	0	339	0	12	144	618	1770	6963	10524	171	126	51	201	111	3	183	21	27	288	129	45	18
29		0	27	114	0	0	0	3	39	33	396	12	12	3	15	15	3	6	0	3	3	6	0	0
30	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	42	0		6	0	39	0	0	6	18	21	0	3	270	12	0	0	0	0	3	0	0	0	0
32	405	0	36		1518	66	480	651	2100	3192	3612	60	72	162	222	87	12	159	24	24	8883	48	45	42
33	12	0	3	1818		2064	33	3	9	15	99	12	6	51	3	153	9	627	141	27	3339	36	15	21
34	21	0	138	72	2346		3	9	36	63	735	24	12	2898	219	45	3	519	444	240	966	36	48	555
35	15	0	0	258	15	0		465	519	135	381	12	18	21	12	30	0	72	0	3	1122	42	6	0
36	42	0	0	351	0	0	342		3402	672	1875	51	36	9	21	48	12	114	3	6	618	75	9	0
37	135	0	15	1194	3	9	375	3408		6066	10830	183	210	54	306	189	30	378	87	30	1032	219	75	6
38	162	0	9	930	0	36	90	549	6045		8724	123	69	75	147	102	21	114	21	24	375	57	63	36
39	378	0	27	2559	24	96	291	1752	10527	8322		3306	1389	546	1467	951	180	822	96	231	1053	582	486	102
40	12	0	3	45	3	3	21	36	195	159	3312		669	36	90	324	6	69	6	12	246	306	36	6
41	39	0	0	69	0	6	18	48	195	96	1647	711		93	1767	261	21	156	12	48	117	1134	582	21
42	45	0	507	270	9	972	3	9	90	198	1683	57	201		3693	81	6	159	18	5982	69	42	513	774
43	177	0	15	246	15	126	15	24	294	195	2298	90	1755	3609		192	42	261	33	2205	72	618	11703	186
44	141	0	6	114	18	15	36	51	210	150	1479	300	282	63	285		768	2190	150	318	1641	1059	1554	123
45	12	0	0	12	0	3	6	12	33	27	177	9	48	9	39	816		120	15	12	264	504	75	12
46	72	0	6	132	174	498	93	153	435	153	1395	81	165	114	279	3288	177		6432	1845	3489	654	1110	678
47	21	0	0	42	147	369	0	9	69	36	273	9	21	15	48	375	30	6681		759	327	123	189	177
48	9	0	6	63	33	150	0	6	57	60	576	18	114	6135	2301	336	30	1809	651		90	63	1587	219
49	51	0	3	8838	2196	1065	1137	777	1206	501	1680	249	165	78	96	1992	291	4194	339	120		288	267	57
50	69	0	0	54	12	3	57	90	222	96	1050	318	1101	60	612	567	552	297	3	21	252		426	21
51	90	0	3	51	15	27	6	6	84	66	891	63	657	483	11928	1572	87	1023	105	1524	243	522		111
52	21	0	6	48	15	615	3	15	27	54	408	12	33	810	186	456	15	879	156	348	84	156	132	

Figure 33 OD travel matrix for all users (06/06/2021)



	0	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
0		1335	222	39	96	0	0	0	0	0	0	0	0	6	0	9	0	0	3	0	0	0	0	0	0	3	0	0
1	1521		387	21	69	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	0	0	3	0	0
2	117	291		129	288	0	0	3	0	0	0	0	6	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0
3	0	18	240		255	0	0	3	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	24	12	762	177		0	0	0	0	0	0	0	0	6	0	0	3	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	3	0	0	0	0	0		1833	0	0	0	0	9	90	0	33	102	0	9	12	12	183	0	324	3	24	6	9
7	0	0	3	0	0	0	2886		0	0	0	0	57	18	0	48	114	0	0	0	3	120	0	234	0	3	6	0
8	0	0	0	0	0	0	0	0		24	0	0	0	0	42	3	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	3	0	9		3	0	0	6	60	3	6	0	21	3	0	0	3	0	0	0	0	0
11	0	0	0	0	0	0	0	3	0	9		3	6	9	6	6	6	3	96	15	0	0	9	0	3	30	3	0
12	0	0	0	0	0	0	0	0	0	3	3		0	15	0	0	3	0	0	3	3	0	0	0	0	3	3	0
13	3	0	0	0	0	0	138	186	0	0	33	0		24	0	15	147	0	12	9	3	3	3	54	3	0	0	18
14	3	0	0	0	3	0	174	63	0	0	27	12	6		0	27	39	0	81	60	9	21	9	27	3	78	3	6
15	0	0	0	0	0	0	6	0	42	81	0	0	0	0		3	3	0	0	0	0	0	0	0	0	0	0	0
16	0	3	0	0	3	0	288	93	0	0	9	0	0	27	0		144	0	33	9	78	60	6	30	3	9	3	3
17	0	0	3	0	0	0	60	57	0	0	33	0	111	201	0	132		0	57	33	30	3	3	33	6	27	3	18
18	0	0	0	0	0	0	0	0	0	0	6	9	0	0	0	0	0		3	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	15	9	3	21	144	0	0	36	0	0	15	0		15	9	3	21	15	6	60	30	6
20	0	0	0	0	0	0	36	12	0	3	15	0	0	63	6	9	27	0	36		0	0	9	12	3	12	3	0
21	0	0	0	0	0	0	33	0	0	0	3	0	0	3	0	114	39	0	3	0		6	0	6	0	3	0	6
22	6	0	0	0	0	0	84	54	0	0	3	0	0	0	0	0	3	0	0	0	3		0	33	0	0	0	6
23	0	0	0	0	0	0	0	0	3	6	6	0	0	3	0	6	6	0	39	6	0	0		0	3	0	0	0
24	0	0	0	0	0	0	417	417	0	0	6	0	18	45	0	21	102	0	3	0	0	72	0		0	3	0	33
25	0	0	0	0	0	0	0	0	0	0	12	0	0	21	0	0	6	0	12	0	0	0	3	0		9	0	0
26	0	0	0	0	9	0	36	15	0	0	18	0	3	75	0	18	27	3	45	12	12	6	3	9	0		6	3
27	0	0	0	0	0	0	0	3	0	0	0	0	0	24	0	0	0	0	6	3	0	0	0	0	0	18		0
28	0	0	0	0	6	0	90	105	0	0	0	0	24	9	0	6	30	0	0	3	6	27	0	51	0	0	0	
29	0	0	0	0	0	0	36	12	0	3	6	6	3	690	0	9	9	3	15	6	6	6	12	3	3	30	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	18	12	0	0	0	0	0	939	0	0	0	0	3	0	0	0	0	0	0	0	0	0
32	29178	2586	2685	657	3312	0	225	471	0	0	15	0	15	276	0	51	189	0	36	33	18	30	6	141	3	33	21	27
33	12	0	0	0	3	0	36	63	0	0	0	0	12	33	0	6	3	0	0	0	0	3	0	6	0	6	3	0
34	6	0	0	0	3	0	108	120	0	0	15	0	6	264	0	0	0	0	3	0	0	3	0	27	0	0	0	3
35	0	0	6	0	0	0	108	171	0	0	3	0	0	12	0	0	6	0	12	0	0	6	0	42	3	0	0	57
36	0	0	3	0	0	0	108	210	0	0	0	0	6	15	0	3	12	0	6	6	0	3	0	60	0	3	0	123
37	0	6	9	0	15	0	651	765	0	0	9	0	57	111	0	18	69	0	21	15	6	66	3	345	6	12	0	219
38	0	3	0	0	9	0	279	225	0	0	9	0	15	66	0	12	132	0	3	15	3	33	0	216	6	3	3	294
39	15	0	3	0	9	0	774	744	0	0	39	3	90	96	0	129	309	3	51	30	24	78	9	306	3	18	6	384
40	0	0	0	0	0	0	15	12	0	0	6	0	63	12	0	6	54	0	0	0	0	0	0	3	0	0	3	24
41	0	0	0	0	0	0	120	138	0	0	99	0	108	45	0	12	306	0	69	9	0	3	3	27	0	0	0	9
42	0	0	0	3	9	0	315	255	0	0	51	0	6	981	3	6	75	0	27	27	0	24	0	57	3	3	3	6
43	0	0	0	0	3	0	357	507	3	0	93	0	63	135	0	12	213	0	57	33	0	27	0	111	6	3	3	24
44	0	0	0	0	0	0	564	579	0	0	84	0	207	141	0	9	156	0	57	18	0	45	3	96	0	21	3	21
45	0	0	0	0	0	0	42	48	0	0	9	0	33	21	0	6	33	0	9	6	0	6	0	0	0	3	0	3
46	0	0	0	0	0	0	567	753	0	0	75	0	129	105	0	27	69	6	33	6	0	54	0	153	0	12	6	27
47	0	0	0	0	3	0	195	189	0	0	24	0	39	42	0	6	3	0	18	0	0	6	3	33	0	3	0	3
48	0	0	0	0	0	0	129	183	0	0	18	0	21	9	0	3	12	0	6	3	0	9	0	33	0	6	3	0
49	30	3	6	12	201	0	330	318	0	0	15	0	45	48	0	15	48	0	30	3	0	30	0	126	0	3	6	123
50	0	0	0	0	3	0	204	312	0	0	51	0	231	57	0	9	102	3	45	9	0	21	0	54	3	21	6	15
51	0	0	0	3	6	0	291	390	0	0	93	0	120	42	0	9	255	0	69	0	3	15	0	63	9	9	0	0
52	3	0	0	0	3	0	204	204	0	0	12	0	45	72	3	3	24	0	24	0	0	18	3	57	0	12	9	0

	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0	0	0	0	8586	18	0	0	3	6	3	0	0	0	0	3	0	0	0	3	0	9	0	0	0
1	0	0	0	1884	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
2	0	0	0	1380	3	0	3	0	15	0	9	0	0	3	6	0	0	0	0	0	9	0	0	0
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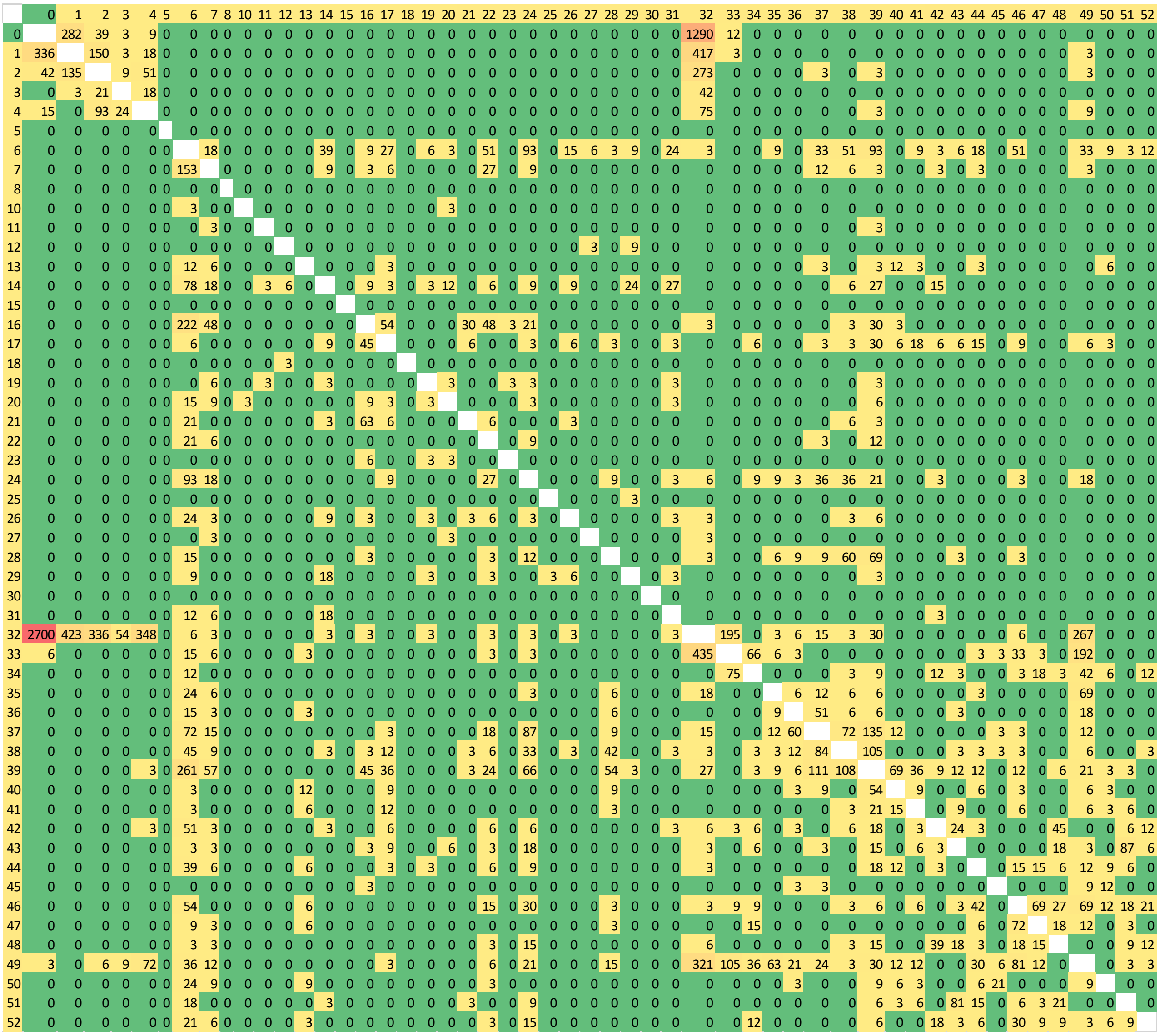
4	3	0	0	738	0	0	0	0	9	3	6	0	0	0	0	0	0	0	0	0	27	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	9	0	27	57	6	36	18	12	114	126	165	3	18	69	51	63	6	117	9	45	117	24	24	15
7	6	0	0	135	21	42	12	15	177	96	78	6	18	84	63	84	12	135	24	36	117	54	42	45
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	3	0	3	0	0	0	3	0	0	3	0	0	0	0	0	0
11	9	0	3	12	0	3	0	0	0	0	6	3	0	3	12	12	0	6	0	0	0	0	6	6
12	18	0	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	9	0	0	15	15	3	0	0	66	3	153	75	117	15	30	54	24	78	6	30	24	186	84	30
14	909	0	744	126	6	39	6	3	12	15	126	3	3	300	36	12	0	27	0	6	18	0	0	12
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	9	0	0	33	3	0	0	0	6	9	117	6	3	3	6	6	0	3	0	0	12	0	0	9
17	198	0	21	15	6	30	3	3	45	18	225	51	231	54	231	114	27	105	0	21	42	45	213	30
18	3	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	24	0	3	24	0	0	0	0	6	3	18	3	0	0	12	0	0	0	0	3	3	0	6	0
20	30	0	9	63	0	0	0	0	0	3	27	0	12	6	12	9	0	0	3	0	6	0	3	6
21	0	0	0	6	0	0	0	0	3	9	24	0	0	0	0	0	3	3	0	0	0	0	0	3
22	0	0	0	6	0	0	0	0	9	3	12	0	3	3	3	0	0	3	0	3	0	3	0	0
23	3	0	0	6	0	0	0	0	3	0	9	0	0	3	0	0	0	0	3	0	0	0	0	0
24	9	0	9	117	9	63	48	33	306	231	219	3	15	27	60	27	6	72	18	12	135	12	24	27
25	3	0	0	3	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0
26	51	0	6	69	0	0	0	0	9	15	30	0	3	0	3	3	3	6	3	0	6	0	0	0
27	6	0	0	3	0	0	0	0	0	0	3	0	0	0	0	0	3	3	3	0	0	0	0	0
28	0	0	0	33	0	3	51	105	243	285	366	9	3	3	21	18	3	45	0	3	81	27	3	0
29		0	24	36	0	0	0	0	6	6	42	0	9	3	12	0	3	3	0	3	3	3	0	0
30	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	27	0		0	0	24	0	0	0	3	0	0	0	81	0	0	0	0	0	0	0	0	0	0
32	51	0	3		1071	21	114	120	450	285	249	9	9	36	60	15	6	75	12	9	4803	6	21	27
33	0	0	0	1293		1023	18	3	0	0	0	3	3	18	3	51	6	234	105	12	1533	15	6	9
34	15	0	45	9	1224		0	0	3	18	48	0	3	912	69	27	0	258	288	96	504	18	12	306
35	3	0	0	99	6	0		96	186	30	72	3	9	18	9	12	0	15	0	0	399	3	6	0
36	6	0	0	63	0	0	69		480	69	129	6	12	3	6	12	3	12	0	6	123	18	6	0
37	24	0	0	432	0	0	102	528		663	1356	42	66	3	60	30	3	84	6	9	228	45	21	3
38	9	0	3	78	0	12	12	63	615		531	12	0	21	27	21	3	27	9	12	57	6	6	6
39	42	0	3	255	12	9	69	153	1209	468		267	105	54	201	132	18	99	9	27	207	69	57	6
40	0	0	0	15	3	3	0	3	51	18	228		120	6	9	18	0	12	3	3	72	69	3	0
41	12	0	0	12	0	3	9	3	54	21	105	147		24	291	78	3	45	3	9	42	180	180	15
42	15	0	90	60	3	378	0	6	6	51	162	0	42		582	18	0	48	12	1350	33	3	123	216
43	21	0	0	99	6	57	9	3	48	30	300	18	282	618		45	18	105	3	606	33	114	2907	45
44	27	0	0	39	3	12	12	12	48	54	264	45	96	12	84		192	690	66	81	459	456	408	66
45	0	0	0	0	0	0	3	3	15	0	30	0	12	0	18	228		48	6	0	90	222	33	6
46	9	0	0	66	90	249	24	45	105	36	174	12	51	45	96	1176	81		2304	624	1377	258	261	354
47	0	0	0	15	120	237	0	3	0	27	45	0	9	9	15	171	6	2553		231	201	63	66	90
48	0	0	0	27	12	60	0	6	12	15	99	0	36	1398	690	105	9	561	246		33	36	441	132
49	9	0	3	4623	1344	555	405	171	300	63	270	90	60	27	15	720	90	1563	198	66		99	51	39
50	24	0	0	9	9	3	9	18	60	15	138	54	207	12	93	204	276	111	0	6	84		111	9
51	21	0	0	12	0	15	3	0	27	33	99	6	186	132	3057	429	30	204	18	396	48	177		45
52	18	0	0	12	9	345	3	6	6	6	72	3	12	204	45	261	6	438	93	186	54	63	66	

Figure 34 OD travel matrix for foreign users (06/06/2021)



	0	1	2	3	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0		282	39	3	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1290	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	336		150	3	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	417	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
2	42	135		9	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	273	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0
3	0	3	21		18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	15	0	93	24		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	9	0	0	0
5	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0		18	0	0	0	0	0	39	0	9	27	0	6	3	0	51	0	93	0	15	6	3	9	0	24	3	0	0	9	0	33	51	93	0	9	3	6	18	0	51	0	0	33	9	3	12
7	0	0	0	0	0	0	153		0	0	0	0	0	9	0	3	6	0	0	0	0	27	0	9	0	0	0	0	0	0	0	0	0	0	0	0	12	6	3	0	0	3	0	3	0	0	0	0	3	0	0	0
8	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	3	0	0		0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	3	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	12	6	0	0	0	0		0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	12	3	0	0	3	0	0	0	0	0	6	0	0
14	0	0	0	0	0	0	78	18	0	0	3	6	0		0	9	3	0	3	12	0	6	0	9	0	9	0	0	24	0	27	0	0	0	0	0	0	6	27	0	0	15	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	222	48	0	0	0	0	0	0	0		54	0	0	0	30	48	3	21	0	0	0	0	0	0	0	3	0	0	0	0	0	3	30	3	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	6	0	0	0	0	0	0	9	0	45		0	0	0	6	0	0	3	0	6	0	3	0	0	3	0	0	6	0	0	3	3	30	6	18	6	6	15	0	9	0	0	6	3	0	0
18	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	6	0	0	3	0	0	3	0	0	0	0		3	0	0	3	3	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	15	9	0	3	0	0	0	0	0	9	3	0	3		0	0	0	3	0	0	0	0	0	0	3	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	21	0	0	0	0	0	0	3	0	63	6	0	0	0		6	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	21	6	0	0	0	0	0	0	0	0	0	0	0	0	0		0	9	0	0	0	0	0	0	0	0	0	0	0	0	3	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	3	3	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	93	18	0	0	0	0	0	0	0	0	9	0	0	0	0	27	0		0	0	0	9	0	0	3	6	0	9	9	3	36	36	21	0	0	3	0	0	0	3	0	0	18	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	24	3	0	0	0	0	0	9	0	3	0	0	3	0	3	6	0	3	0		0	0	0	0	3	3	0	0	0	0	0	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0		0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	0	12	0	0	0		0	0	0	3	0	0	6	9	9	60	69	0	0	0	3	0	0	3	0	0	0	0	0	0
29	0	0	0	0	0	0	9	0	0	0	0	0	0	18	0	0	0	0	3	0	0	3	0	0	3	6	0	0		0	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	12	6	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
32	2700	423	336	54	348	0	6	3	0	0	0	0	0	3	0	3	0	0	3	0	0	3	0	3	0	3	0	0	0	0	3		195	0	3	6	15	3	30	0	0	0	0	0	0	6	0	0	267	0	0	0
33	6	0	0	0	0	0	15	6	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0	435		66	6	3	0	0	0	0	0	0	0	3	3	33	3	0	192	0	0	0
34	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75		0	0	0	3	9	0	0	12	3	0	0	3	18	3	42	6	0	12
35	0	0	0	0	0	0	24	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	6	0	0	0	18	0	0		6	12	6	6	0	0	0	0	3	0	0	0	0	69	0	0	0
36	0	0	0	0	0	0	15	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	9		51	6	6	0	0	0	3	0	0	0	0	0	18	0	0	0
37	0	0	0	0	0	0	72	15	0	0	0	0	0	0	0	0	3	0	0	0	0	18	0	87	0	0	0	9	0	0	0	15	0	0	12	60		72	135	12	0	0	0	0	3	3	0	0	12	0	0	0
38	0	0	0	0	0	0	45	9	0	0	0	0	0	3	0	3	12	0	0	0	3	6	0	33	0	3	0	42	0	0	3	3	0	3	3	12	84		105	0	0	0	3	3	3	3	0	0	6	0	0	3
39	0	0	0	0	3	0	261	57	0	0	0	0	0	0	0	45	36	0	0	0	3	24	0	66	0	0	0	54	3	0	0	27	0	3	9	6	111	108		69	36	9	12	12	0	12	0	6	21	3	3	0
40	0	0	0	0	0	0	3	0	0	0	0	0	12	0	0	0	9	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	3	9	0	54		9	0	0	6	0	3	0	0	6	3	0	0
41	0	0	0	0	0	0	3	0	0	0	0	0	6	0	0	0	12	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	21	15		0	9	0	0	6	0	0	6	3	6	0
42	0	0	0	0	3	0	51	3	0	0	0	0	0	3	0	0	6	0	0	0	0	6	0	6	0	0	0	0	0	0	3	6	3	6	0	3	0	6	18	0	3		24	3	0	0	0	45	0	0	6	12
43	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	3	9	0	0	6	0	3	0	18	0	0	0	0	0	0	0	3	0	6	0	0	3	0	15	0	6	3		0	0	0	0	18	3	0	87	6
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45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0		0	0	0	9	12	0	0
46	0	0	0	0	0	0	54	0	0	0	0	0	6	0	0	0	0	0	0	0	0	15	0	30	0	0	0	3	0	0	0	3	9	9	0	0	0	3	6	0	6	0	3	42	0		69	27	69	12	18	21
47	0	0	0	0	0	0	9	3	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	6	0	72		18	12	0	3	0
48	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	15	0	0	0	0	0	0	0	6	0	0	0	0	0	3	15	0	0	39	18	3	0	18	15		0	0	9	12
49	3	0	6	9	72	0	36	12	0	0	0	0	0	0	0	0	3	0	0	0	0	6	0	21	0	0	0	15	0	0	0	321	105	36	63	21	24	3	30	12	12	0	0	30	6	81	12	0		0	3	3
50	0	0	0	0	0	0	24	9	0	0	0	0	9	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	9	6	3	0	0	6	21	0	0	0	9		0	0
51	0	0	0	0	0	0	18	0	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	3	6	0	81	15	0	6	3	21	0	0		0
52	0	0	0	0	0	0	21	6	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0	15	0	0	0	0	0	0	0	0	0	12	0	0	0	0	6	0	0	18	3	6	0	30	9	9	3	6	9	

Figure 35 OD travel matrix for Italian users (06/06/2021)

In addition to the OD travel matrix, it has been prepared, as an illustration and visualization of the retention of users in space, a heat map for Italian users. Since the heat map shows the concentration of users in space, it cannot be created aggregated, but is made for illustration purposes in this report for a time period from 08:30. Examples heat maps is shown in Figure 36 to Figure 38.

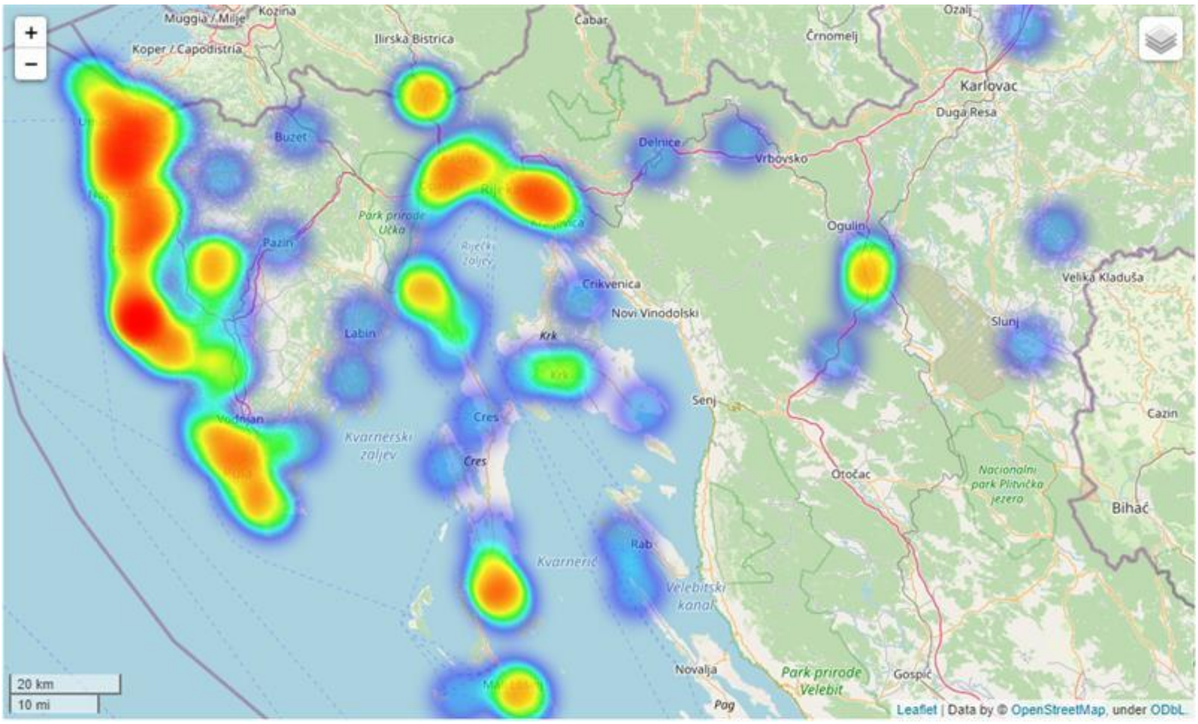
Muggia / Milje
Kozina
Koper / Capodistria
Ilirska Bistrica
Čabar
Črnomelj
Ozalj
Karlovac
Duga Resa
Buzet
Delnice
Vrbovsko
Pazin
Park prirode Učka
Riječki zaljev
Crikvenica
Novi Vinodolski
Ogulin
Veliká Kladuša
Slunj
Labin
Krk
Senj
Cres
Vodnjan
Kvarnerski zaljev
Otočac
Nacionalni park Plitvička jezera
Cazin
Bihać
Rab
Kvarnerić
Velebitski kanal
Novalja
Park prirode Velebit
Gospić
Pag
20 km
10 mi
Leaflet | Data by © OpenStreetMap, under ODbL.

Figure 36 Heatmap of population concentration in space - Italian users (03/06/2021, 08:30 am)

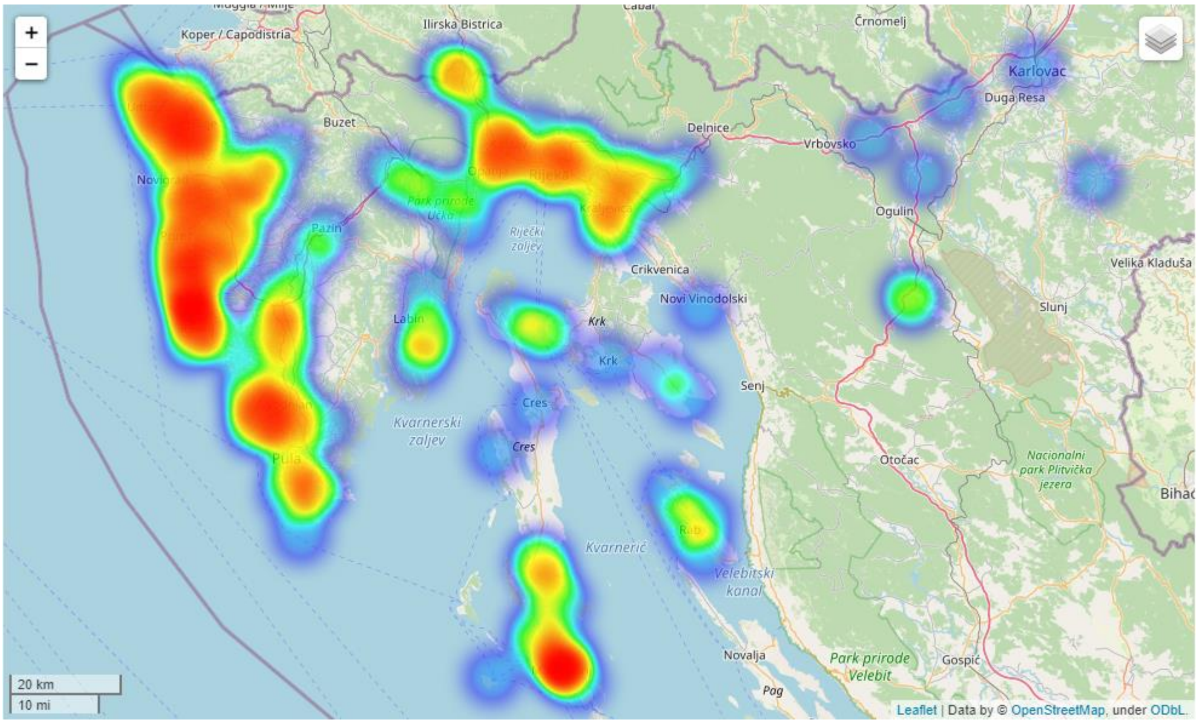
Koper / Capodistria
Ilirska Bistrica
Črnomelj
Karlovac
Duga Resa
Buzet
Delnice
Vrbovsko
Novigrad
Ogulin
Pazin
Park prirode Učka
Riječki zaljev
Crikvenica
Veliká Kladuša
Novi Vinodolski
Slunj
Labin
Krk
Senj
Cres
Kvarnerski zaljev
Pula
Otočac
Nacionalni park Plitvička jezera
Bihać
Rab
Kvarnerić
Velebitski kanal
Novalja
Park prirode Velebit
Gospić
Pag
20 km
10 mi
Leaflet | Data by © OpenStreetMap, under ODbL.

Figure 37 Heatmap of population concentration in space - Italian users (04/06/2021, 08:30 am)

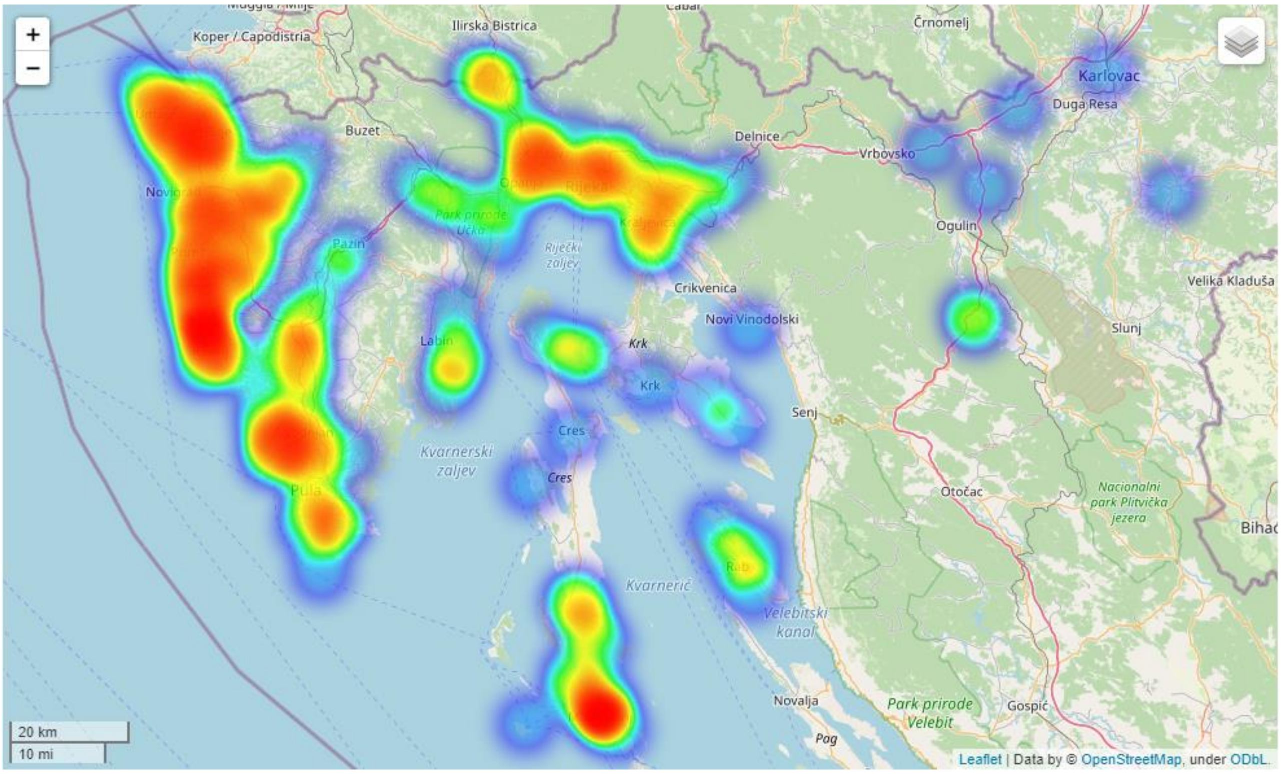
Koper / Capodistria
Ilirska Bistrica
Črnomelj
Karlovac
Duga Resa
Buzet
Delnice
Vrbovsko
Novigrad
Park prirode Učka
Pazin
Ogulin
Riječki zaljev
Crikvenica
Velika Kladuša
Novi Vinodolski
Slunj
Labin
Krk
Krk
Senj
Cres
Kvarnerski zaljev
Cres
Pula
Otočac
Nacionalni park Plitvička jezera
Rab
Kvarnerić
Velebitski kanal
Novalja
Pag
Park prirode Velebit
Gospić
20 km
10 mi
Leaflet | Data by © OpenStreetMap, under ODbL.

Figure 38 Heatmap of population concentration in space - Italian users (06/06/2021, 08:30 am)

The attached image contains actual data and serves as an illustration of possibilities of analytics. The Web-GIS tool with related data will enable the conduct of various analyses and combinations of views in accordance with the actual analytical needs.

To demonstrate the possibilities of analytics, separate analytics has been created for one area of interest – the Rijeka Airport.

An example of analytics includes an analysis of the number of users in the zone per hour, and the histogram for all users, domestic users, foreign users, and only Italian users for the day 3 June 2021 is shown in Figure 39 to Figure 43.

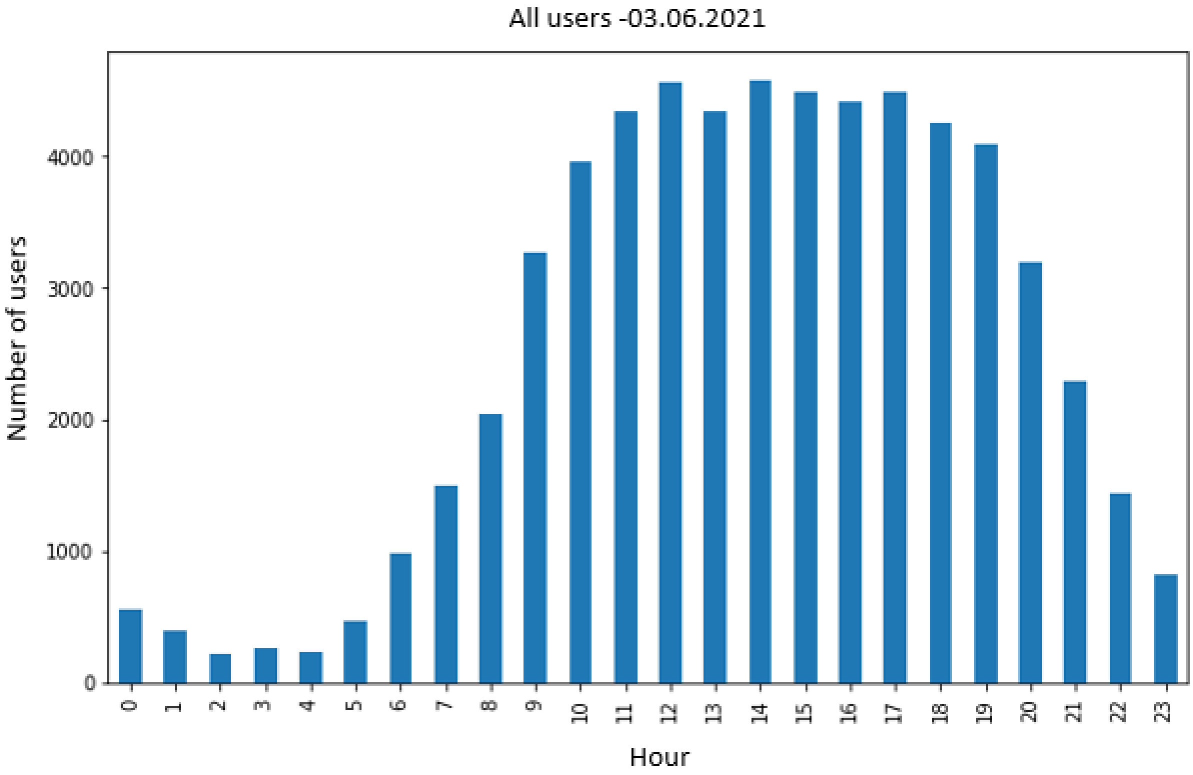

Figure 39 Number of users in the zone per hour, histogram for all users

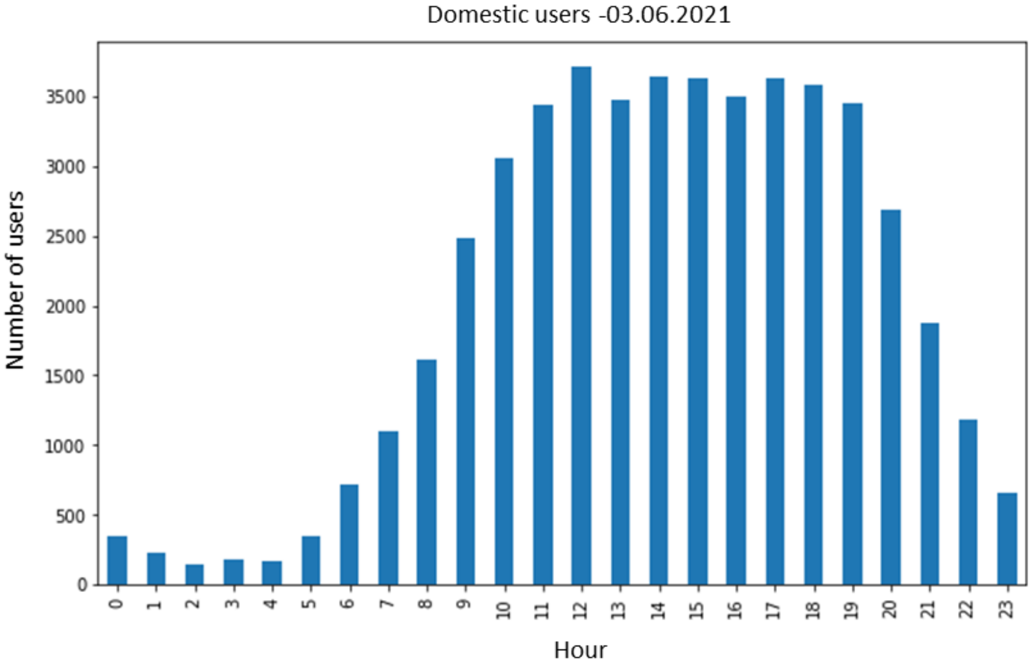

Figure 40 Number of users in the zone per hour, histogram for domestic users

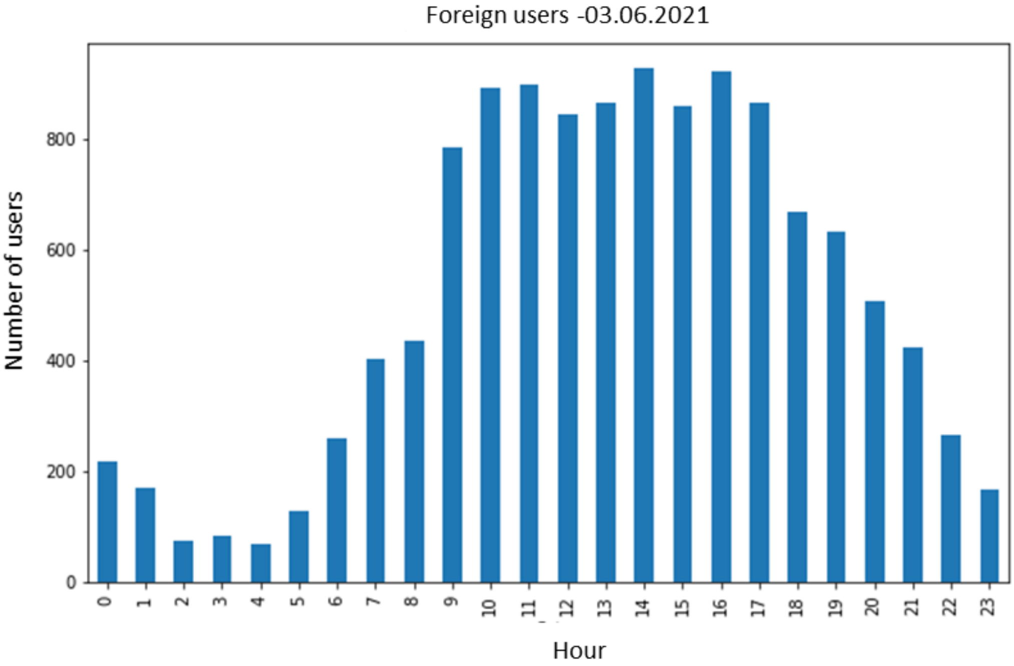

Figure 41 Number of users in the zone per hour, histogram for foreign users

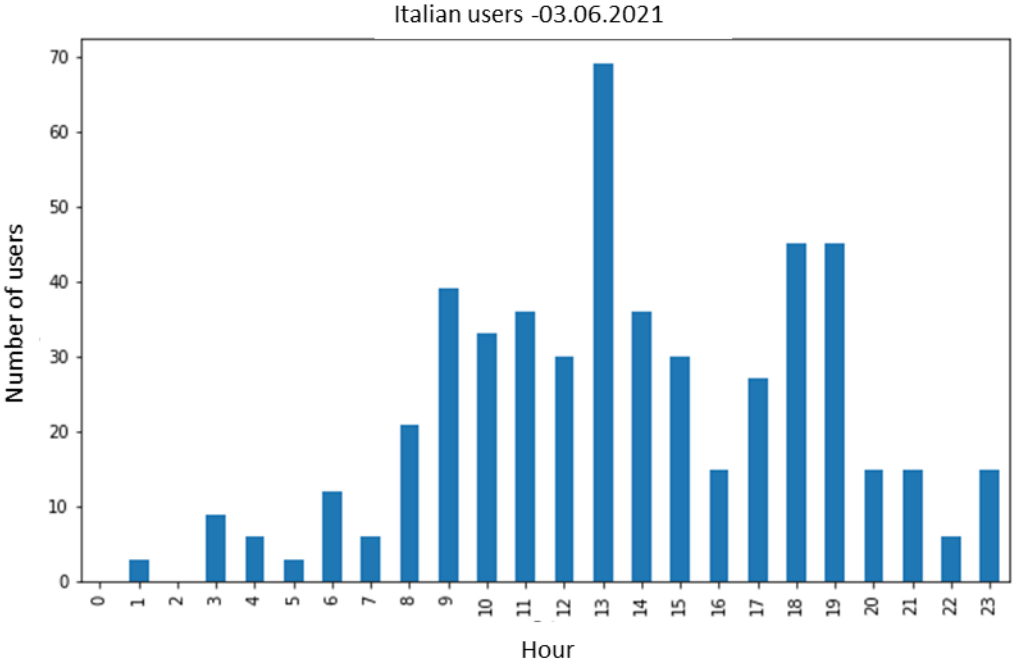

Figure 42 Number of users in the zone per hour, histogram for Italian users

It is possible to carry out different types of analyses. An example is the analysis of the number of arrivals at the airport by plane, other means of transport, analysis of departures from the airport, and the like. An example of analytics for the number of arrivals at the airport, but not by airplane, in the form of histograms for all users for the day 3 June 2021 is shown in Figure 29.

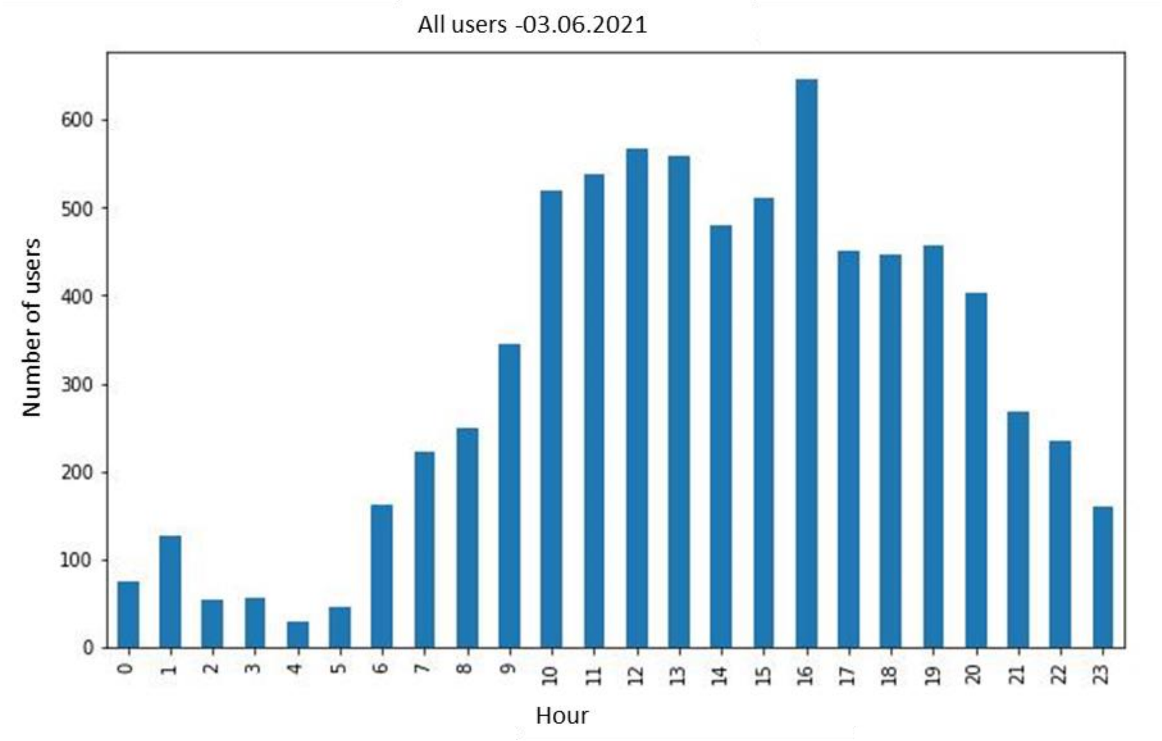

Figure 43 Number of arrivals at the airport, but not by airplane, histogram for all users

The following visualisations show the gravitation area of the Rijeka Airport. The first visualisation (Figure 44) shows where people come from at the Rijeka Airport (Rijeka Airport is their travel destination), at the level of the coverage area.

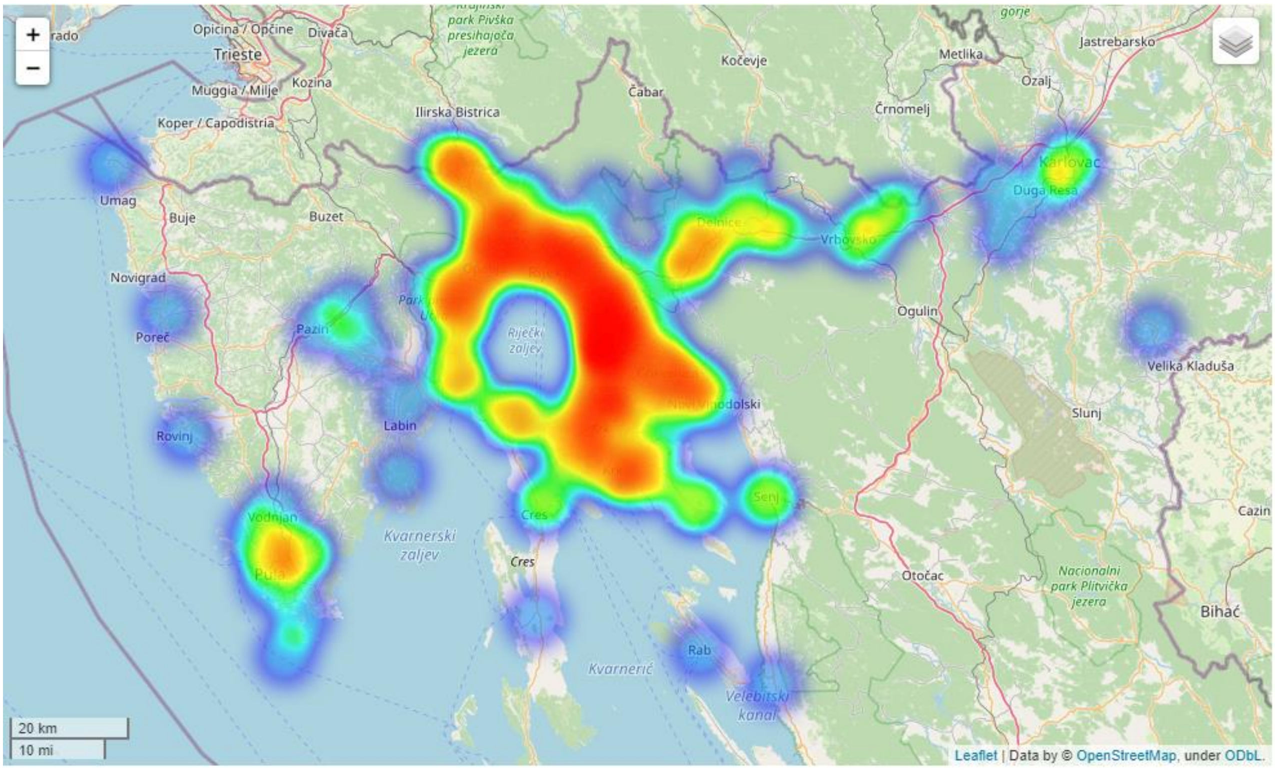
+
−
Opicina / Općine
Divača
Trieste
Muggia / Milje
Kozina
Koper / Capodistria
Ilirska Bistrica
park Pivška presihajoča jezera
Kočevje
Čabar
Metlika
Jastrebarsko
Ozalj
Črnomelj
Karlovac
Duga Resa
Umag
Buje
Buzet
Delnice
Vrbovsko
Novigrad
Poreč
Pazin
Riječki zaljev
Ogulin
Velika Kladuša
Crikvenica Vinodolski
Slunj
Rovinj
Labin
Cres
Senj
Cazin
Vodnjan
Pula
Kvarnerski zaljev
Otočac
Nacionalni park Plitvička jezera
Bihać
Rab
Kvarnerić
Velebitski kanal
20 km
10 mi
Leaflet | Data by © OpenStreetMap, under ODbL.

Figure 44 Gravitation area of the Rijeka Airport – heat map of the area where people come from to the Rijeka Airport – the coverage area

The second visualisation (Figure 45) shows where people went to from the Rijeka Airport (Rijeka Airport is their source or beginning of travel), at the level of the coverage area.

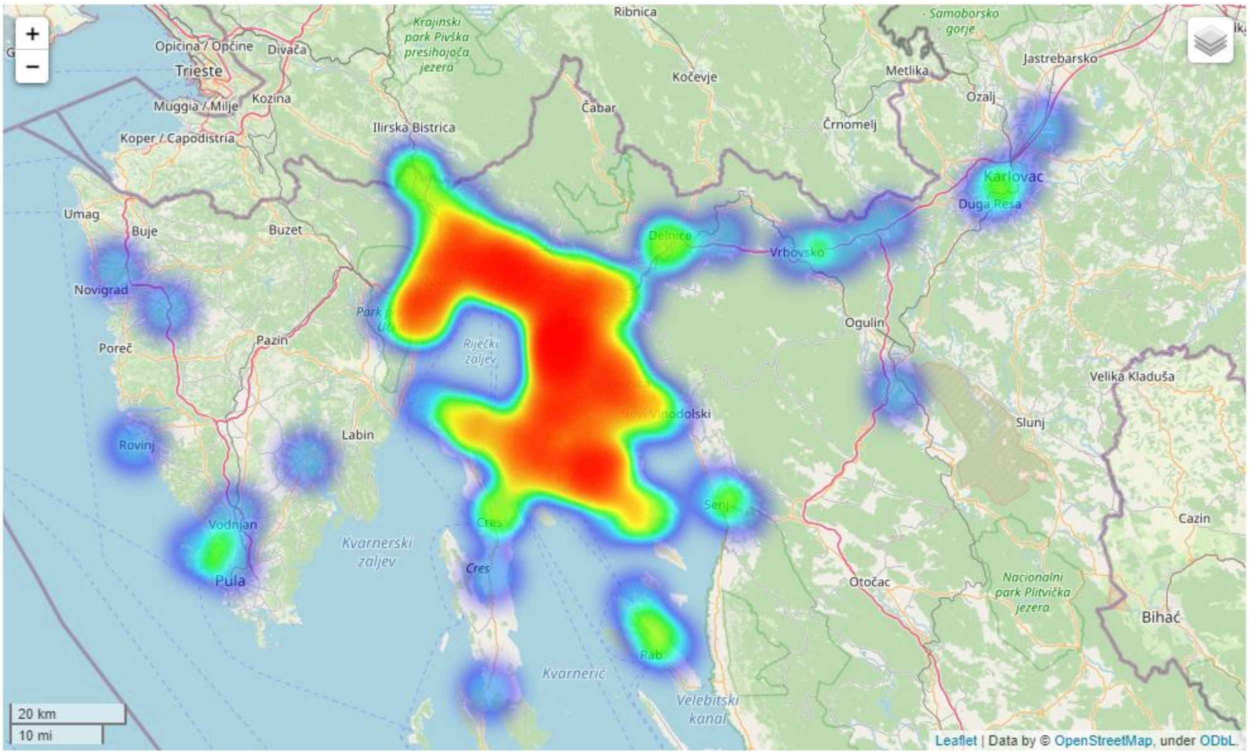
Trieste
Opicina / Općine
Divača
Muggia / Milje
Kozina
Koper / Capodistria
Krajinski park Pivška presihajoča jezera
Ilirska Bistrica
Ribnica
Kočevje
Čabar
Samoborsko gorje
Metlika
Jastrebarsko
Ozalj
Črnomelj
Karlovac
Duga Resa
Delnice
Vrbovsko
Ogulin
Umag
Buje
Buzet
Novigrad
Poreč
Pazin
Riječki zaljev
Novi Vinodolski
Velika Kladuša
Slunj
Rovinj
Labin
Vodnjan
Pula
Kvarnerski zaljev
Cres
Senj
Cazin
Otočac
Nacionalni park Plitvička jezera
Bihać
Rab
Kvarnerić
Velebitski kanal
20 km
10 mi
Leaflet | Data by © OpenStreetMap, under ODbL.

Figure 45 Gravitation area of the Rijeka Airport – heat map of the area where people go to from the Rijeka Airport – the coverage area

These analyses will be possible for selected zones within the web GIS tool.

5 Web-GIS visualization tool functionality description

This chapter defines a list of functionalities of the Web-GIS visualisation tool according to the requirements in the MIMOSA project task. The Web-GIS tool is used to visualise, display, and generate reports based on information obtained by analysing anonymised datasets.

The Web-GIS Tool will enable stakeholders to perform dedicated queries and create reports and visualization on population migration within the analysed area. They will be able to perform analysis on collected data using several criteria like time frame for analysis, transport modes, types of user, etc., or any wanted combination (i.e., draw desire lines among chosen zones for typical day during the summer seasons only for Italian users arrived by car). This application and data will be used primarily for key public stakeholders as a strategical decision support tool for transport planning.

The following basic functionalities of the application are defined:

- The application will be available through the web interface
- The application will include support for different levels of users, depending on the level of powers available. All users will be able to perform all analytical functionalities described in this requirements list. Advanced users will be able to manually edit predefined zones etc… User roles and its allowed operation are configurable and can be changed if required.
- Access to the application will be protected by username and password
- The application will have the possibility to display the geographical map as background
- The application will include (where applicable) the possibility to display the spatial decomposition defined by the project (local self-government units)
- The application will have (where applicable) the possibility to display the locations of transport terminals and other defined points of interest (e.g. ports, stations, airports, border crossings...) and their associated geographic interest zones
- The application will have the possibility to export data in graphic format (e.g. jpeg, pdf...) and in numerical format (e.g. csv). All such generated data reports can be used according to conditions defined by Prigoda.
- The application will have the possibility to generate statistical reports in numerical and graphic formats
- The application will have the option to select the analytics through a menu or by direct selection on the map
- The application will have a menu by which the user will define and configure the type of analysis
- The application menu will be multilingual (Croatian, English, and Italian)

All functionalities of the Web-GIS tool will be organized into the following modules:

- Motion visualization module for OD travel matrix
- Motion visualization module for transport terminals and other defined points of interest (e.g., ports, terminals, airports, border crossings...)
- Module for the visualization of average time of remaining in space

The WEB GIS visualisation tool will enable the following types of analysis and display:

- **Motion visualization module for OD travel matrix**
  - **Display mode**
    - View of the OD travel matrix on a map
    - View the OD travel matrix in tabular format
    - Zone-by-zone load visualization (like desire lines)
  - **Local self-government units selection method**
    - Selection on the map or from the menu
    - By entering identification data (entry of the ID, selection from the list) Origin zone, Destination zone, group Origin-Destination zones, POI zone...
  - **Type of analytics**

        - For all trips
        - For a particular mode of transport
        - For different categories of users (e.g., domestic, foreign, Italian...)
        - For a specific period of time (in a day)
        - Use of absolute values
        - Use of percentages
        - Filter by values (show greater than and the like...)
        - Use multiple criteria (e.g., show foreign users with cars)

- **Motion visualization module for transport terminals and other defined points of interest (e.g. ports, stations, airports, border crossings...) - POI**
    - **Display mode**
        - View on map
        - Tabular view
        - Visualization of loads by terminals and points of interest
    - **POI selection method**
        - Selection on the map or from the menu
        - By entering identification data (entry of the ID, selection from the list) Origin zone, Destination zone, group Origin-Destination zones, POI zone...
    - **Type of analytics**
        - For all trips
        - For a particular mode of transport
        - For different categories of users (e.g., domestic, foreign, Italian...)
        - For a specific period of time (in a day)
        - Use of absolute values
        - Use of percentages
        - Filter by values (show greater than and the like...)
        - Use multiple criteria (e.g., show foreign users with cars)
- **Module for the visualization of average time of remaining in space**
    - **Display mode**
        - Heat Map view
        - Tabular view
        - View the number of people in local self-government units
    - **Selection mode**
        - Selection on the map or from the menu
    - **Type of analytics**
        - For all trips
        - For a particular mode of transport
        - For different categories of users (e.g., domestic, foreign, Italian...)
        - For a specific period of time (in a day)

- Use of absolute values
- Use of percentages
- Filter by values (show greater than and the like...)
- Use multiple criteria (e.g., show foreign users with cars)

The system manual is attached to this document as Annex 2.

6 Conclusion

The present report, developed within the project "MIMOSA – MarItime and MultimOdal Sustainable pAssenger transport solutions and services", contains a definition of the methodology and collection and summary of analysis of data from the mobile telecommunications network that will be used in order to improve the multimodal transport offers between the targeted regions. The report contains a description of the methodology, a description of privacy policy, and a summary report based on the analysis of two sets of data.

The SumBOOST (Sustainable Urban Mobility Toolbox) methodology was selected as the target methodology for conducting the analysis, that defines the necessary steps in the implementation of the analysis and the link between the analysis of the big dataset and other available documents and datasets. The defined methodology has been scientifically validated and its application will ensure the comparability of the results of the analyses to be carried out for the target periods defined by the project task.

The report contains a summary of the results of the big datasets analysis for one target period in the previous year, which will be used to compare the results of the 2021 analyses. The second part of the report also contains a summary of the results of the analysis of mass data sets for one target period in 2021, for key characteristic days. The OD travel matrices for all users, for foreign users, and for Italian users were presented for characteristic days which include also the public holiday, i.e. the "long weekend". The dates selected were 3, 4, and 6 June. Afterwards the heat maps of the concentration of the population in the space were presented, for Italian users and for the same specified dates. For the additional area, the area of the Rijeka Airport, an additional demonstration analytics was made which includes the analytics of the number of users in the zone per hour. Moreover, the analytics of the gravitation area of Rijeka Airport is presented in the form of a heat map of the area from which people come to the Rijeka Airport within the coverage area, as well as the analytics of the gravitation area of the Rijeka Airport as a heat map of the area where people go to from the Rijeka Airport within the coverage area.

One of the key goals of this MIMOSA project was to establish a decision-making platform, which consists of analyzed big data sets for predefined time periods and Web GIS tool. The Web-GIS tool will be used to visualize, display, and generate reports based on information obtained by analyzing anonymized datasets. Web-GIS Tool will enable stakeholders to perform dedicated queries and create reports and visualization on population migration within the analyzed area. They will be able to perform analysis on collected data using several criteria like time frame for analysis, transport modes, types of user, etc., or any required combination (i.e., draw desire lines among all or only selected zones for typical working day during the summer seasons only for Italian users travelled by car during the morning). This example in brackets shows the complexity

of potential analytical requirements, which can be addressed only with appropriate interactive analytical tool.

Therefore, the summary of analysis presented in this report are an example of the analytical possibilities. All analytical possibilities of the collected data, including the visualization, will be available through the online Web-GIS tool upon its delivery in the final phase of the project, as described in chapter Web-GIS tool functionality description.

Within this project, different lessons have been learnt, in particular in relation to operational aspects regarding the utilization of big data in transportation planning. The main conclusion is that approach that combines big data science methods with traditional methodologies is appropriate and applicable for transport planning and that the symbiose of those methods can significantly improve conventional research. Appropriately anonymized and processed mobile network data has proven to be an important data set that can be utilized for mobility planning and optimization.

During the application of the methodology, it was found that the big data set sometimes provides a more detailed database than required for understanding of transport system. The big data detects all the trips that user makes during the day. It records all type of movement, short trips within the zone or even short recreative walking. That kind of movement are usually not the transport research objective. Also, since the mobile phone penetration is continuously rising and since mobile telecom users are spending more time actively using their devices, the data available for research is becoming more massive, resulting with the fact that mobile network user footprint is becoming more complete since there is more data available to reconstruct potential movement with potential data gaps decreasing. Also, the evolution of mobile network generations (majority of users in urban environment is using 4G network, 5G is on the rise) supports intentions to decrease position error and enhance positioning accuracy, since the position accuracy is key input parameter that directly influence the overall analysis results. Therefore, this methodology can be considered as futureproof since every new generation will bring enhancement in terms of position determination, which will result in more accurate analysis.

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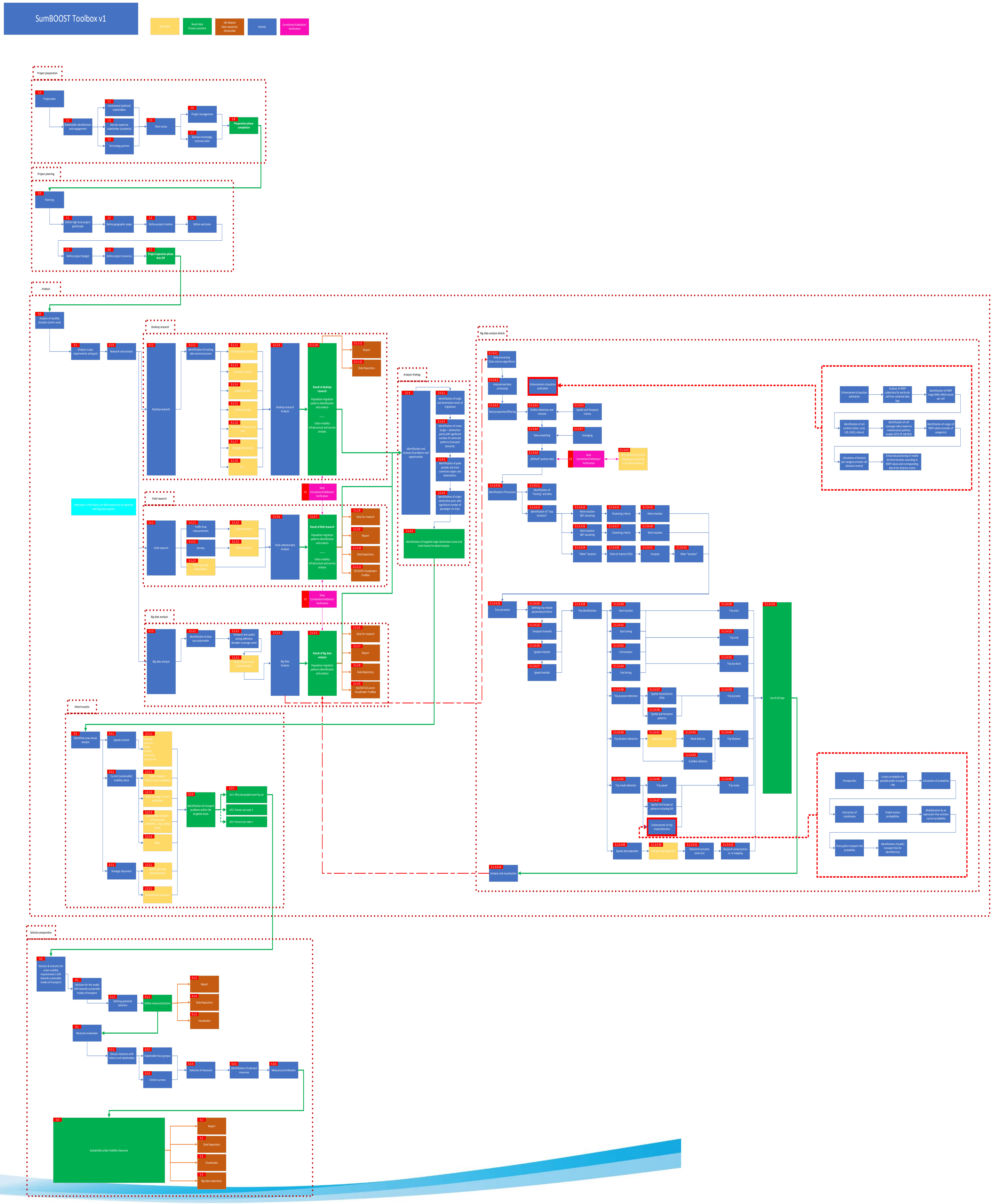
Annex 1. SUMBooST Toolbox detail methodology scheme


SumBOOST Toolbox v1
Input data
Result data Process outcome
SW Module Data repository Deliverable
Activity
Correlation/Validation/ Verification
Project preparation
1.0 Preparation
1.1 Stakeholder identification and engagement
1.2 Institutional (political) stakeholders
1.3 Domain expertise stakeholder (academia)
1.4 Technology partner
1.5 Team setup
1.6 Project management
1.7 Domain knowledge, technical skills
1.8 Preparation phase completion
Project planning
2.0 Planning
2.1 Define high level project goal/scope
2.2 Define geographic scope
2.3 Define project timeline
2.4 Define work plan
2.5 Define project budget
2.6 Define project resources
2.7 Project operation phase Kick Off
Analysis
3.0 Analysis of mobility situation (entire area)
3.1 Analysis scope, requirements and goals
3.1.0 Research and analysis
Desktop research
3.1.1 Desktop research
3.1.1.1 Identification of existing data owners/sources
3.1.1.2 Demographical analysis
3.1.1.3 Economic activity
3.1.1.4 Spatial content
3.1.1.5 Traffic flow data
3.1.1.6 Transport infrastructure data
3.1.1.7 Strategic documents
3.1.1.8 Etc...
3.1.1.9 Desktop research Analysis
3.1.1.10 Result of desktop research Population migration patterns identification and analysis —— Urban mobility infrastructure and service analysis
3.1.1.11 Report
3.1.1.12 Data Repository
V1 Data Correlation/Validation/ Verification
Potentialy, in the future, on-field research to be replaced with big data anaylsis
Field research
3.1.2 Field research
3.1.2.1 Traffic flow measurements
3.1.2.2 Surveys
3.1.2.3 Interview with stakeholders
3.1.2.4 Data collection
3.1.2.5 Data collection
3.1.2.6 Field collected data Analysis
3.1.2.7 Result of field research Population migration patterns identification and analysis —— Urban mobility infrastructure and service analysis
3.1.2.8 Data for research
3.1.2.9 Report
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3.1.2.11 GIS DATA Visualisaton ToolBox
V2 Data Correlation/Validation/ Verification
Big data analysis
3.1.3 Big data analysis
3.1.3.1 Identification of data source/provider
3.1.3.2 Temporal and spatial zoning definition (broader coverage zone)
3.1.3.3 Data collection and anonymisation
3.1.3.4 Big Data Analysis
3.1.3.5 Result of big data analysis Population migration patterns identification and analysis
3.1.3.6 Data for research
3.1.3.7 Report
3.1.3.8 Data Repository
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Analysis findings
3.1.4 Identification and analysis of problems and opportunities
3.1.4.1 Identification of origin and destination zones of migrations
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3.1.4.3 Identification of peak periods and most commons origins and destinations.
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3.1.4.5 Identification of targeted origin-destination zones and time frames for detail analysis.
Big data analysis details
3.1.3.4.1 Data processing (Data science algorithms)
3.1.3.4.2 Anonymized data processing
Enhancement of position estimation
3.1.3.4.3 Data preparation/filtering
3.1.3.4.4 Outliers detection and removal
3.1.3.4.5 Spatial and Temporal criteria
3.1.3.4.6 Data smoothing
3.1.3.4.7 Averaging
3.1.3.4.8 „Refined" position data
V3 Data Correlation/Validation/ Verification
3.1.3.4.9 TEST DEVICE GPS DATA (statistical positioning error determination)
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3.1.3.4.11 Identification of "moving" activities
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Enhancement of position estimation
Analysis of RSRP collections for particular cell from collected data logs
Identification of RSRP range (MIN; MAX) values per cell
Identification of cell context (urban, rural, LOS, NLOS, indoor)
Identification of cell coverage radius based on mathematical pathloss models (ETSI TR 138 901)
Identification of ranges of RSRP values (number of categories)
Calculation of distance per category and per cell (distance matrix)
Enhanced positioning of mobile terminal location according to RSRP values and corresponding data from distance matrix
Prerequisites
A priori probability for possible public transport ride
Calculation of probability
Exctraction of coordinates
Visited sectors probabilities
Multiplication by an expression that contains a priori probability
Final public transport ride probability
Identification of public transport line for identified trip
Detail anaylsis
3.2 Identified zones detail analysis
3.2.1 Spatial content
3.2.1.1 Housing Industry Shops Centers University Leisure, etc.
3.2.2 Current (sustainable) mobility status
3.2.2.1 Public transport infrastructure availability
3.2.2.2 Public transport service availability
3.2.2.3 Sustainable transport infrastructure availability... (eg. Cycling lanes)
3.2.2.4 Other
3.2.3 Strategic document
3.2.3.1 Spatial planning documentation
3.2.3.2 Development strategies
3.2.4 Identification of transport problems within the targeted zones
3.2.5 UC1: Why do people travel by car
UC2: Future use case 2
UCn: Future use case n
Solution preparation
4.0 Solution & scenarios for urban mobility improvement (shift towards sustainable modes of transport)
4.1 Solutions for the modal shift towards sustainable modes of transport
4.1.1 Defining potential solutions
4.1.2 Define measures/actions
4.1.3 Report
4.1.4 Data Repository
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4.2 Measures evaluation
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5.0 Sustainable urban mobility measures
5.1 Report
5.2 Data Repository
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Annex

Ericsson Nikola Tesla

Project Mimosa

User Manual

Project “MIMOSA”
Analysis of traffic flows, needs and habits of residents of the Primorje-Gorski Kotar County and cross-border passengers to regional destinations

Interreg
Italy - Croatia
MIMOSA
EUROPEAN UNION

This Annex document consists of user manual for software solution developed for project Mimosa.

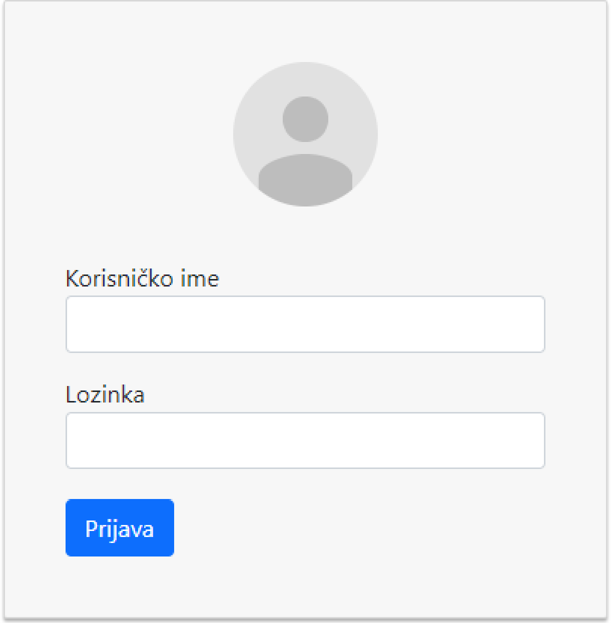
This manual is the first version of document.

The „Prigoda" has three months for beta usage of this tool (which might result with functional and operational modifications), and final version of manual will be delivered following the end od test period.

The final version of manual might differ from this deliverable.

Login

- When accessing on secured page, user is asked to enter username and password in browser popup



Korisničko ime
Lozinka
Prijava

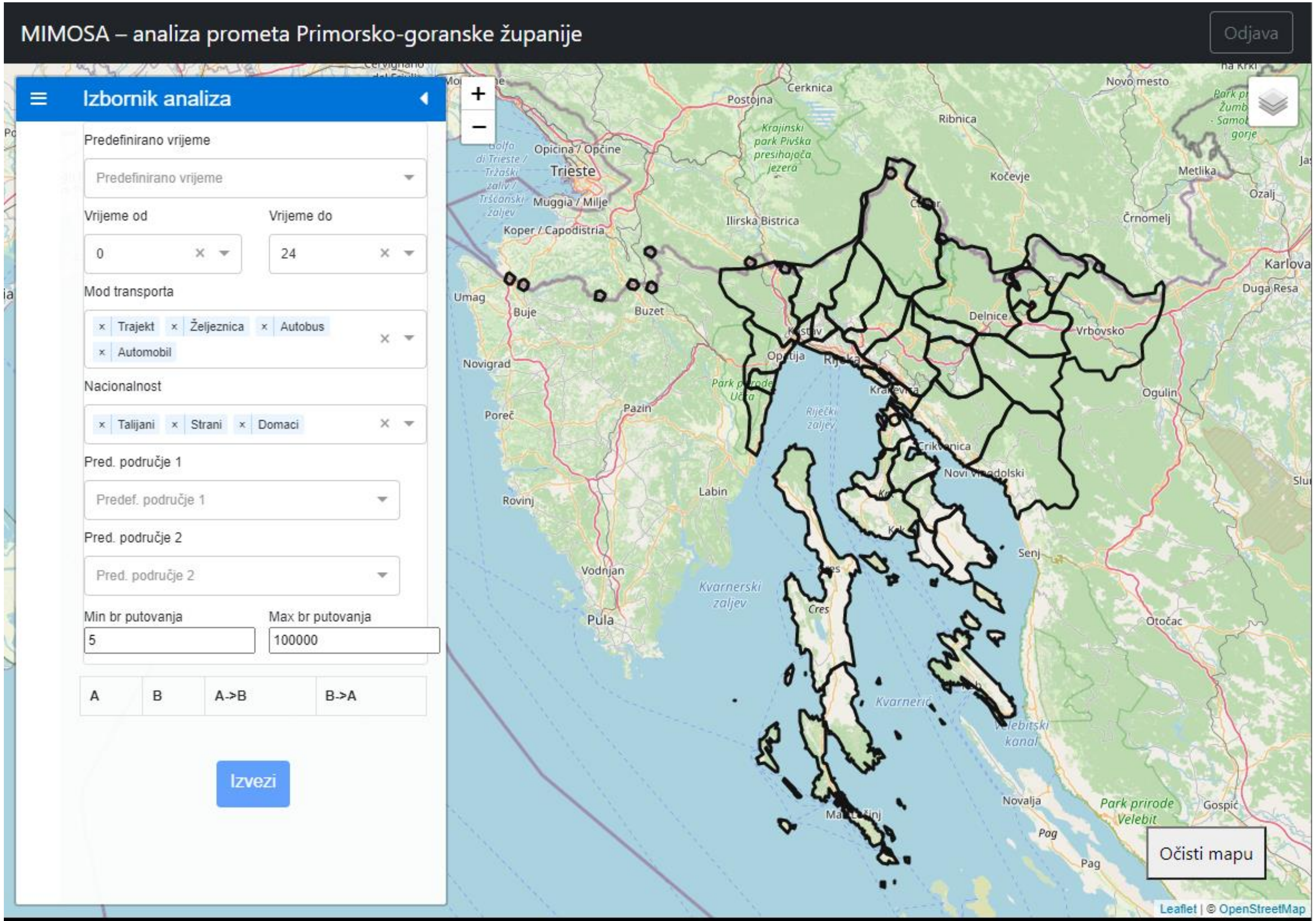
- Obtaining login credentals: Login credentals will be provided by administrator

Software modules:

- Software solution is modular application. This version consists of following modules

1. **Origin-Destination Matrix**
   - Tool for visualization and reporting on population migrations among spatially defined locations
2. **Heat-maps**
   - Tool for spatial graphical representation of transport and logistics data including gravitational area where the individual values are represented as colors

Origin-Destination Matrix



MIMOSA – analiza prometa Primorsko-goranske županije

Izbornik analiza

Predefinirano vrijeme: Predefinirano vrijeme

Vrijeme od: 0

Vrijeme do: 24

Mod transporta: Trajekt, Željeznica, Autobus, Automobil

Nacionalnost: Talijani, Strani, Domaci

Pred. područje 1: Predef. područje 1

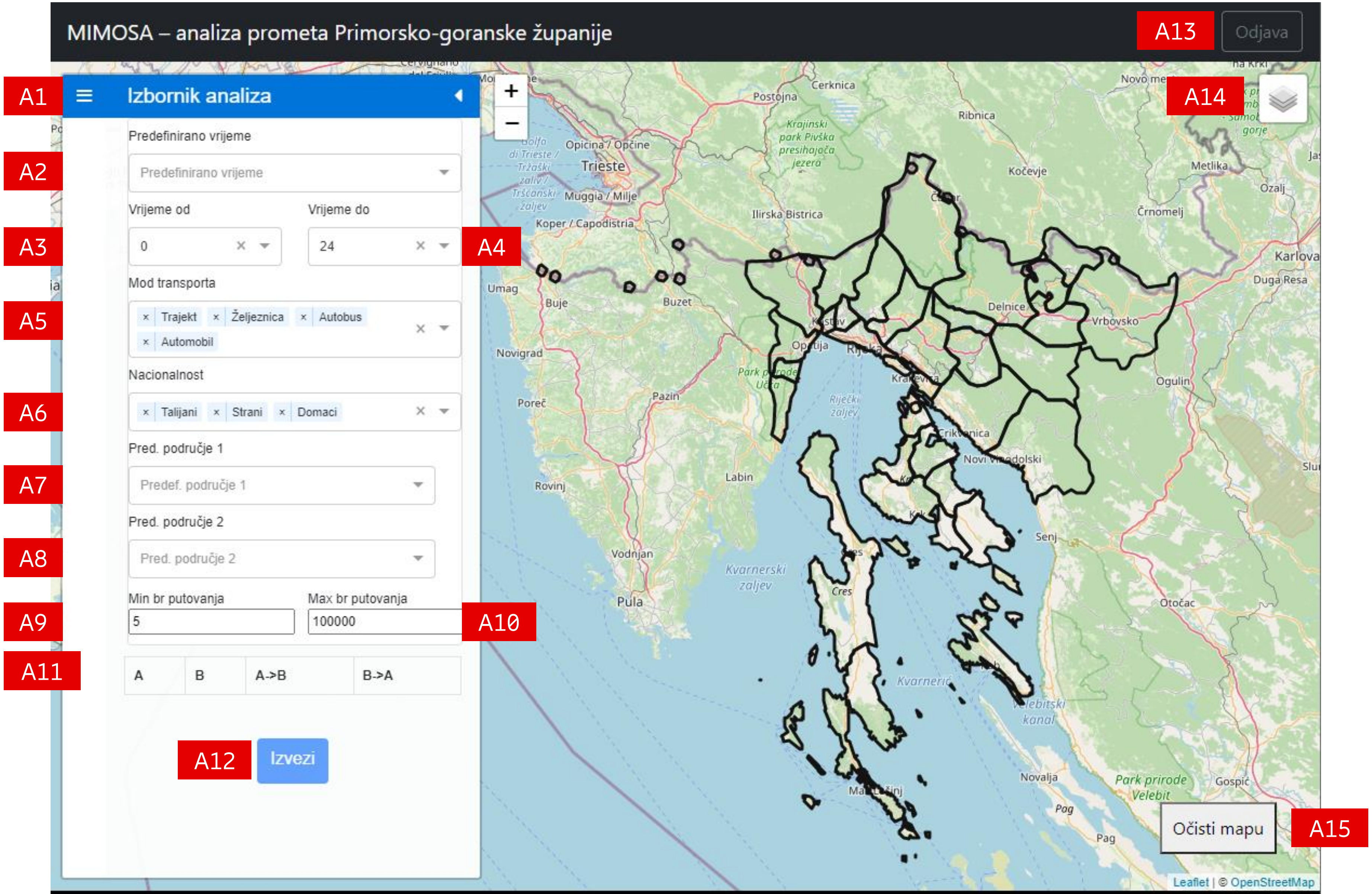
Pred. područje 2: Pred. područje 2

Min br putovanja: 5

Max br putovanja: 100000

Odjava
A
B
A->B
B->A
Izvezi
Očisti mapu
Leaflet | © OpenStreetMap
Postojna
Cerknica
Novo mesto
Ribnica
Kočevje
Metlika
Črnomelj
Ozalj
Karlovac
Duga Resa
Trieste
Muggia / Milje
Koper / Capodistria
Ilirska Bistrica
Umag
Buje
Buzet
Novigrad
Poreč
Pazin
Rovinj
Labin
Vodnjan
Pula
Opatija
Rijeka
Delnice
Vrbovsko
Ogulin
Crikvenica
Novi Vinodolski
Senj
Cres
Kvarnerski zaljev
Kvarnerić
Velebitski kanal
Otočac
Novalja
Pag
Gospić
Park prirode Velebit
Krajinski park Pivška presihajoča jezera
Park prirode Učka
Riječki zaljev

User interface



MIMOSA – analiza prometa Primorsko-goranske županije

Izbornik analiza

Predefinirano vrijeme: Predefinirano vrijeme

Vrijeme od: 0

Vrijeme do: 24

Mod transporta: Trajekt, Željeznica, Autobus, Automobil

Nacionalnost: Talijani, Strani, Domaci

Pred. područje 1: Predef. područje 1

Pred. područje 2: Pred. područje 2

Min br putovanja: 5

Max br putovanja: 100000

A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
Odjava
A
B
A->B
B->A
Izvezi
Očisti mapu
+
−
Trieste
Koper / Capodistria
Umag
Buje
Buzet
Novigrad
Poreč
Pazin
Rovinj
Labin
Vodnjan
Pula
Opatija
Rijeka
Kraljevica
Crikvenica
Novi Vinodolski
Senj
Delnice
Vrbovsko
Ogulin
Otočac
Novalja
Pag
Gospić
Cres
Kvarnerski zaljev
Kvarneric
Velebitski kanal
Postojna
Cerknica
Ribnica
Kočevje
Ilirska Bistrica
Metlika
Ozalj
Črnomelj
Karlovac
Duga Resa
Leaflet | © OpenStreetMap

User interface – Menu description

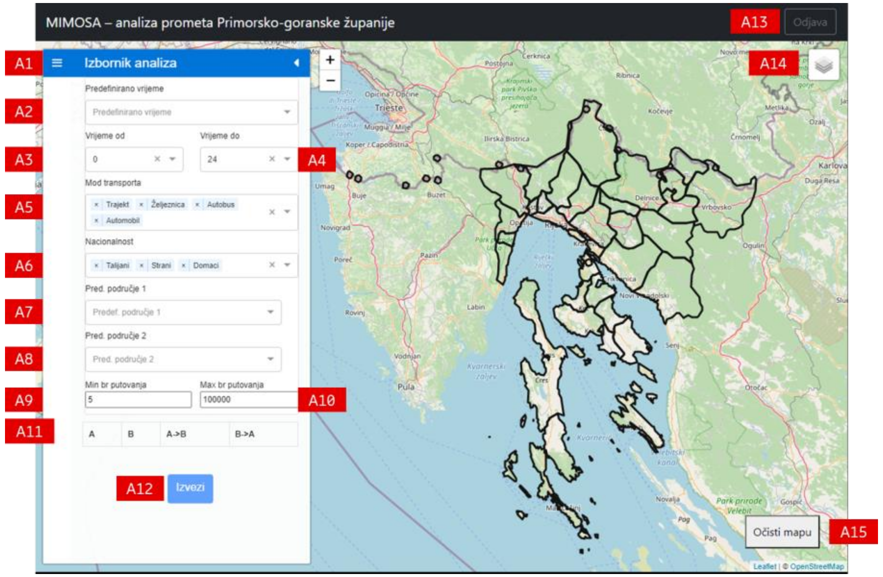
1. Analysis menu
2. Preset time selection
3. Selection of the predefined start time of the analysis
4. Selection of the predefined end time of the analysis
5. Choice of transport mode
6. Selection of nationality
7. Selection of a predefined area 1
8. Selection of predefined area 2
9. Minimum trip filter
10. Maximum trip filter
11. Table with numerical results
12. Data export control (figure or table)
13. Logout button
14. Selection of cartographic background layer
15. Clear map button

Origin-Destination Matrix: Operations

1. Show movements between pair of selected sectors
2. Show movements between group of sectors
3. Show movements between group of predefined sectors
4. Show sector info
5. Download movements information

1. Show movements between pair of selected sectors

1. A1. Analysis menu
2. A2. Preset time selection
3. A3. Selection of the predefined start time of the analysis
4. A4. Selection of the predefined end time of the analysis
5. A5. Choice of transport mode
6. A6. Selection of nationality
7. Hold CTRL key and select origin sector on map
8. Hold ALT key and select destination sector on map
9. Number of trips between selected sectors is shown on map and in table A11


MIMOSA – analiza prometa Primorsko-goranske županije

Izbornik analiza

Predefinirano vrijeme: Predefinirano vrijeme

Vrijeme od: 0

Vrijeme do: 24

Mod transporta: Trajekt, Željeznica, Autobus, Automobil

Nacionalnost: Talijani, Strani, Domaci

Pred. područje 1: Predef. područje 1

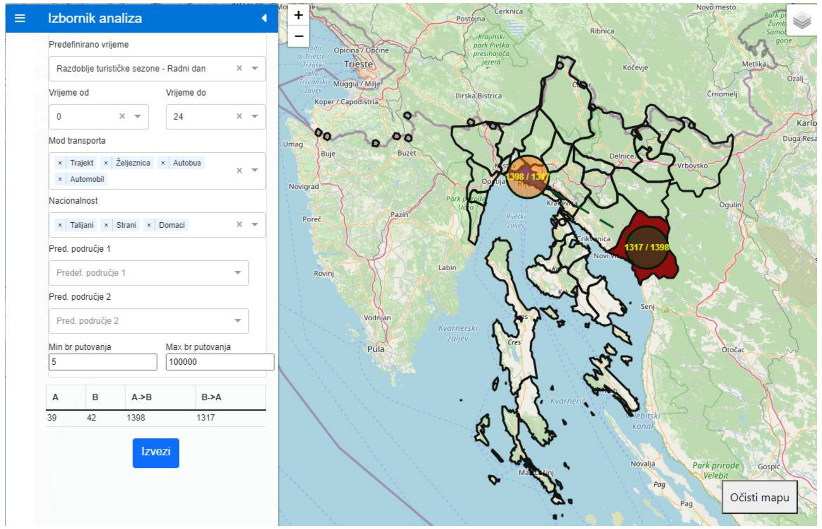
Pred. područje 2: Pred. područje 2

Min br putovanja: 5

Max br putovanja: 100000

A	B	A->B	B->A

A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
Izvezi
A13
Odjava
A14
Očisti mapu
A15
Trieste
Koper / Capodistria
Umag
Buje
Novigrad
Poreč
Rovinj
Pula
Labin
Cres
Senj
Otočac
Gospić
Pag
Leaflet | © OpenStreetMap


Izbornik analiza

Predefinirano vrijeme: Razdoblje turističke sezone - Radni dan

Vrijeme od: 0

Vrijeme do: 24

Mod transporta: Trajekt, Željeznica, Autobus, Automobil

Nacionalnost: Talijani, Strani, Domaci

Pred. područje 1: Predef. područje 1

Pred. područje 2: Pred. područje 2

Min br putovanja: 5

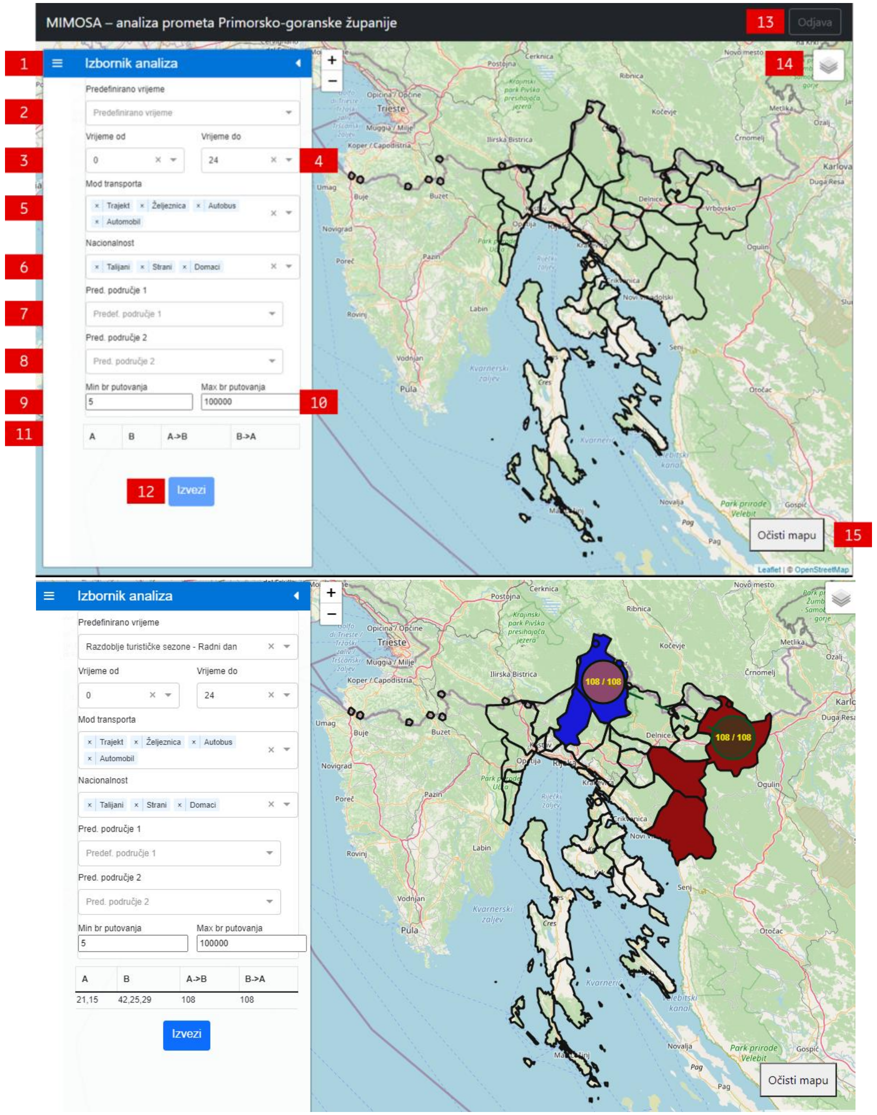
Max br putovanja: 100000

A	B	A->B	B->A
39	42	1398	1317

Izvezi
1398 / 1317
1317 / 1398
Očisti mapu
Trieste
Umag
Novigrad
Poreč
Rovinj
Pula
Labin
Senj
Otočac

2. Show movements between group of sectors

1. A1. Analysis menu
2. A2. Preset time selection
3. A3. Selection of the predefined start time of the analysis
4. A4. Selection of the predefined end time of the analysis
5. A5. Choice of transport mode
6. A6. Selection of nationality
7. Hold CTRL key and select number of origin sectors on map
8. Hold ALT key and select number of destination sectors on map
9. Number of trips between selected sectors is shown on map and in table A11



MIMOSA – analiza prometa Primorsko-goranske županije

Predefinirano vrijeme: Predefinirano vrijeme

Vrijeme od: 0

Vrijeme do: 24

Mod transporta: Trajekt, Željeznica, Autobus, Automobil

Nacionalnost: Talijani, Strani, Domaci

Pred. područje 1: Predef. područje 1

Pred. područje 2: Pred. područje 2

Min br putovanja: 5

Max br putovanja: 100000

A	B	A->B	B->A

Predefinirano vrijeme: Razdoblje turističke sezone - Radni dan

Vrijeme od: 0

Vrijeme do: 24

Mod transporta: Trajekt, Željeznica, Autobus, Automobil

Nacionalnost: Talijani, Strani, Domaci

Pred. područje 1: Predef. područje 1

Pred. područje 2: Pred. područje 2

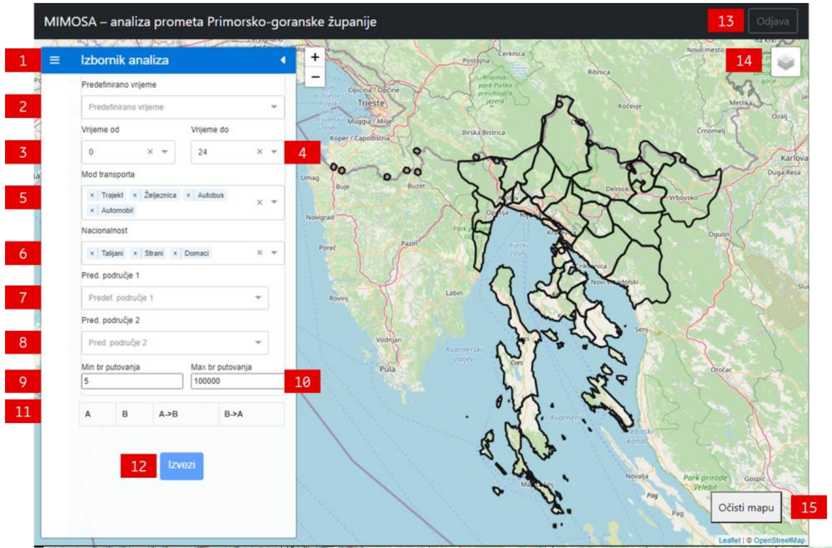
Min br putovanja: 5

Max br putovanja: 100000

A	B	A->B	B->A
21,15	42,25,29	108	108

3. Show movements between group of predefined sectors

1. A1. Analysis menu
2. A2. Preset time selection
3. A3. Selection of the predefined start time of the analysis
4. A4. Selection of the predefined end time of the analysis
5. A5. Choice of transport mode
6. A6. Selection of nationality
7. A7. Selection of a predefined area 1
8. A8. Selection of predefined area 2
9. Number of trips between selected sectors is shown on map and in table A11



MIMOSA – analiza prometa Primorsko-goranske županije

Izbornik analiza

Predefinirano vrijeme: Predefinirano vrijeme

Vrijeme od: 0

Vrijeme do: 24

Mod transporta: Trajekt, Željeznica, Autobus, Automobil

Nacionalnost: Talijani, Strani, Domaci

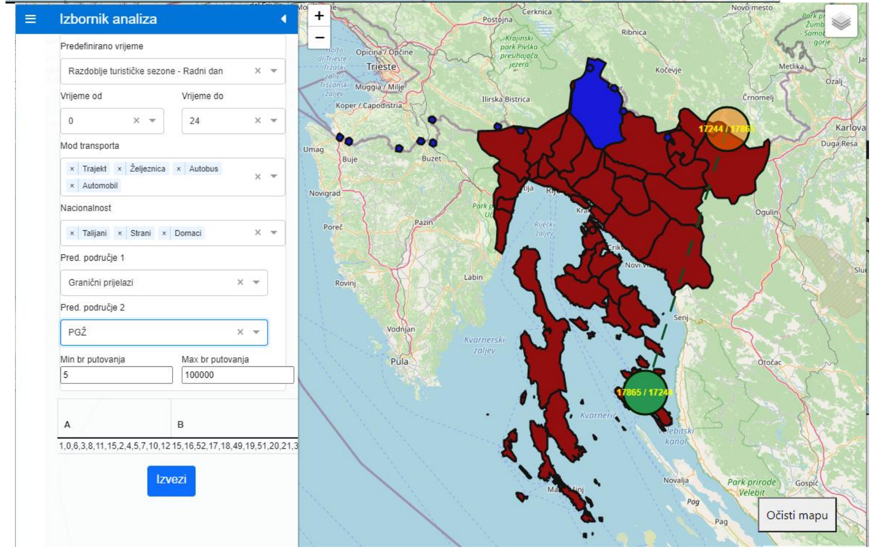
Pred. područje 1: Predef. područje 1

Pred. područje 2: Pred. područje 2

Min br putovanja: 5

Max br putovanja: 100000

A	B	A->B	B->A



Izbornik analiza

Predefinirano vrijeme: Razdoblje turističke sezone - Radni dan

Vrijeme od: 0

Vrijeme do: 24

Mod transporta: Trajekt, Željeznica, Autobus, Automobil

Nacionalnost: Talijani, Strani, Domaci

Pred. područje 1: Granični prijelazi

Pred. područje 2: PGŽ

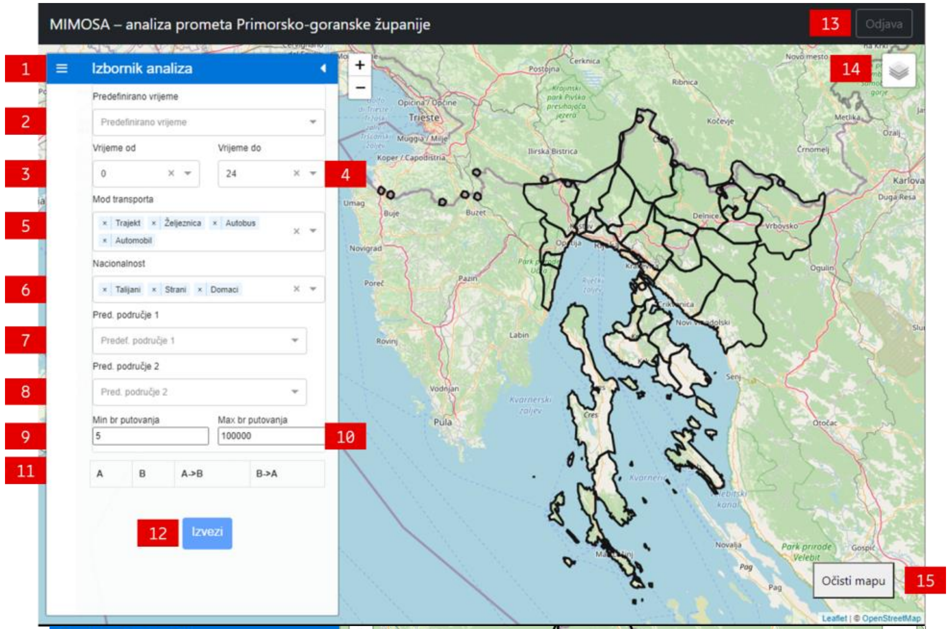
Min br putovanja: 5

Max br putovanja: 100000

A	B
1,0,6,3,8,11,15,2,4,5,7,10,12	15,16,52,17,18,49,19,51,20,21,3

4. Show sector info

1. Hover the mouse pointer above targeted sector
2. Available Sector information will be shown on screen


MIMOSA – analiza prometa Primorsko-goranske županije
Odjava
Izbornik analiza
Izvezi
Očisti mapu
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
A
B
A->B
B->A
Trieste
Koper / Capodistria
Ilirska Bistrica
Delnice
Novigrad
Poreč
Rovinj
Labin
Pula
Cres
Kvarnerski zaljev
Senj
Novalja
Otočac
Leaflet | © OpenStreetMap

Predefinirano vrijeme: Predefinirano vrijeme

Vrijeme od: 0

Vrijeme do: 24

Mod transporta: Trajekt, Željeznica, Autobus, Automobil

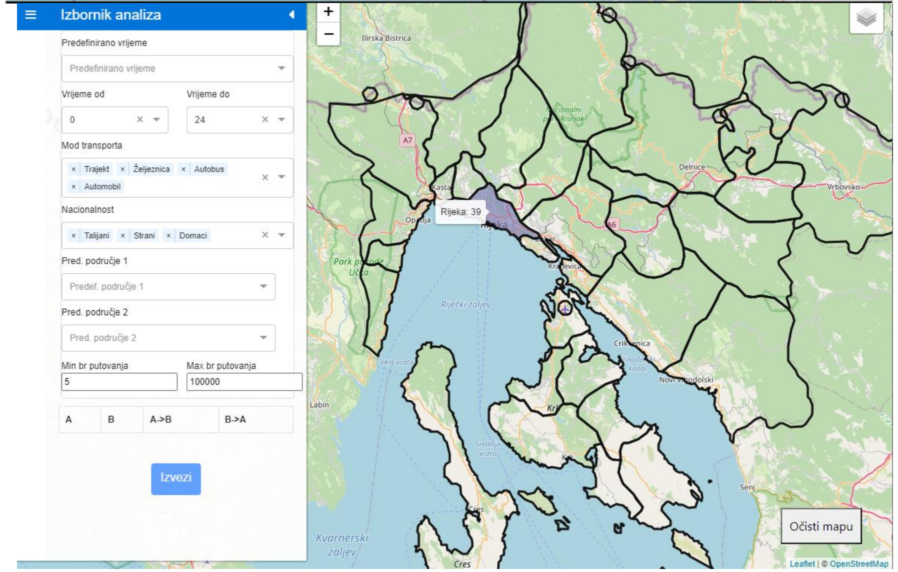
Nacionalnost: Talijani, Strani, Domaci

Pred. područje 1: Predef. područje 1

Pred. područje 2: Pred. područje 2

Min br putovanja: 5

Max br putovanja: 100000


Izbornik analiza
Izvezi
Očisti mapu
A
B
A->B
B->A
Rijeka: 39
Ilirska Bistrica
Delnice
Vrbovsko
Opatija
Kraljevica
Riječki zaljev
Crikvenica
Novi Vinodolski
Labin
Senj
Kvarnerski zaljev
Cres
Leaflet | © OpenStreetMap

Predefinirano vrijeme: Predefinirano vrijeme

Vrijeme od: 0

Vrijeme do: 24

Mod transporta: Trajekt, Željeznica, Autobus, Automobil

Nacionalnost: Talijani, Strani, Domaci

Pred. područje 1: Predef. područje 1

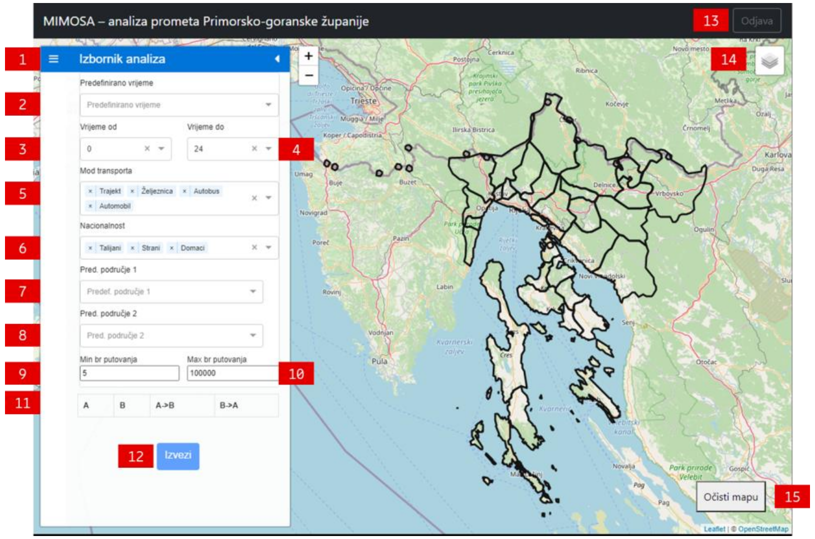
Pred. područje 2: Pred. područje 2

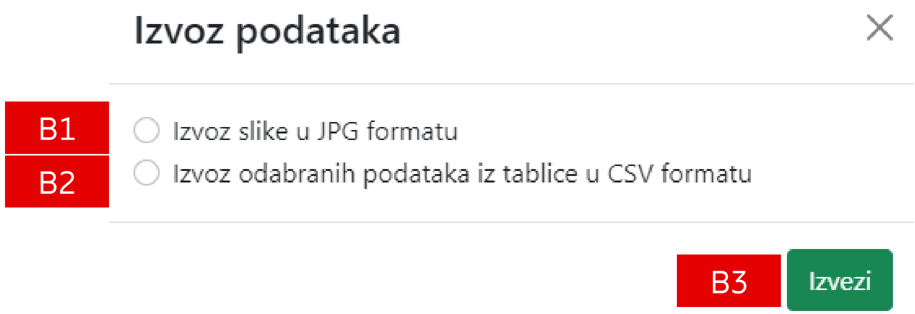
Min br putovanja: 5

Max br putovanja: 100000

5. Download movements information

1. A1. Analysis menu
2. A2. Preset time selection
3. A3. Selection of the predefined start time of the analysis
4. A4. Selection of the predefined end time of the analysis
5. A5. Choice of transport mode
6. A6. Selection of nationality
7. Selection of sectors for analysis (sector pairs, group of sectors, predefined sectors)
8. Data export button (figure or table)
9. B1. Screen export in JPG format
10. B2. Export selected data from table in CSV format
11. B3. Data export button


MIMOSA – analiza prometa Primorsko-goranske županije
13
Odjava
1
Izbornik analiza
Predefinirano vrijeme
2
Predefinirano vrijeme
Vrijeme od
Vrijeme do
3
0
24
4
Mod transporta
5
Trajekt
Željeznica
Autobus
Automobil
Nacionalnost
6
Talijani
Strani
Domaci
Pred. područje 1
7
Predef. područje 1
Pred. područje 2
8
Pred. područje 2
Min br putovanja
Max br putovanja
9
5
100000
10
11
A
B
A->B
B->A
12
Izvezi
14
Očisti mapu
15

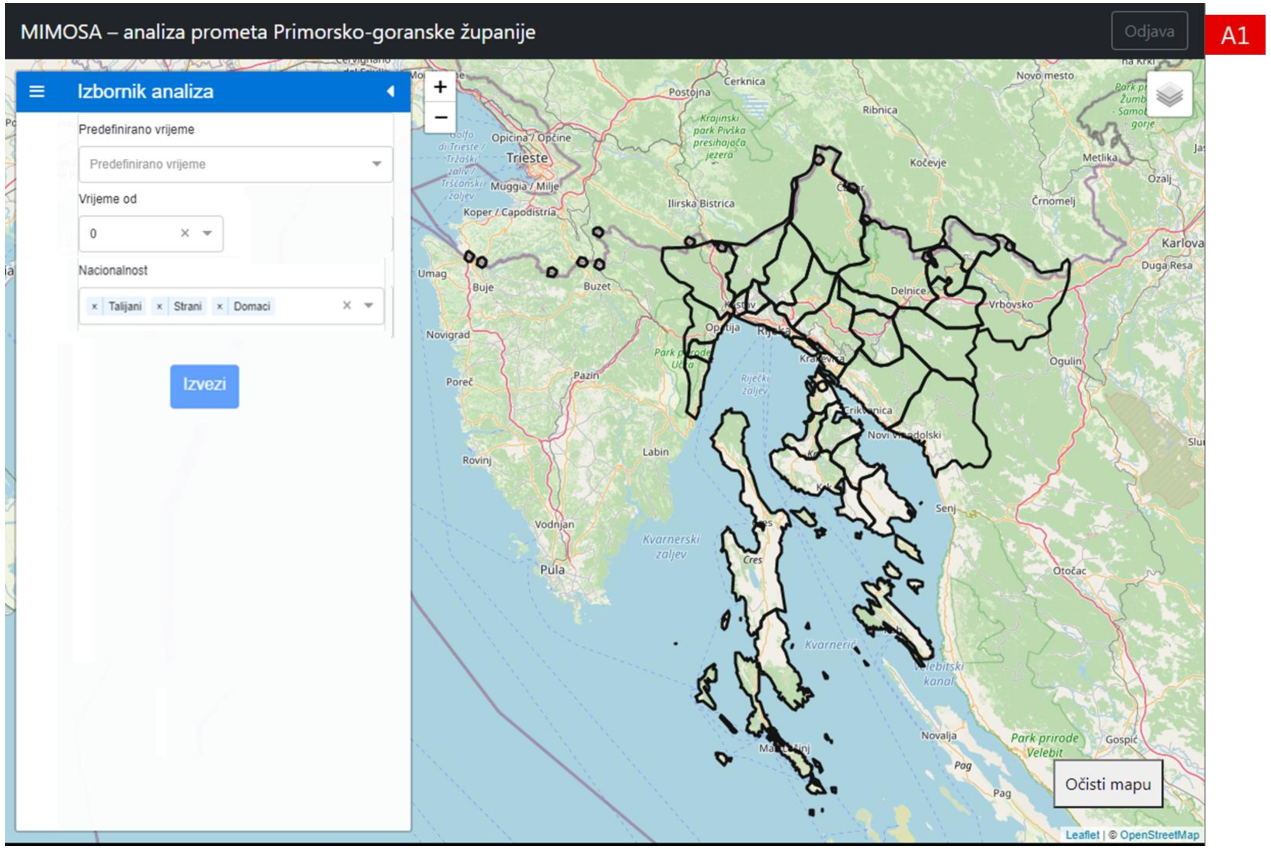

Izvoz podataka

B1 ○ Izvoz slike u JPG formatu

B2 ○ Izvoz odabranih podataka iz tablice u CSV formatu

B3 Izvezi

Heat-maps



MIMOSA – analiza prometa Primorsko-goranske županije

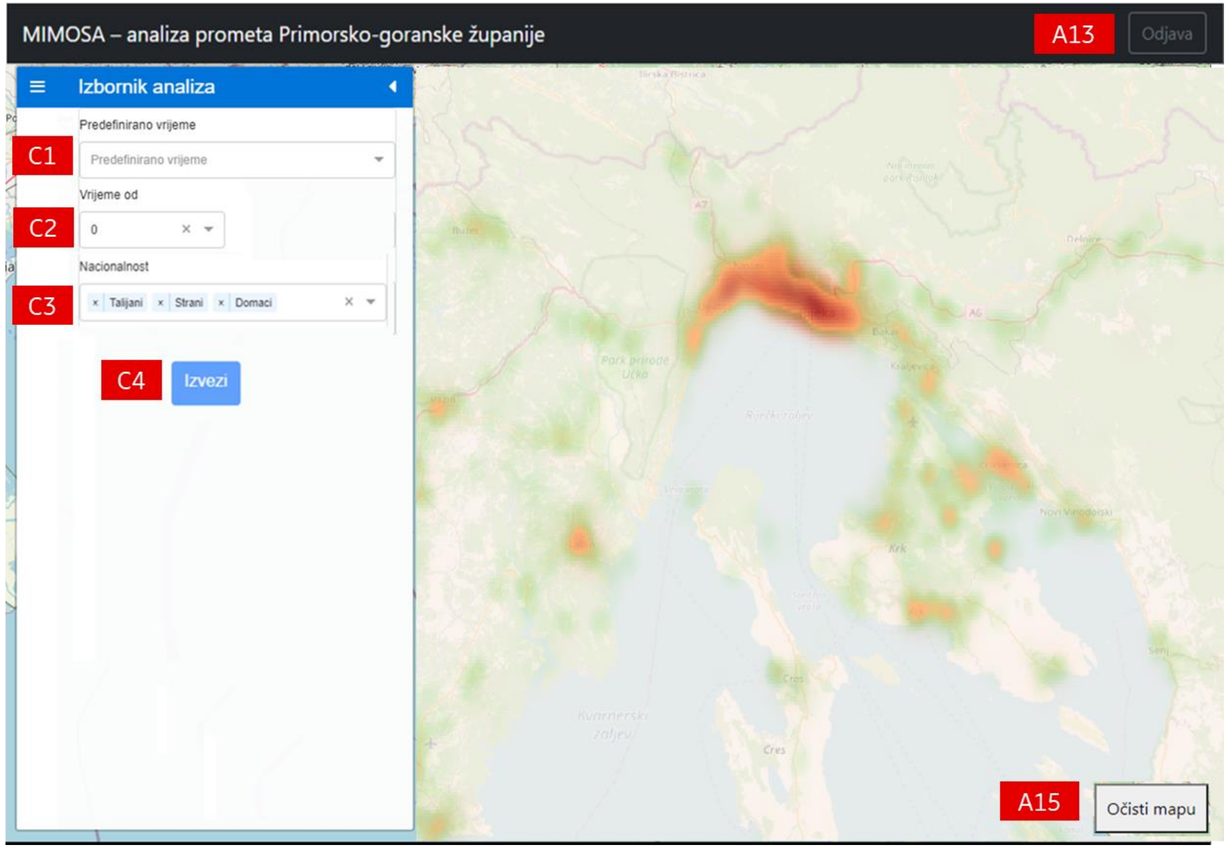
Izbornik analiza

Predefinirano vrijeme: Predefinirano vrijeme

Vrijeme od: 0

Nacionalnost: Talijani, Strani, Domaci

Odjava
A1
+
−
Izvezi
Očisti mapu
Trieste
Koper / Capodistria
Postojna
Cerknica
Ribnica
Kočevje
Ilirska Bistrica
Umag
Buje
Buzet
Novigrad
Poreč
Pazin
Rovinj
Labin
Vodnjan
Pula
Kvarnerski zaljev
Cres
Rijeka
Opatija
Crikvenica
Novi Vinodolski
Senj
Delnice
Vrbovsko
Ogulin
Karlovac
Duga Resa
Črnomelj
Metlika
Otočac
Novalja
Pag
Gospić
Park prirode Velebit
Leaflet | © OpenStreetMap



MIMOSA – analiza prometa Primorsko-goranske županije

Izbornik analiza

Predefinirano vrijeme: Predefinirano vrijeme

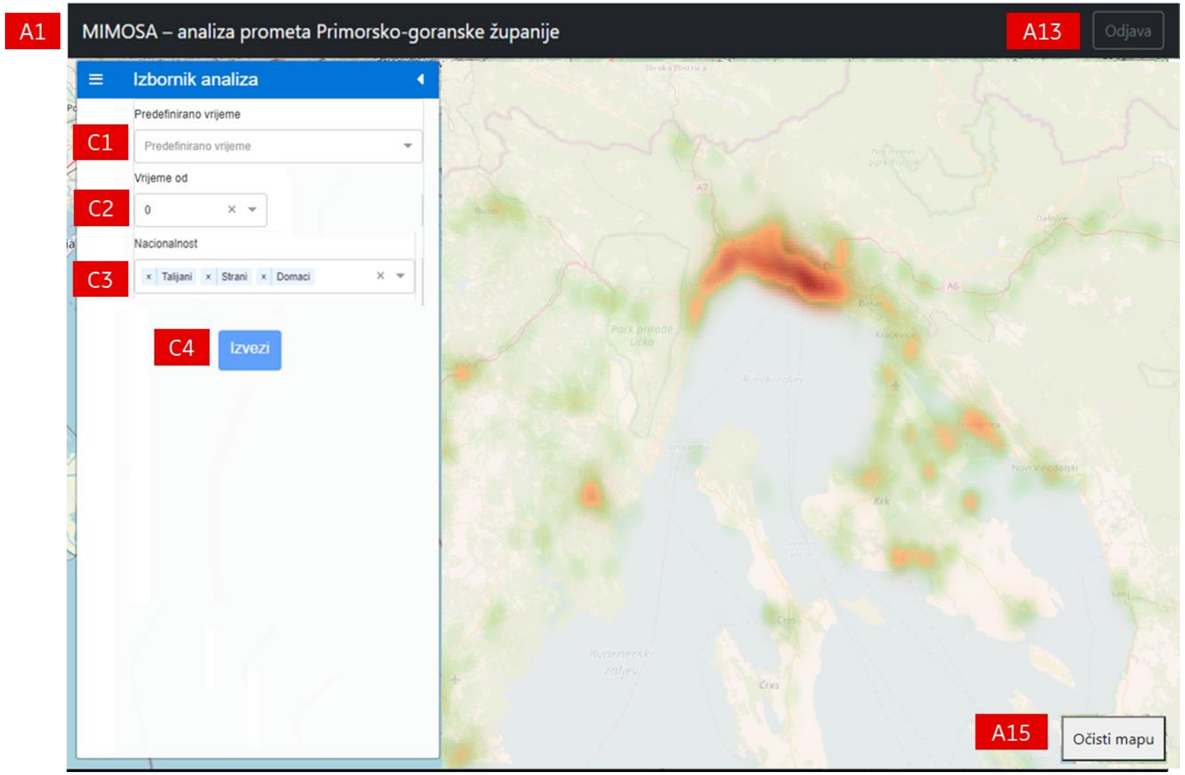
Vrijeme od: 0

Nacionalnost: Talijani, Strani, Domaci

A13
Odjava
C1
C2
C3
C4
Izvezi
A15
Očisti mapu

User interface – Menu description

1. A1.Menu analysis
2. C1. Preset time selection
3. C2. Selection of the predefined start time of the analysis
4. C3. Selection of nationality
5. C4. Data export control (figure or table)
6. A13. Logout button
7. A15. Clear map button


A1
MIMOSA – analiza prometa Primorsko-goranske županije
A13
Odjava
Izbornik analiza
C1
C2
C3
C4
Izvezi
A15
Očisti mapu

Predefinirano vrijeme: Predefinirano vrijeme

Vrijeme od: 0

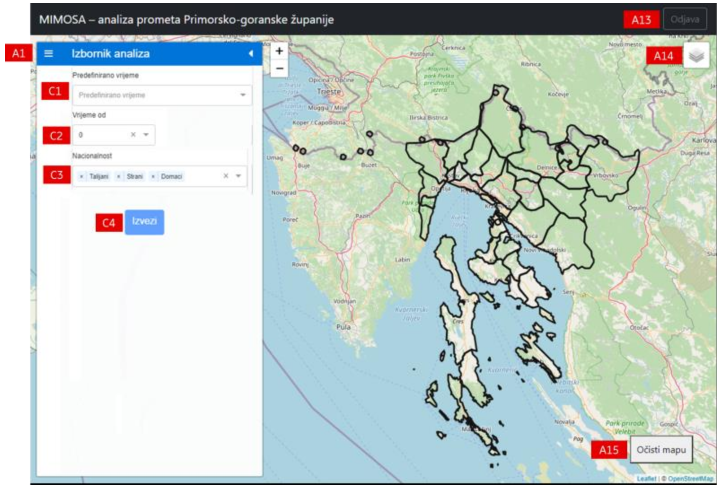
Nacionalnost: Taljani, Strani, Domaci

Heat maps: Operations

1. Display heat map view of concentration of population in space
2. Display gravitational area of origins related to selected sector
3. Display gravitational area of destinations related to selected sector
4. Display number of people in sector
5. Display average retention time in sector

1. Display heat map view of concentration of population in space

1. A1. Analysis menu
2. C1. Preset time selection
3. C2. Selection of the predefined start time of the analysis
4. C3. Selection of nationality
5. Heat map will be shown on screen



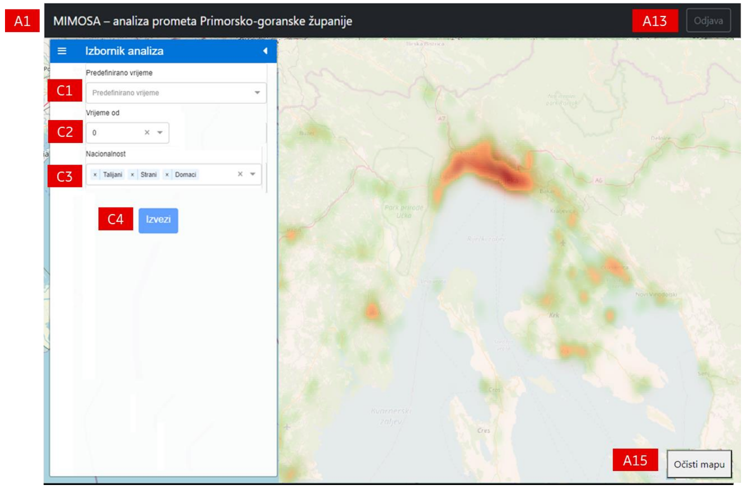
MIMOSA – analiza prometa Primorsko-goranske županije

Predefinirano vrijeme: Predefinirano vrijeme

Vrijeme od: 0

Nacionalnost: Taljani, Strani, Domaci

A13
Odjava
A1
Izbornik analiza
A14
C1
C2
C3
C4
Izvezi
A15
Očisti mapu



MIMOSA – analiza prometa Primorsko-goranske županije

Predefinirano vrijeme: Predefinirano vrijeme

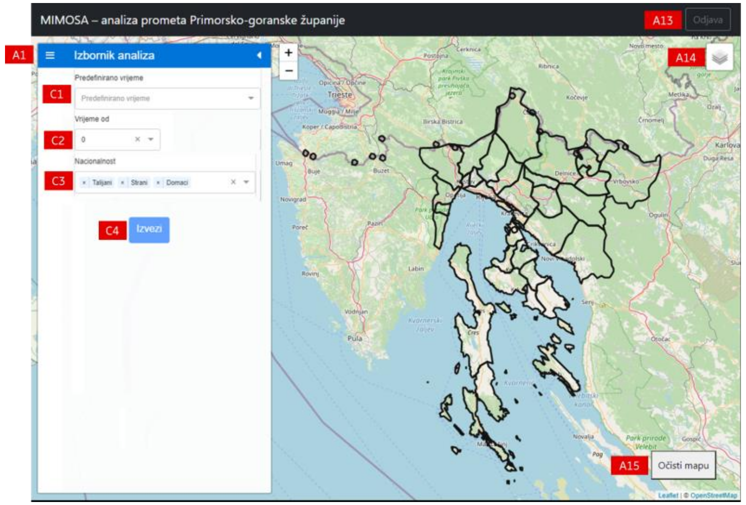
Vrijeme od: 0

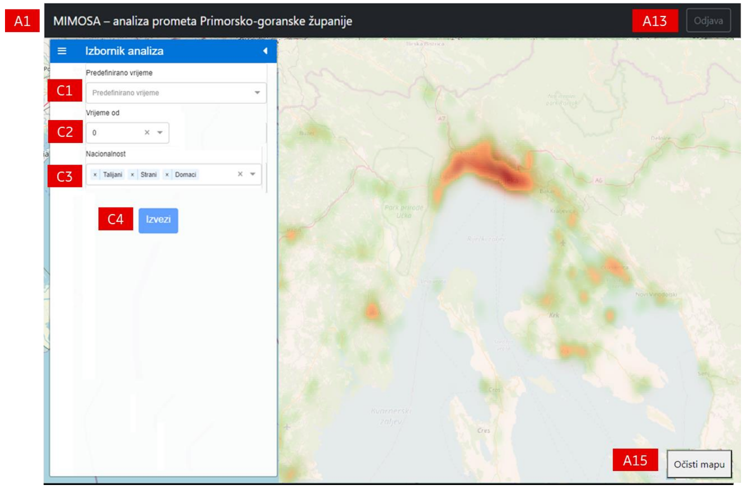
Nacionalnost: Taljani, Strani, Domaci

A1
A13
Odjava
Izbornik analiza
C1
C2
C3
C4
Izvezi
A15
Očisti mapu

2. Display gravitational area of origins related to selected sector

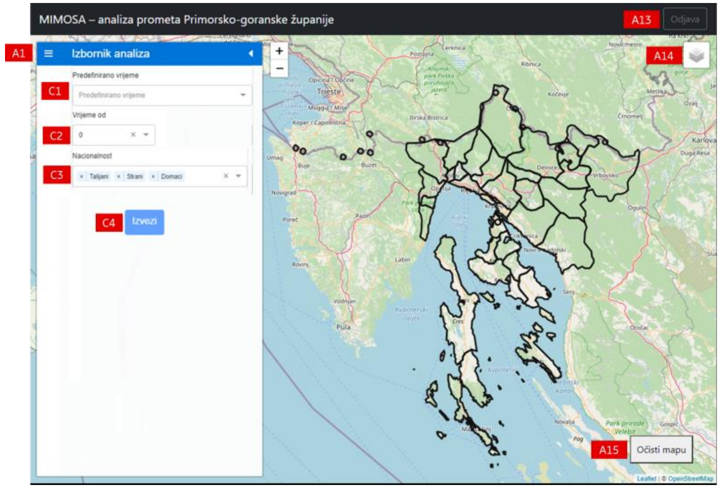
1. A1. Analysis menu
2. C1. Preset time selection
3. C2. Selection of the predefined start time of the analysis
4. C3. Selection of nationality
5. Hold CTRL key and select origin sector on map
6. Heat map will be shown on screen

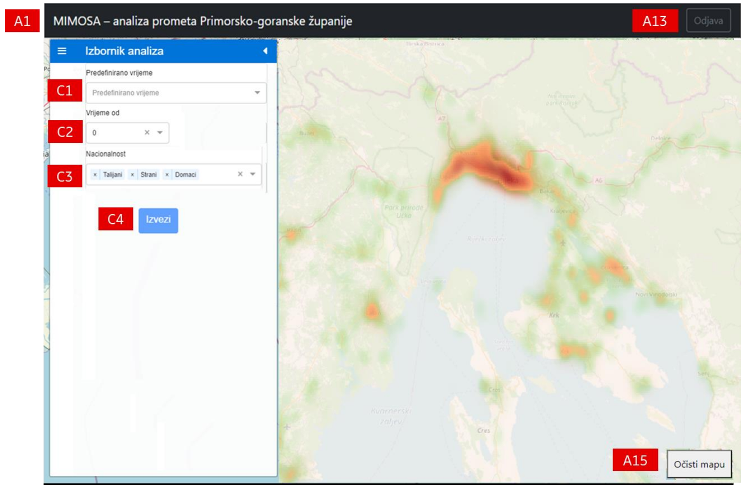

MIMOSA – analiza prometa Primorsko-goranske županije
A13
Odjava
A1
Izbornik analiza
Predefinirano vrijeme
C1
Predefinirano vrijeme
Vrijeme od
C2
0
Nacionalnost
C3
Talijani
Strani
Domaci
C4
Izvezi
A14
A15
Očisti mapu


A1
MIMOSA – analiza prometa Primorsko-goranske županije
A13
Odjava
Izbornik analiza
Predefinirano vrijeme
C1
Predefinirano vrijeme
Vrijeme od
C2
0
Nacionalnost
C3
Talijani
Strani
Domaci
C4
Izvezi
A15
Očisti mapu

3. Display gravitational area of destinations related to selected sector

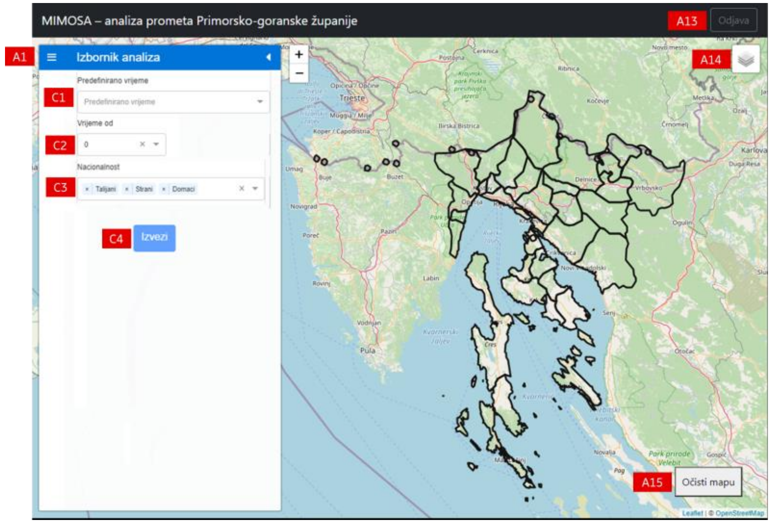
1. A1. Analysis menu
2. C1. Preset time selection
3. C2. Selection of the predefined start time of the analysis
4. C3. Selection of nationality
5. Hold ALT key and select origin sector on map
6. Heat map will be shown on screen


MIMOSA – analiza prometa Primorsko-goranske županije
A13
Odjava
A1
Izbornik analiza
A14
Predefinirano vrijeme
C1
Predefinirano vrijeme
Vrijeme od
C2
0
Nacionalnost
C3
Taljani
Strani
Domaci
C4
Izvezi
A15
Očisti mapu


A1
MIMOSA – analiza prometa Primorsko-goranske županije
A13
Odjava
Izbornik analiza
Predefinirano vrijeme
C1
Predefinirano vrijeme
Vrijeme od
C2
0
Nacionalnost
C3
Taljani
Strani
Domaci
C4
Izvezi
A15
Očisti mapu

4. Display number of people in sector

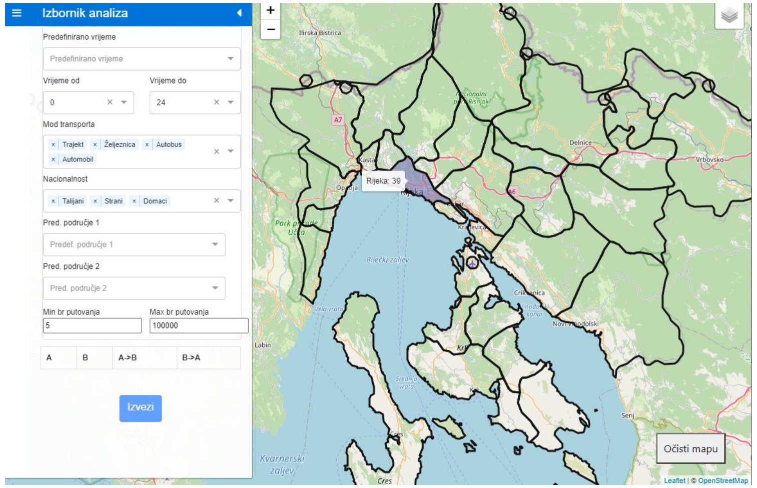
1. A1. Analysis menu
2. C1. Preset time selection
3. C2. Selection of the predefined start time of the analysis
4. C3. Selection of nationality
5. Select sector on map
6. Available data on number of people will be shown on screen


MIMOSA – analiza prometa Primorsko-goranske županije
A13
Odjava
A1
Izbornik analiza
C1
C2
C3
C4
Izvezi
A14
A15
Očisti mapu
Leaflet | © OpenStreetMap

Predefinirano vrijeme: Predefinirano vrijeme

Vrijeme od: 0

Nacionalnost: × Talijani × Strani × Domaci


Izbornik analiza
A
B
A->B
B->A
Izvezi
Rijeka: 39
Očisti mapu
Leaflet | © OpenStreetMap

Predefinirano vrijeme: Predefinirano vrijeme

Vrijeme od: 0

Vrijeme do: 24

Mod transporta: × Trajekt × Željeznica × Autobus × Automobil

Nacionalnost: × Talijani × Strani × Domaci

Pred. područje 1: Predef. područje 1

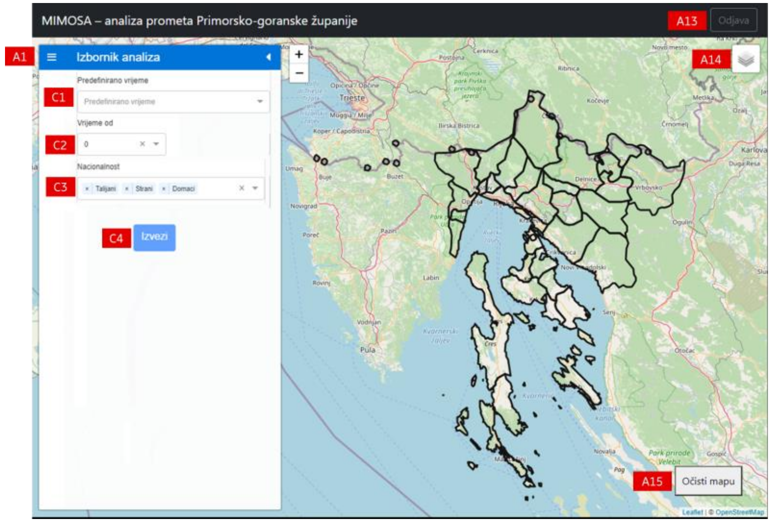
Pred. područje 2: Pred. područje 2

Min br putovanja: 5

Max br putovanja: 100000

5. Display average retention time in sector

1. A1. Analysis menu
2. C1. Preset time selection
3. C2. Selection of the predefined start time of the analysis
4. C3. Selection of nationality
5. Select sector on map
6. Available data average retention time will be shown on screen


MIMOSA – analiza prometa Primorsko-goranske županije
A13
Odjava
A1
Izbornik analiza
C1
C2
C3
C4
Izvezi
A14
A15
Očisti mapu

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Vrijeme od: 0

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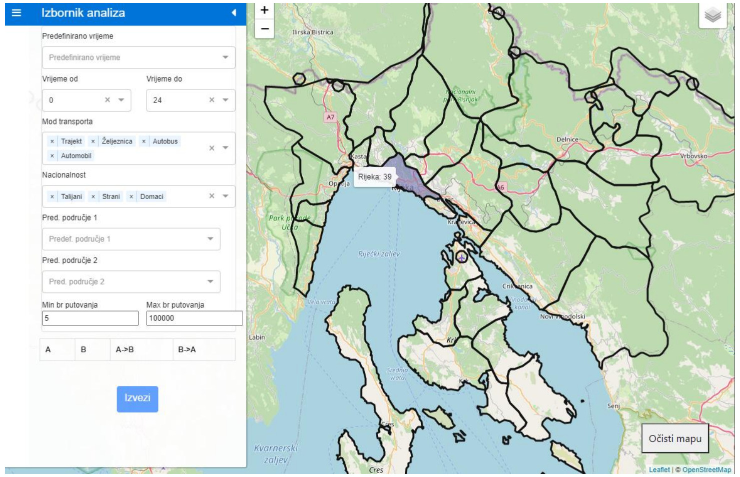
Izbornik analiza
A
B
A->B
B->A
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