D.5.3.3 INNOVATIVE “MOBILE HUB”

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1.1 Introduction and the background to the MIMOSA innovative “Mobile Hub” pilot

This Mimosa pilot action is related to the definition and testing of an Innovative “Mobile HUB” allowing to support an e-bike sharing service to be provided in a flexible, innovative and economic way. The “Mobile Hub” is defined as a management tool allowing to manage and monitor the free sharing of the 32 e-bikes procured in the framework of the MIMOSA WP4 activities (for more detail see the D.4.4.1 “Innovative electric light vehicles sharing service supported by a Mobile Hub in Emilia-Romagna Region”).

The idea of a physical “Mobile Hub” supporting the development of a flexible e-bike sharing service started in the framework of the Interreg Italy-Croatia project Moses. In this project, an 18 e-bikes free sharing service for tourists was tested in the Ravenna Cruise Terminal during the Summer of 2018. The justification for putting in places such a service was related to the distance existing between the Ravenna Cruise Terminal and the Ravenna city center (more than 11 km). Considering also the high average age of the tourists arriving at the Ravenna cruise terminal, e-bikes were identified as a reliable solution for older people interested in adopting more sustainable transport modes.

The Moses project main idea was also related to the need to provide an e-bike sharing service at a lower cost compared to a traditional sharing service and with the possibility to manage the required level of flexibility in terms of tourists’ demand and geographical area to be covered by the service. In fact, flexibility is fundamental in areas characterized by a very high touristic flows variance (mainly related to seaside seasonal tourism), where bike-sharing service request is limited to 4/5 summer months. Traditional bike-sharing services have high management costs not compatible with such a limited use during the year.

In order to support in a more flexible way this e-bike sharing service, a physical “Mobile Hub” was realized (see Figure 1). This physical Mobile Hub developed in the Moses project was a 20 feet container designed to host and recover 18 e-bikes. It was positioned in the Ravenna Cruise Terminal in order to serve directly the tourists arriving in the city by cruise ships. The Mobile Hub was equipped for the recharge of the e-bikes and with a “mobile desk” to be used both for the booking procedure and for maintenance activities when needed. Moreover, the Mobile Hub was a reliable solution for locking the e-bikes if the hosting structures don’t have dedicated rooms where to store in a safe mode these e-bikes.

The Moses pilot was successful as it was possible to report several travels conducted by the tourists arriving at the Ravenna Cruise Terminal and it was possible to collect evidence on the effective use to reach the Ravenna city centre.

Figure 1. The Moses Mobile Hub and the electric bikes used for the pilot activities in 2018 Ravenna test.

Figure 2. The interior of the Moses Mobile Hub developed in Ravenna.

The Mobile Hub developed in the framework of the Moses project also showed some limits. The main limit was related to the costs associated to move such a heavy structure to displace it in different urban areas. As evidenced in the business model analysis conducted during the Moses project, it was very difficult for a "Mobile Hub manager" to cover the costs associated to move only 2 times in a year this structure.

The Mimosa WP5 pilot was defined starting from the main evidence collected in 2018 and from the great interest of the regional and local stakeholders in the role of e-bikes in providing reliable and effective sustainable mobility solutions for tourists. In particular, as evidenced in the Mimosa Application Form, the ambition was to develop a more sustainable business model able to provide an e-bike sharing service in an effective way and able to be moved in a fast and convenient way in order to follow the seasonal flexible touristic demand.

During 2021, ITL organized several meetings with the local and regional stakeholders in order to develop a Mobile Hub in line with the main stakeholders' key requests and needs. During these local meetings, the key request was to create a "soft" management scheme with low managerial costs. Based on the collected evidence, the agreed solution was to pass from the development of a "**Physical Mobile Hub**" to a "**Virtual Mobile Hub**". So the Mimosa Mobile Hub was intended as a digital tool aimed at supporting the management and the data collection of the pilot action. More in detail the key ambitions were to develop and test a platform allowing to monitor in real-time the position of the 32 Mimosa e-bikes and to have an e-bikes booking system able to reduce the main legal risks in charge to ITL and to the involved stakeholders (hotels in particular).

1.2 The MIMOSA e-bikes monitoring and management platforms

The Mimosa Virtual Mobile Hub was based on two different online platforms. One platform was dedicated to monitoring the GPS systems installed in each e-bike. This platform allowed to collect in real time the data related to the position of each e-bike. Moreover, it allowed to check in real-time the e-bikes batteries levels and to block the e-bikes (through a remote disconnection of the batteries' alimentation) in case irregular movements were detected. The second platform was related to e-bike booking system management. This platform was designed in order to be privacy compliant and to help the 16 involved hotels in collecting all the documentation needed to manage an e-bike free rental service reducing any kind of civil and legal risks.

The first part of the Mimosa Virtual Mobile Hub was composed of an online platform called "**BikeSquare**". The BikeSquare platform was a "digital ecosystem" developed together with the GPS system in order to allow an easy monitoring of big bikes' fleets and also to create reliable databases for data collection. BikeSquare is an innovative Italian start-up powered by E.on. The goal of this start-up is to promote electric cycle tourism in Italy and in Europe.

The BikeSquare main dashboard (Figure 3) was composed of three different sections: the fleet monitoring panel, the e-bike real-time localization panel and a statistic panel.

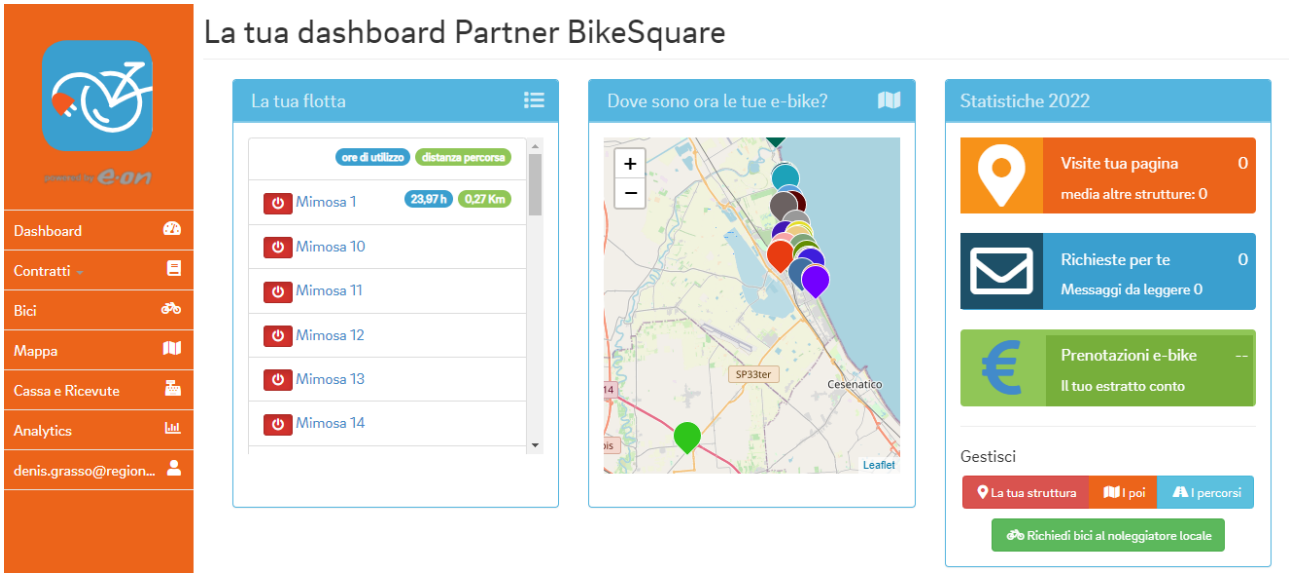


Figure 3. BikeSquare main dashboard.

The e-bike fleet management panel (Figure 4) allowed to have real-time control of the battery and electric motor status of each e-bike. When a bike was moving, a dedicated icon indicated that the e-bike was moving. This real-time monitoring alert system was the base of the alarm system included in the platform. When an e-bike was moved in a period not foreseen for the sharing service utilization (for example during the night and/or in the winter period), an automatic alarm was sent to selected emergency contacts. Moreover, through this monitoring panel, it was possible to stop in real-time an e-bike through a remote control able to interrupt the electric motor alimentation.

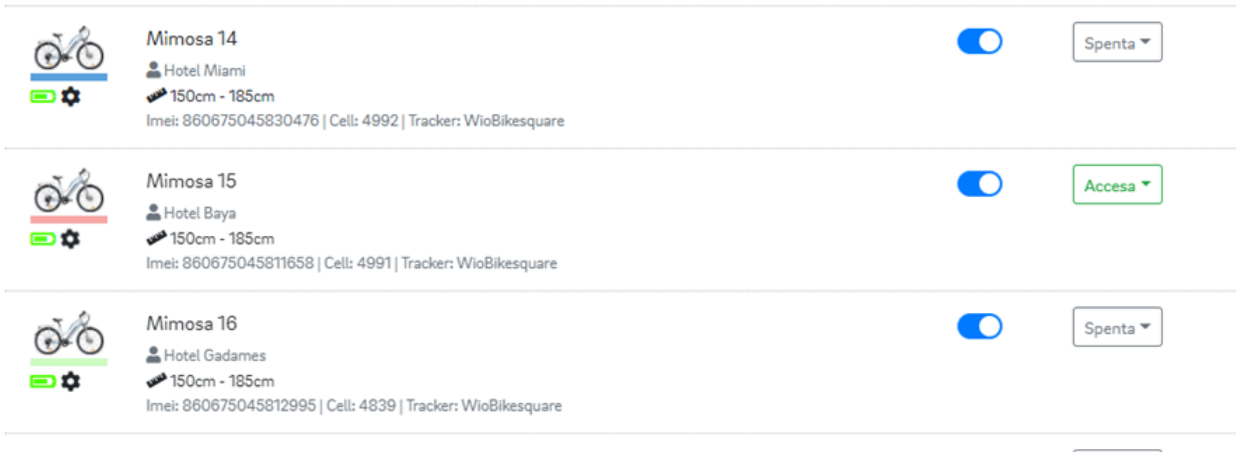


Figure 4. A screenshot from the BikeSquare platform where it is possible to see a section of the e-bike monitoring page. As evidenced in the photo, for each e-bike it was possible to monitor the battery status and if the e-bike is turned on or turned off. Moreover, it was possible to stop the e-bikes moving the blue button on the right side.

The e-bike real-time localization panel allowed to monitor the paths registered in a specific period. Thanks to this dedicated panel, it was possible to monitor and download all the data related to the e-bike paths.

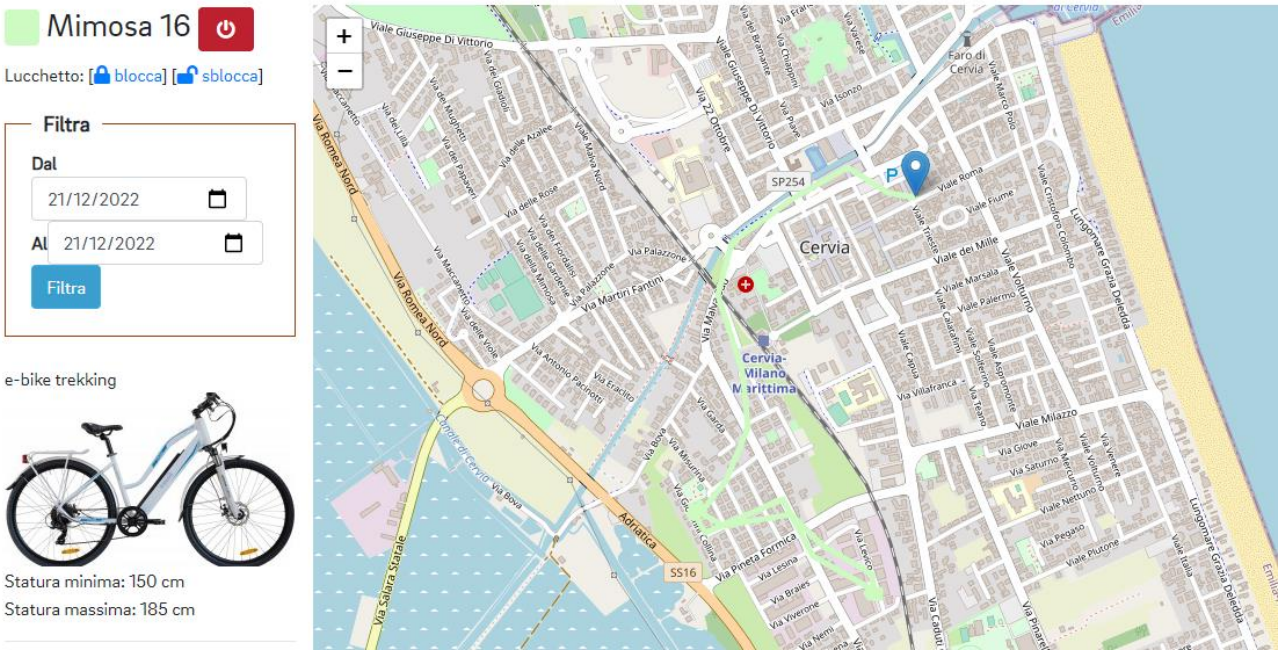


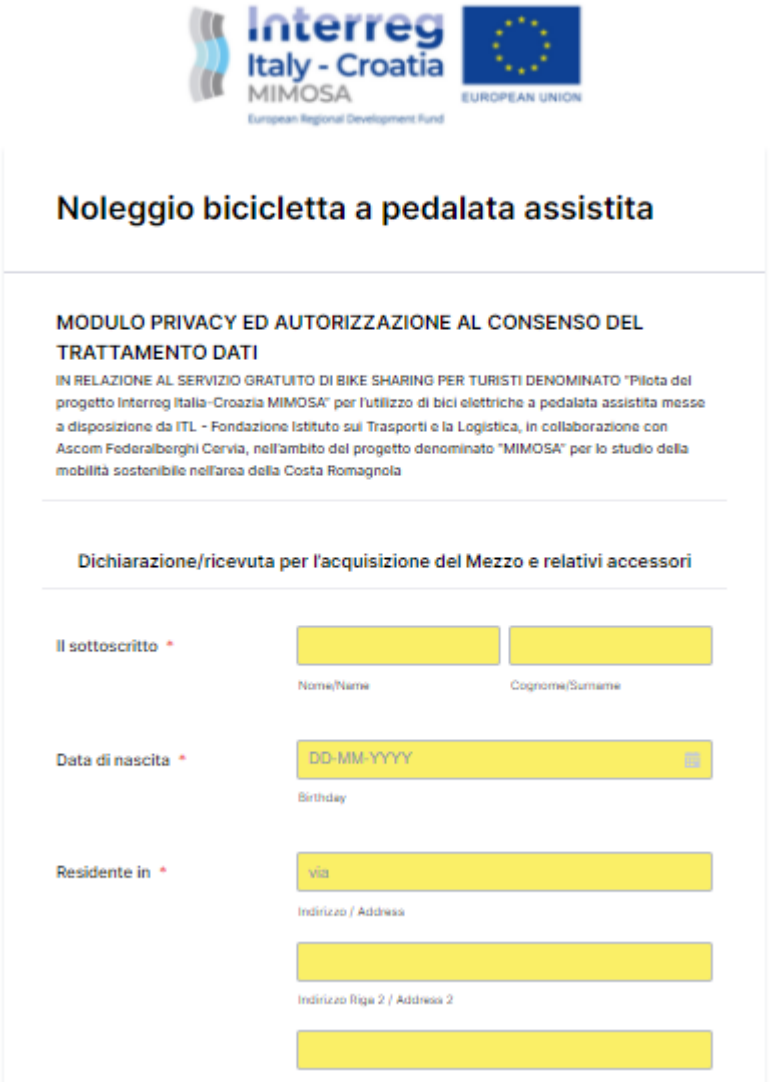
Figure 5. The Bike-Square e-bikes real-time localization panel.

Another panel allowed to have a clear view of the places where all the e-bikes were stored during the night (Figure 6). Based on these points, it was possible to set the alarm notification system.

Figure 6. The BikeSquare panel dedicated to e-bikes night storage position monitoring.

The second part of the Mimosa Virtual Mobile Hub was dedicated to the management of the e-bike monitoring system. Due to privacy and data protection rules, it was not possible to use the booking systems associated with the BikeSquare platform. For this reason, ITL, in collaboration with technical externals, developed a dedicated online booking platform allowing to collect from the tourists all the required authorizations on data utilization and assumption of all the responsibilities related to the utilization of the Mimosa e-bike sharing service.

The platform was completely designed by ITL based on the legal framework defined with external lawyers in order to manage an e-bike sharing service with no legal risks for the hotels and responsible partners (FederAlberghi, ITL and Emilia-Romagna Region). Moreover, the platform was designed in order to collect all the required privacy authorizations from the tourists using the service.



Noleggio bicicletta a pedalata assistita

MODULO PRIVACY ED AUTORIZZAZIONE AL CONSENSO DEL TRATTAMENTO DATI

IN RELAZIONE AL SERVIZIO GRATUITO DI BIKE SHARING PER TURISTI DENOMINATO "Pilota del progetto Interreg Italia-Croazia MIMOSA" per l'utilizzo di bici elettriche a pedalata assistita messe a disposizione da ITL - Fondazione Istituto sui Trasporti e la Logistica, in collaborazione con Ascom Federalberghi Cervia, nell'ambito del progetto denominato "MIMOSA" per lo studio della mobilità sostenibile nell'area della Costa Romagnola

Dichiarazione/ricevuta per l'acquisizione del Mezzo e relativi accessori

Il sottoscritto *

Nome/Name

Cognome/Surname

Data di nascita *

DD-MM-YYYY

Birthday

Residente in *

via

Indirizzo / Address

Indirizzo Riga 2 / Address 2

Figure 7. A screenshot of the Mimosa e-bikes booking platform (Source: https://www.fondazioneitl.org/mimosa-modulistica-pilota-cervia/).

The Mimosa e-bikes booking platform was composed of the following modules:

- **E-bikes users' data collection form.** This online form allowed to collect from the tourist all the required information and documents on the e-bike users, acceptance of the pilot rules, assumption of responsibilities and acceptance of privacy and data treatment rules. Automatically the system was able to generate a PDF contract signed digitally by the users;
- **Hotels e-bike booking activation form.** This online form allowed the hotel staff to check all the information and authorizations signed by the tourist. Moreover, this module

allowed to check if an e-bike was available for free rent. If all the required information were provided, it was possible to activate the beginning of the e-bike free renting;

- **Hotels e-bikes end booking form.** This online form allowed to manage the conclusion of the e-bikes free rental. A guided procedure allowed to the hotels' staff to check the return of the Mimosa e-bike in the due time and if the e-bike had no damage. If everything was ok, the hotel staff can conclude the practice and the e-bike booking procedure was ended.

A graphic summary of these procedures was summarized in the Figure below.

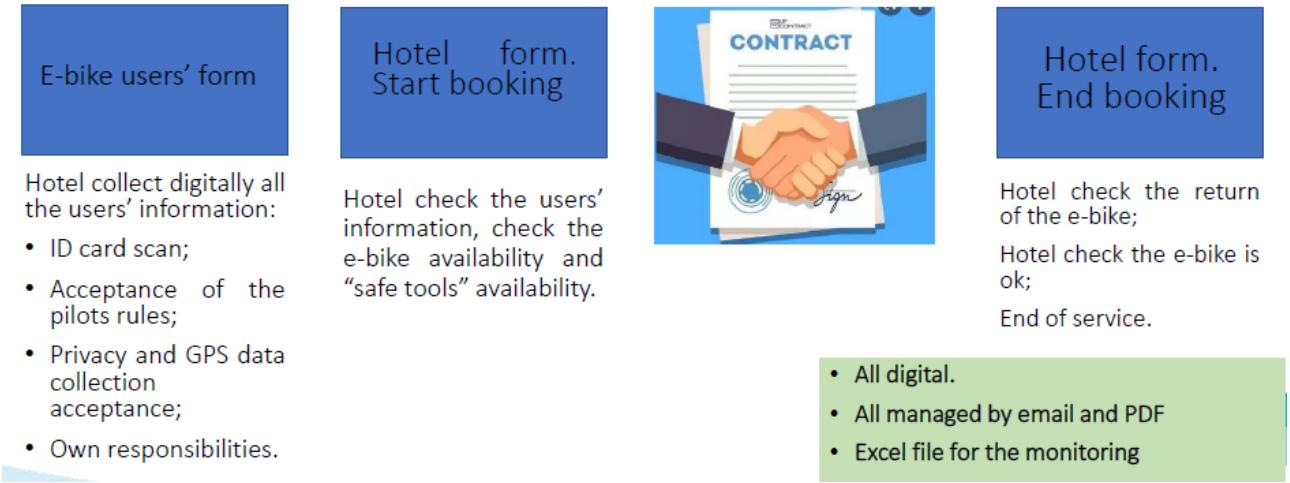


Figure 8. Graphic summary of the Mimosa online booking platform developed by ITL.

The first testing period (June – October 2021) was managed in a hybrid way, both with paper and digital documents. The second testing period (Summer 2022) was designed in order to be all digital. Nevertheless, as evidenced in the paragraph related to the pilot problems, this platform was not effectively used and the collected paper documents were stored by the hotels only for the duration of the free renting service. As all the free renting activities went well, all the documents were destroyed after the rental conclusion in order to avoid privacy problems (even if this was not foreseen in the agreed pilot management rules defined with the involved hotels).

The Mimosa booking platform is available online by accessing this link: https://www.fondazioneitl.org/mimosa-modulistica-pilota-cervia/

1.3 The Mimosa e-bikes data processing and methodological aspects

One of the key objectives of the Mimosa WP5 pilot action was to collect data on the e-bike paths traveled by tourists during the 2 years of the testing period. This data collection was possible thanks to the GPS systems installed in each e-bike (for more details on the GPS equipment see D.4.4.1). All the GPS were equipped with a dedicated SIM allowing them to directly send the data to the BikeSquare dedicated platform.

The GPS monitoring system was very effective for the management of such a e-bike sharing service. There were more problems in relation to the "quality" of the collected data. These limits were not related to the "low level" of the adopted GPS technological solution, but it was a normal business for this kind of monitoring activities. Based on the market reviews conducted during the pilot development phases in 2021, more precise GPS systems have a higher cost compared to the adopted technological solution and they are used more for more advanced mapping activities not compatible with the installation on an e-bike.

The quality of collected e-bike journey data means that the collected data needed to be further elaborated in order to be more precisely overlapped with the road network. In fact, as evidenced in the Figure below, not always the tracked paths corresponded with the road network and in some cases, there were data outside the project area due to temporary GPS malfunctioning and/or quality of satellite connection.

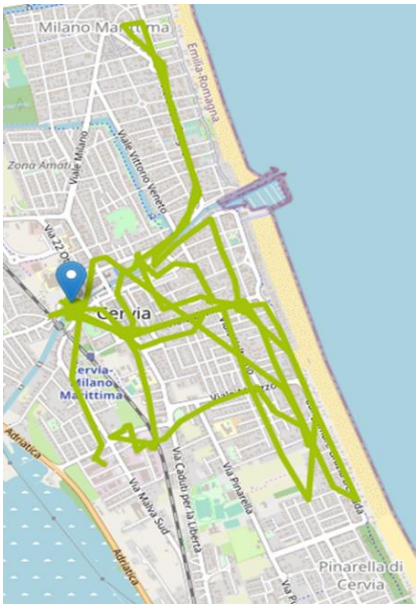


Figure 9. Example of the e-bikes rough paths data.

The causes of these data detection problems were multiple. In some cases, the e-bike was on a narrow road and/or in a closed building where the GPS signal was not detected. In other cases, there were temporary problems related to the GPS systems due to electric power source interruption, automatic internal GPS setup delays and other technological problems related to the functioning of such a complex technological system.

For all these reasons it was needed to process the collected data in order to have reliable and relevant data on the e-bike traveled paths. This data processing activity required the adoption of advanced open-source algorithms aimed to remove overlapping consecutive points and points outside the study area. In a second moment, using another dedicated open-source algorithm, the "clean data" were processed in order to define the e-bikes' trajectories and identification of the stops.

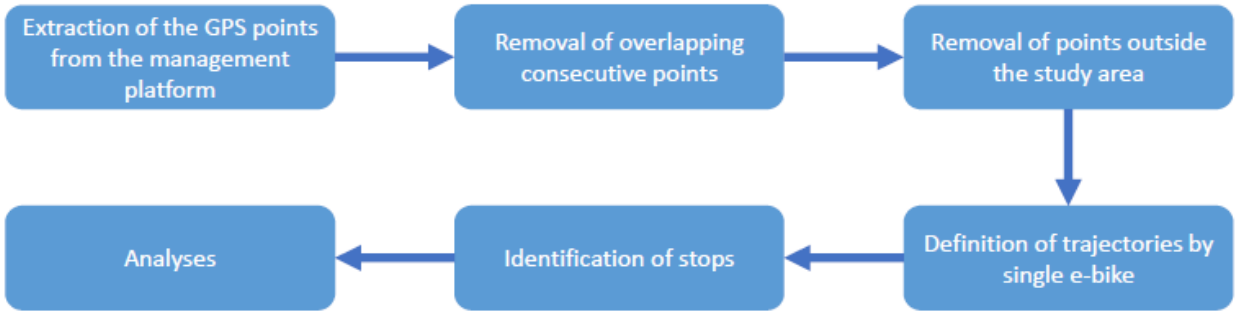


Figure 10. Scheme of the adopted methodology for the e-bikes data cleaning and elaboration.

One of the biggest challenges was related to the removal of the overlapping consecutive points. The adopted GPS systems were able to detect a point every 30 seconds. So each single e-bike track was composed of a sequence of consecutive points. When the e-bike stopped in a place, the GPS system continues to monitor the position and to send the data to the platform. The problem was related to the precision of the GPS systems. The Mimosa adopted GPS systems had a margin of error of about 5 meters. This means that when an e-bike stopped in a place, the GPS system generated a "cloud of points" with a diameter of 5 meters. This cloud of points was wider when the GPS signal was lower. In these cases, it was necessary to apply an algorithm allowing to clean the data and remove the false e-bike movements. Moreover, it was important also to analyze these data as allowed to understand where an e-bike stopped during its journey.

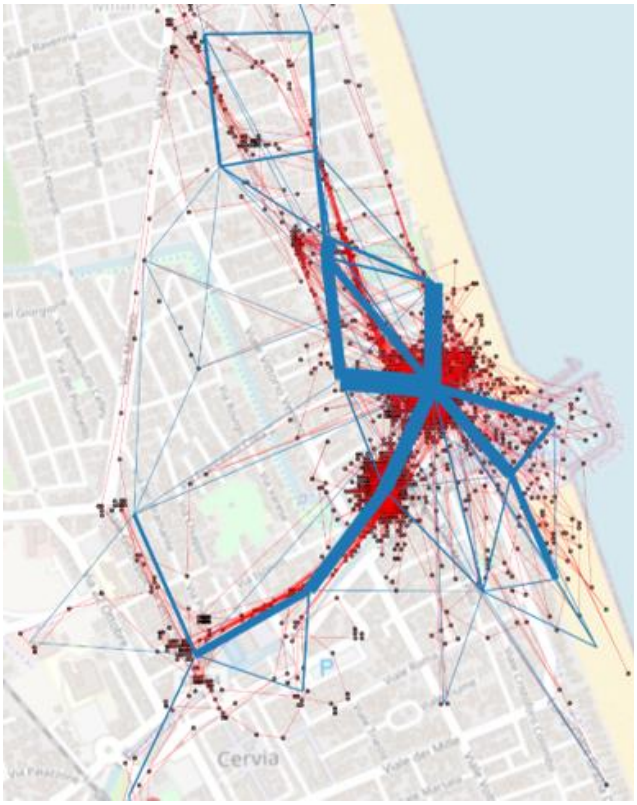


Figure 11. Example of the "cloud of points" generated from the GPS system when it stopped in a place. In blue it is possible to see how a dedicated algorithm allowed to transform and clean these data into more realistic one.

More in detail, the e-bikes monthly databases were downloaded, merged, and sorted by bike ID (1st level) and timestamp. Speed was then iteratively computed as the ratio between the travelled distance and the time between each observation and the following, in order to drop those observations with unrealistic speed values (equal to 0km/h or higher than 40km/h). Points outside the boundaries of the project area were dropped as well. Observations with the same bike ID were grouped to define the path travelled by each bike in the whole observation period. Then, different algorithms were tested for detecting the stops and for reasonably splitting the trajectories into trips. First, trajectories were split when the bike did not leave a buffer area with a radius of 180m around the observation at issue in 3 minutes. This operation was performed to drop displacements linked to GPS error. Secondly, trajectories were split in case of a gap between consecutive observation times higher than 3 minutes. The resulting trajectories were finally grouped to identify the flow lines.

In relation to the trajectories' aggregation analysis, the adopted open-source algorithm was "Moving Pandas trajectory aggregator". In relation to the trajectories' separation the adopted open-source algorithm was "Moving Pandas trajectory splitter". These algorithms allowed to:

- Create trajectories from a CSV file;
- Find locations for given time stamps and time spans;
- Compute movement speed, direction, and sampling intervals;
- Detect and extract stops;
- Split trajectories into individual trips;
- Clean, simplify, generalize, and aggregate trajectories;
- Create static and interactive visualizations.

More details on these algorithms are available on the official Moving Pandas webpages[1].

1.4 Mimosa testing activities in Cervia-Milano Marittima: key results

The Mimosa pilot in Cervia/Milano Marittima was officially launched on 28/06/2021 with a public event held in Cervia.

il Resto del Carlino

Mobilità sostenibile

Sciame di bici elettriche per gli hotel di Cervia

Progetto Mimosa: consegnati i primi 32 modelli nelle strutture alberghiere

Sciame di biciclette elettriche a Cervia con il progetto 'Mimosa' per la promozione della mobilità elettrica e sostenibile nelle strutture alberghiere: consegnati i primi 32 modelli agli albergatori aderenti. L'iniziativa di promozione della mobilità elettrica e sostenibile tra i turisti del comune di Cervia è nata dall'Istituto sui Trasporti e la Logistica (ITL) in collaborazione con la Regione Emilia-Romagna, Federalberghi Ascom Cervia e FIVE. Alla conferenza stampa erano presenti l'assessore regionale Andrea Corsini, il sindaco di Cervia Massimo Medri, il presidente dell'Istituto sui Trasporti e la Logistica Guido Fabbri, il presidente di Federalberghi Ascom Cervia Gianni Casadei, l'amministratore di Fabbrica Italiana Veicoli Elettrici (FIVE) Fabio Giatti. Nella stessa occasione sono stati consegnati i modelli agli albergatori selezionati i quali li metteranno a disposizione dei propri ospiti. Il presidente di Federalberghi Ascom Cervia, Gianni Casadei, ha spiegato: «Questa iniziativa si colloca in continuità con gli sforzi che da anni l'associazione porta avanti per la promozione della sostenibilità ambientale tra i propri associati. Gli alberghi che parteciperanno all'iniziativa del progetto Mimosa sono stati estratti a sorte tra gli hotel che aderiscono al programma Cervia Eco-Friendly Hotel, un programma che coinvolge oltre 100 hotel che hanno assunto impegni in termini di riduzione degli sprechi ed utilizzo di energia certificata green. Tale iniziativa si lega inoltre alla firma della Carta di Cervia». Insomma, Cervia sempre più green e volta all'ecosostenibilità, anche grazie all'aumento delle piste ciclabili che trovano sempre più gradimento tra i turisti. Anche il sindaco Medri ha evidenziato come già da anni Cervia sia molto attenta al tema della mobilità sostenibile e ciclabile, prova gli oltre 40 km di percorsi ciclabili esistenti. «Il progetto europeo 'Mimosa' è molto interessante da un lato per la sua dimensione internazionale, dall'altro per la possibilità di raccogliere dati circa gli spostamenti dei turisti nel nostro territorio. Questo per noi è molto importante soprattutto in vista degli investimenti infrastrutturali previsti per promuovere la ciclabilità. Da un lato la promozione del grande asse di mobilità dolce che interesserà tutto il sistema costiero fino a Ravenna, dall'altro il miglioramento dei collegamenti ciclabili tra il centro di Cervia e i siti maggiormente attrattivi come ad esempio l'asse centro-saline e centro-parco urbano».

Figure 12. Local newspaper news of the Mimosa pilot startup in Cervia/Milano Marittima (Source: Resto del Carlino)

[1] https://anitagraser.github.io/movingpandas/

The WP5 Mimosa pilot was divided into two different testing periods, even if the detection of the e-bikes position was never stopped. The first testing period was from June 2021 to September 2022. The second testing period was from April 2022 to September 2022. Based on the collected data, **nearly 6.000 km** were travelled during the Mimosa testing period. It is important to underline, that both the travelled distance and the number of trips could be sensitive to the adopted algorithms. In fact, as described in the previous methodological paragraphs, it was needed to adopt automatic trajectories 'split algorithms to obtain reliable data. Moreover, only e-bikes trajectories longer than 500 m were considered. This assumption was needed in order to eliminate the "points cloud effect" generated by the GPS system when an e-bike stopped for more than one minute.

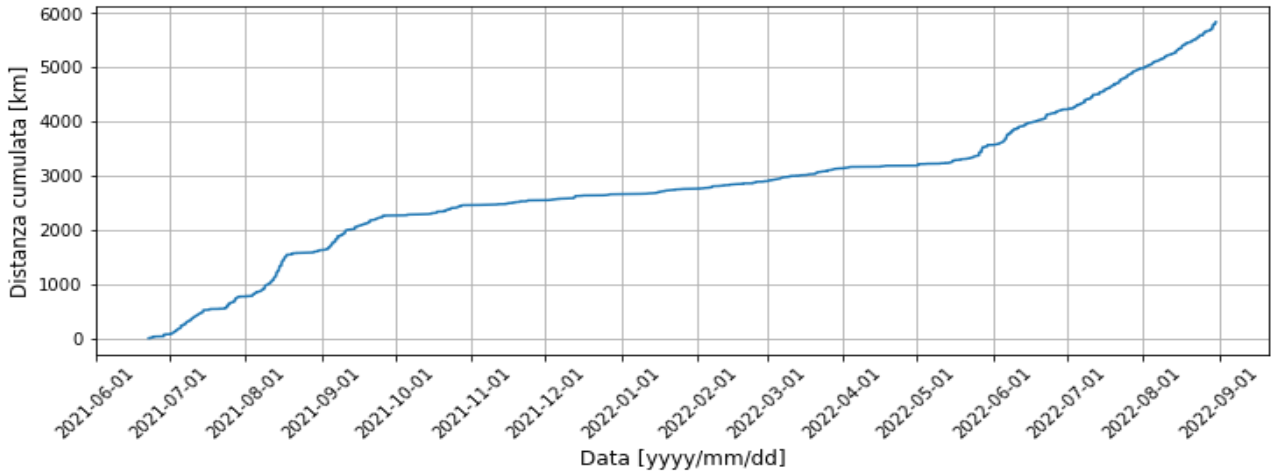


Figure 13. Cumulated e-bikes travelled km during the MIMOSA pilot testing phase in Cervia/Milano Marittima (Source: ITL elaboration).

As evidenced in the graphic above, the largest part of the travelled kilometers were detected in the 2021 and 2022 summer periods. The two months where the highest number of travels were registered were July and August. The number of travels was calculated using one of the algorithms presented in the previous paragraph (trajectories splitter). In this case, the number of trips was calculated considering the times passing from one journey to another one. Based on these data, during the Mimosa testing period about **1.920** travels were registered.
Nevertheless, as evidenced in Figure 14, the travelled km were not equally distributed among all the 16 involved hotels. There were a limited number of hotels able to generate the largest amount of the travelled km and others that were not able to use the e-bikes as requested in the contracts signed in the Mimosa pilot implementation phases.

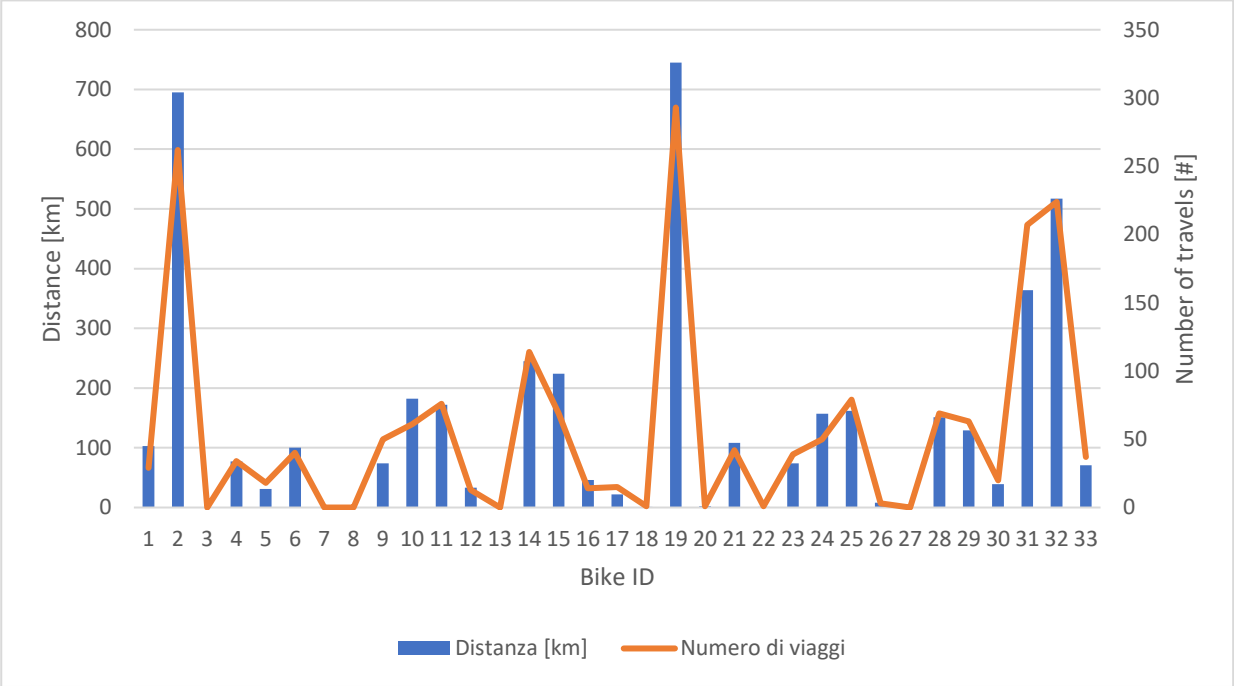


Figure 14. Summary of the travelled km and number of travels split for single Cervia/Milano Marittima hotels. The data were sensitive to the adopted algorithms (Source: ITL).

The geographical analysis of the collected data allowed to create also detailed maps of the cycle journeys travelled by the tourists using the Mimosa e-bikes. Also in this case, it was needed an advanced data elaboration in order to transform points data in linear data. This data elaboration was conducted using the open-source QGIS software and in particular the dedicated free plug-in (PointsToPaths plug-in).

Thanks to these detailed maps, it was possible to have a clear view of the e-bikes travels during the pilot testing period. The most evident conclusion is that the tourists used the Mimosa e-bikes mainly to move among the different project area main cities: Cervia, Milano Marittima, Cesenatico, Lido di Savio and Lido di Classe. From Cervia to Cesenatico there are about 10 km and from Cervia to Lido di Classe (passing through Lido di Savio) there are about 8 km. Based on the collected data, it was possible to notice that the largest part of the e-bikes uses was localized along the coastline cycle paths. So the main use of the Mimosa e-bikes was related to people using this sharing service in order to reach the beaches from the hotels and to visit the other touristic cities of the area. Based also on qualitative data collected by the hotel managers during the Mimosa pilot implementation, many tourists reported to choose the Mimosa e-bike sharing service to avoid problems with the car parking research (both in terms of difficulties to find a parking lot during the summer peak period and in terms of avoid to paying for the car parking).

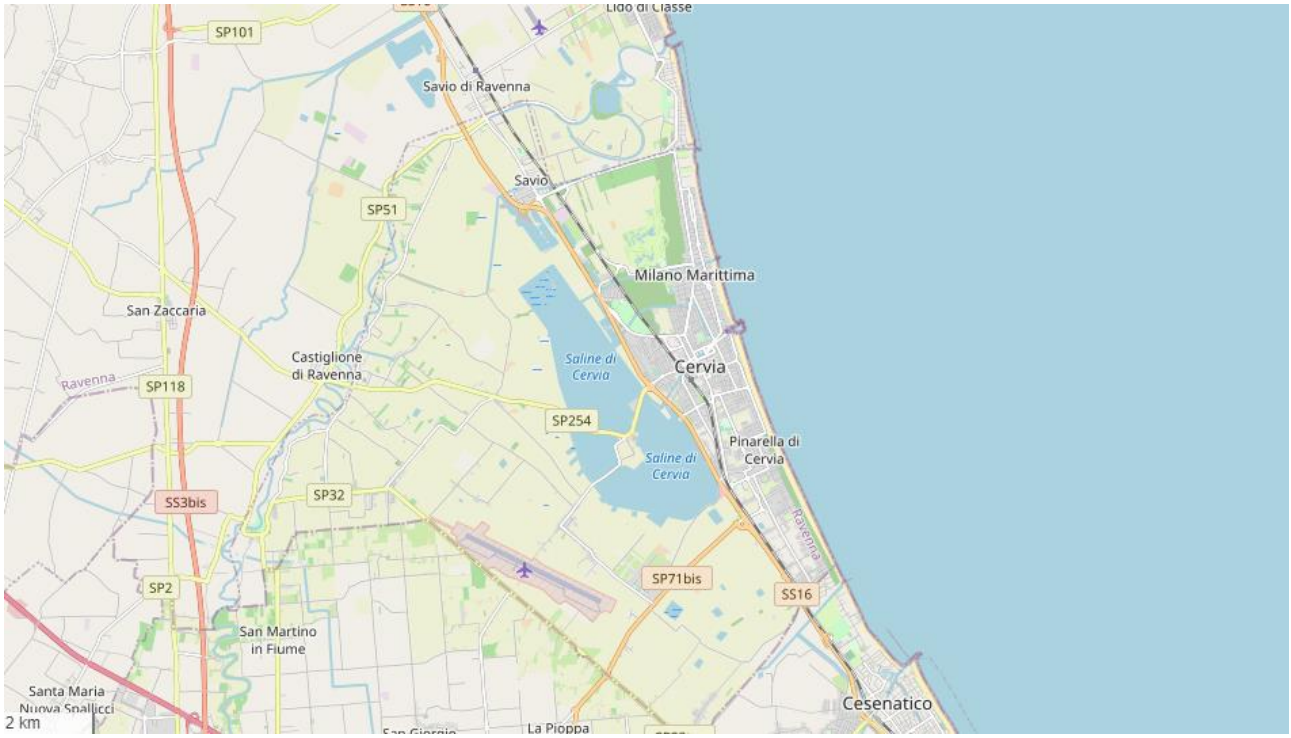


Figure 15. General overview of the Mimosa project area (Source: OpenStreetMap).

The collected data allowed to identify other interesting information on the tourists' e-bikes utilizations. As evidenced in the elaborated maps, several travels were registered not along the coastline paths but in direction to the inland areas where some urban green parks are located. Moreover, several travels were directed to the "Saline di Cervia", a natural area famous for its production of salt from the sea water. There are different access points to this area and several registered Mimosa travels were directed to these access points.

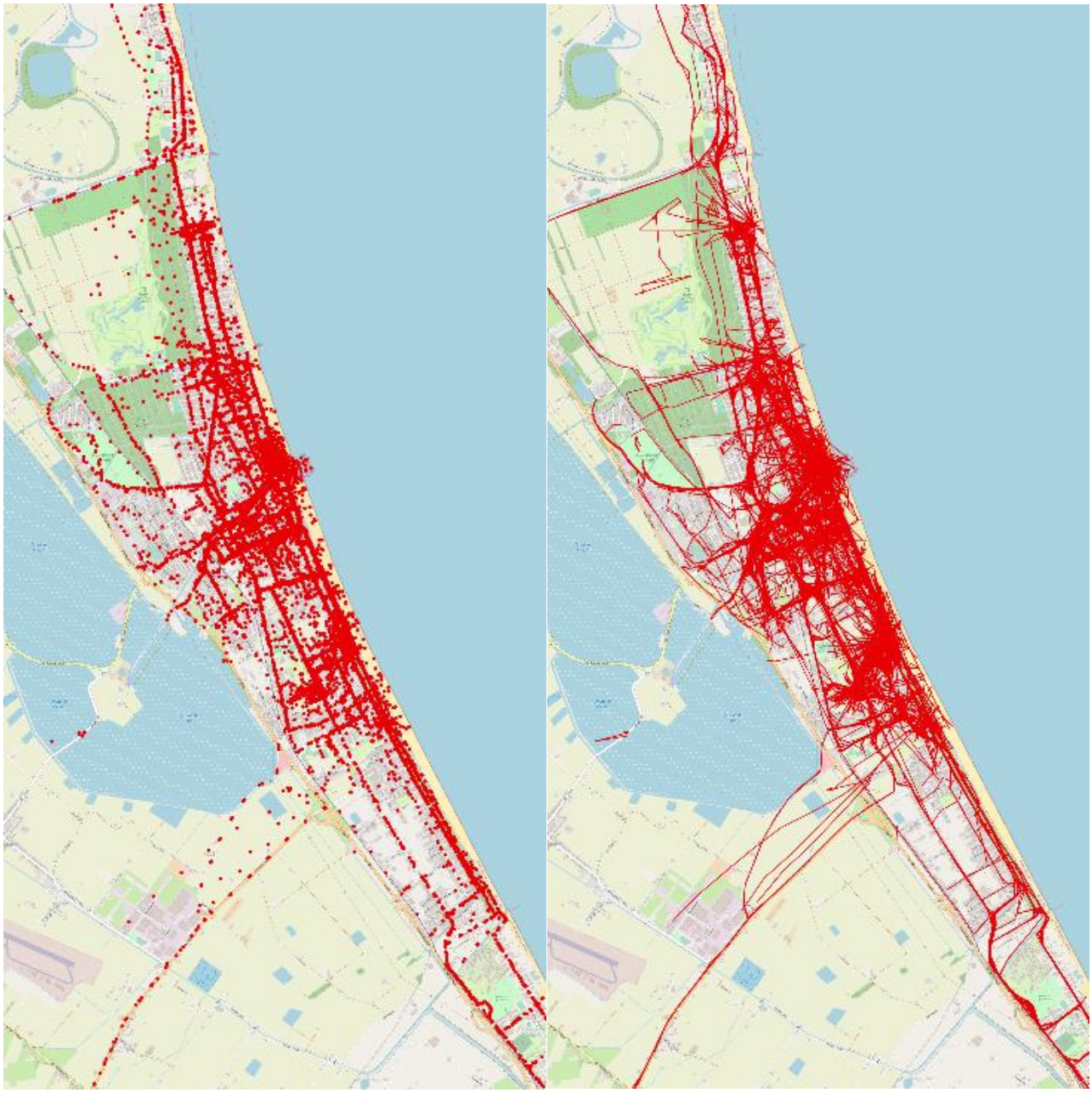


Figure 16. These maps showed in the left side the single points collected by the GPS systems as cleaned after the algorithms application. On the right side the map with the points aggregated in e-bikes paths (Source: ITL elaboration).

Based on an advanced open-source algorithm, it was possible to also start up some general considerations on the main e-bikes stopping points. As evidenced in the map below, it was possible to analyze the number of transits in each road arc and the number of e-bikes stops based

on the “cloud of points” generated by the GPS systems when an e-bike stopped in a point for more than a minute.
Based on this preliminary analysis (to be further developed as the utilized open-source algorithm had some limits and problems), it was possible to notice as the main stopping points were located at the beach’s main accesses, the main urban squares and public parks’ accesses. Based on the qualitative evidence collected during the Mimosa testing phase, it was also possible to conclude that many of these stopping points are provided with fix lock system allowing to stop the e-bikes in a safe way.

Figure 17. Map showing the number of e-bikes transit in each detected road arc. Thanks to this map it is possible to identify the most utilized road and the main stopping points (Source: ITL elaboration).

It was possible to collect data also on longer e-bicycle journeys. In particular it was possible to register different travels from Cervia to Cesena city center (about 20 km for a one-way travel) and from Cervia to Sant'Apollinare in Classe UNESCO church (about 18 km for a one-way travel). Both these travels were conducted following two existing cycle paths.

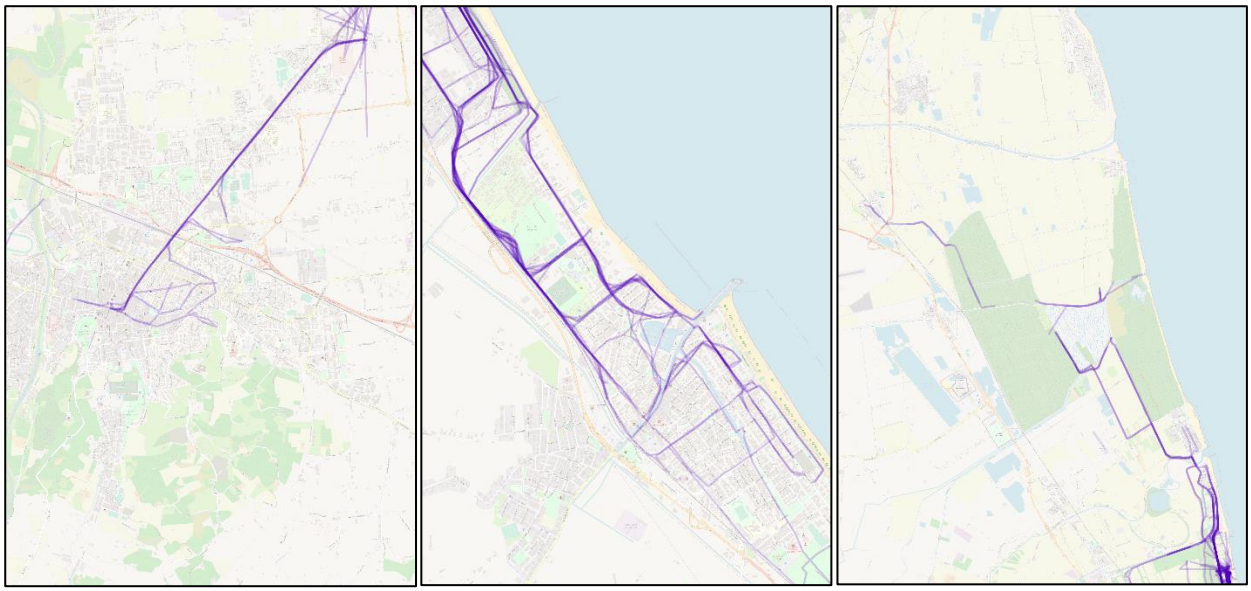


Figure 18. Map showing the longer e-bikes paths registered during the Mimosa pilot implementation. On the right the registered data from Cervia to Cesena city center, the second map show the paths toward the salty lagunas and on the left the registered paths from Cervia to Ravenna Sant Apollinare in Classe UNESCO church.

These longer travels allowed to make some general consideration on the added value of an e-bikes in supporting not only longer bike suburban/out-of-towns travels but also in terms of generating new sustainable cycle-touristic opportunities for the local economic operators.

1.5 Problems and potential solutions

The key problem registered during the WP5 Mimosa pilot implementation was related to the very low use of the e-bikes booking platform created by ITL. The need for an own ITL e-bike booking platform was needed in order to eliminate all the privacy problems related to the management of sensitive and personal data collected for the management of the Mimosa e-bikes sharing service. Even if this e-bikes booking platform was built in strict collaboration with the involved local stakeholders, in the implementation phase this platform registered a very low utilization. Hotels

involved in the Mimosa pilot implementation preferred to manage the single booking procedure using paper documents and to destroy these documents as soon as the e-bike was returned to the hotel.

Based on the evidence collected in a dedicated physical event held in Cervia on 30/09/2022, hotel managers underlined the Mimosa virtual registration/booking platform was too complicated for a hotel. The hotel managers present at the Cervia event underlined as the tourists are usually scared of "bureaucracy" and the hotel staff at the hotel desk have many different activities to do during the peak period. From the point of view of the interviewed hotel managers, "*a tourist is willing to sign a contract or any other document only if the provided text can be read in not more than 30 seconds*".

Nevertheless, based on the external lawyer's assistance activated by ITL during the Mimosa pilot action development phase, the adopted bureaucracy was needed in order to manage/avoid all the main risks related to the pilot implementation (privacy, data collection, legal responsibilities with users and hotels and e-bikes ownership). Despite the big efforts in summarize and shorten more than possible the e-bike rental contract, this was 3 A4 pages long as all the usage and responsibilities conditions had to be reported and undersigned before all the e-bike utilization.

The adopted solution developed during the Mimosa project was related to the digitalization of all the booking and contracting procedures. Nevertheless, the digitalization process activated in the framework of the Mimosa project was not able to reach the awaited effect. A potential solution to overcome this problem could be the utilization of one of the existing commercial platforms for the management of such booking service. These platforms have a higher price compared to the specific solution developed by ITL in the Mimosa project but it could be a good investment for managing in a more easy way these booking procedures.

The second problem was related to the quality of the collected GPS data, as already mentioned in the Mimosa deliverable 4.4.1. In terms of GPS system ability to correctly map the e-bike position there are huge "geographical data resolution" differences. Hence, it is very important to pay particular attention to this aspect in selecting the GPS technology to be adopted. Based on the evidences collected during the Mimosa pilot implementation, we suggested selecting the GPS systems allowing to provide data in the WGS84 standard and with at least 6 numbers in the coordinate values (despite the 4 numbers collected with the Mimosa GPS systems). The cost to have a more precise GPS system is higher (based on a market review conducted in 2021, more precise GPS systems required from 20 to 30% of additional costs). So it is important to choose the right GPS model on the basis of the type of analysis you intend to develop. Moreover, it is

important to have staff with advanced programming skills able to assist interested stakeholders in conducting the required data processing and analysis.

1.6 Conclusion and recommendations

The Mimosa Virtual Mobile Hub is more than a platform for e-bike management and free renting. Based on the different actions developed during the Mimosa pilot development and implementation phases, it is possible to conclude that the Mimosa Virtual Mobile Hub:

- It is an innovative **public-private cooperation scheme**, involving the local hotel association (FederAlberghi), 16 different hotels selected for their high sustainability standards and under the Emilia-Romagna general framework;
- It is the definition of a **legal framework** allowing to manage an e-bike free renting service with no/low legal risks for the hotels and responsible partners as ITL;
- It is the definition of an **insurance scheme** (only civil responsibility as theft insurances were in charge to the single hotels);
- It is a **data collection system** allowing to collect data from the 32 GPS systems installed in each e-bike using a dedicated online platform;
- It is a **safety system** allowing to reduce e-bikes thefts risks thanks to alarming systems activated by the GPS systems.

The Mimosa Virtual Mobile Hub connected all these different aspects in order to provide a ready-to-use platform at the local level. In this sense, we can conclude that the Mimosa Virtual Mobile Hub is a “technological ecosystem” allowing to provide a flexible e-bike sharing services in different geographical areas.

In particular, the development of a virtual Mobile Hub allowed for overcoming the main technical and costs problems related to the provision of an e-bike sharing service using a physical infrastructure as done in the Interreg Italy-Croatia project Moses. The Mimosa pilot implementation allowed to demonstrate that such a virtual solution was effective in providing a flexible and cost-efficient e-bike sharing service covering a wide geographical area and involving local touristic stakeholders with no experience in the management of such a service. The success of this scheme was demonstrated from one side by the high number of km travelled by tourists during the pilot testing phase and from another side by the public-private cooperation scheme built in the framework of the Mimosa pilot (see the D.4.4.1 for more details on the involved stakeholders and their role in the Mimosa pilot implementation). Moreover, the adopted

management schemes demonstrated to be cost-efficient in providing such a sharing service compared to the traditional stations-based and free-floating bike-sharing services.

As evidenced also in the Mimosa D.4.4.1, now the ambition in the medium term (5 years) is to continue the e-bike sharing service during the summer seasons involving the hotels/group of hotels with the highest number of kilometers registered during the Mimosa testing period and the local municipalities. Moreover, the ambition is to continue with an effective data collection from the GPS systems installed on the e-bikes. Based on the analysis of the collected data, the ambition is to help the policymakers collecting new data for improving the cycling policies and have better support in taking data-oriented policy decisions. Moreover, another ambition for the future is to increase the internal skills in terms of data elaboration in order to better analyze the collected data and to provide local decision-makers with better tools for the planning of bicycle mobility in the Emilia-Romagna coastal area.

The key recommendations for public and private operators interested in developing such a flexible e-bike sharing service supported by a virtual managerial and monitoring platform (Virtual Mobile Hub) are:

- Plan and design the e-bike sharing service with the local public and private stakeholders since the real beginning of the project idea. It is very important to agree on all the managerial and responsibilities aspects before starting with the implementation phase. The collaboration among public and private touristic operators is fundamental;
- There isn't a solution that fits all the different territorial contexts. So it is very important to plan such an e-bike sharing service considering the specific needs and the existing sustainable public transport offer. Anyway, the adopted Mimosa virtual Mobile Hub solution demonstrates to be a reliable model in touristic areas with a very variable touristic demand (this is particularly true for the Mediterranean tourism and its peak during the summer season). Adopting such a model has a low management cost and a high flexibility in terms of area where to provide the service;
- Such a touristic e-bike sharing service allows to collect a huge amount of data on the real utilization of urban spaces by the tourist. This huge amount of data required high-level skills in terms of data analysis. But is important to underline that all these analyses can be conducted with open-source software (QGIS in particular) and open-source advanced algorithms. As these data are very important, it is strongly recommended to plan an e-bike sharing service foreseen also a data collection specific activity;

- Data-oriented decision-making process is one of the most important success factors for effective and reliable public policies and investments. This kind of initiative allows to collect data on tourist travel behaviours. In fact, tourists do not always use the city spaces like the local residents. So the collected data can give to the policymakers an additional important data oriented information on how to create/improve the bike paths infrastructures;
- Digital/virtual solutions could be an effective strategy in terms of creating more flexible and cost-efficient sustainable mobility solutions for tourists. Moreover, going digital can help in also involving stakeholders with no skills in providing mobility solutions to tourists. The involvement of these stakeholders (like the hotels in the Mimosa pilot action) can help in bringing closer to the final user the sustainable mobility solutions.

A virtual management and monitoring e-bike sharing platform, completed with an appropriate cooperation among public and private local touristic stakeholders, could be an effective solution for the promotion of new innovative and sustainable mobility services for tourists.