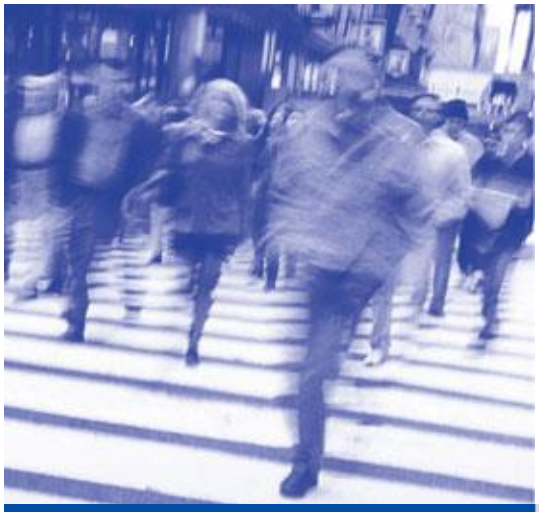

2020 CiViTAS
Cleaner and better transport in cities

PORTIS

# Feasibility study on car sharing and car pooling initiatives in the city of Trieste

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2020 CiViTAS
Cleaner and better transport in cities
PORTIS

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# Table of Contents

## List of Figures



## List of Tables

# 1 Introduction

## 1.1 The Civitas Portis project

This feasibility report concerning sharing mobility is designed in the framework of Civitas Portis project, as part of the European programme Horizon 2020, which aims at enhancing the governance to foster cooperation and synergies in port cities between the urban environment and the port. Moreover, the objective is to create sustainable and resilient mobility infrastructures, as well as an integrated and multi-modal mobility strategy in the city.

In Trieste, one of the five port cities involved in the project, there is the need to improve the transport system and mobility strategies, in order to find sustainable and efficient solutions to connect the Old Port to the rest of the city and to exploit its potential in the best possible way. In this regard, the city needs to adopt a SUMP (Sustainable Urban Mobility Plan) to incorporate the area of the Old Port together with the New Port in the mobility strategy of the Municipality and in the public transport system as well.

The SUMP has been adopted by the City Council recently and it foresees the opportunity to start sharing mobility services in the city of Trieste as well as in the surrounding territory of the Province.

Accessibility, intermodality, sustainability, public transport and sharing mobility are some key points taken into account. This study focuses on car sharing and car pooling but it considers them as parts of an integrated system of transportation, based on the Mobility as a Service (MaaS) concept.

The feasibility analysis presented in this study relies on third-party data from national scale surveys or academic studies reporting local scale data published some years ago.

# 2 Sharing mobility and car sharing

The term sharing mobility refers to a mode of transport, which is included in the sphere of the sharing economy, where the movement of people in the territory takes place using vehicles that are shared instead of personally owned. The idea lying behind sharing mobility is the shift of mobility from the ownership of a vehicle to the concept of mobility as a service (MaaS). The vehicle fleet available to users is used as a rental service for which payment is based on the time (rate per minute) or on the distance (rate per kilometre). Usually, users create an account on a mobile app and through the car sharing platform they can visualise on the map where available car are situated and book the vehicle they prefer. Access to the vehicle is monitored by the app, so that users can open it, drive until they reach the desired location, close the vehicle, end the rental and pay for it.

Car sharing services are divided in two main categories: station-based car sharing and free-floating car sharing. The main difference between the two types of service is that with the latter mode users can end the rental and park the car wherever they want (free parking spots, parking with fees, etc.) with the only limitation being the coverage of the service over the area where the rental ends and, of course, the following of the rules of parking. On the other hand, when using a station-based car sharing service, the user can only pick up and leave the vehicle in given stations which are usually distributed around the city. It is possible to end the rental in a station chosen by the user (car sharing station-based one way) or in some cases users are obliged to bring the car back to the same station where it was picked up (car sharing station-based round-trip).

Other differences characterising the two different types of car sharing service are related to the fees applied. For instance, free-floating services generally apply per minute tariffs (euro/minute) and a distance limit (usually 50 kilometres): if the user exceeds the kilometres included, a distance tariff is added to the hourly one (euro/kilometre). Whereas when considering the station-based car sharing service the rates are usually based only on the duration of the rental (euro/minute).

# 3 Economic analysis

## 3.1 Comparison between car sharing and private vehicle total cost of ownership

A costs analysis has been made considering the cost of ownership and use of private owned vehicles and then comparing them with the costs of use of a car sharing service in order to assess the cost-effectiveness of car sharing services for users. To calculate the costs of ownership of a private owned vehicle, the analysis has been based on data gathered from ACI (Automobile Club d'Italia) documents and tables released in the ordinary supplement number 47 of the Gazzetta Ufficiale n. 305 valid in the period from the 31st December 2019 until the 30th June 2020. These data show the costs related to the kilometres travelled by fuel and diesel-powered vehicles. In particular, the costs contained in the ACI documents include:

(1) Depreciation share of initial capital
(2) Interest share of invested capital
(3) RCA (Responsabilità Civile Auto) insurance
(4) Automobile tax
(5) Fuel
(6) Tyres
(7) Maintenance and repair

The above-mentioned data are comprehensive of all expenditures incurred for the use and ownership of cars (TCO-Total cost of ownership) and refer to standard values of annual distance travelled (15,000 km). They are useful to define the cost per kilometre of different models of vehicles in production for both fuel and diesel-powered:

- Average cost per kilometre for fuel-powered vehicles: 0.64€/km
- Average cost per kilometre for diesel-powered vehicles: 0.59€/km
- Average costs per kilometre for both fuel and diesel-powered vehicles: 0.62€/km

A market analysis concerning the car sharing service supply in Italy has been carried out besides the TCO analysis in order to compare the cost of ownership of a vehicle with the cost of using a car sharing service. Data in relation to rates applied by Italian car sharing operators have been gathered to define an average tariff to be applied in the following simulations and in the design of a car sharing service for the city of Trieste.

Two scenarios have been developed to compare the cost of using a private owned vehicle with that of a car sharing service: the first related to urban routes and the second to suburban ones. In the urban scenario the average speed in Trieste is assumed to be 31.9 kilometres per hour according to the report about driving habits

of the Italian population published by Osservatorio UnipolSai[1] based on the analysis of data recorders installed on cars. On the other hand, an average speed of 100 kilometres per hour has been assumed in the case of out-of-town routes by taking the average of Italian speed limits on main and secondary suburban roads (respectively 110 km/h and 90 km/h).

The results of the analysis show that the use of the private owned vehicle, both for urban and suburban travels, is more expensive than the use of a car sharing service. In the urban route scenario, the cost-effectiveness of car sharing is not significant for short rentals, but it increases over time. For suburban travels, on the other hand, car sharing is less expensive than the use of the private car for short rentals as well as for shorter distances. Moreover, the use of car sharing services is cheaper if the vehicles of the fleet are battery electric or hybrid vehicles (BEV or HEV).

## 3.2 Users' cost perception

In 2018 ICS (Iniziativa Car Sharing) developed a methodology to help car sharing users to evaluate the costs related to their own mobility profile, taking into account both the use of the private owned vehicle and the use of a car sharing service, as well as an analysis about cost-effectiveness of using a car sharing service. ICS showed the amount of fixed and variable costs associated to car ownership and highlighted that the variables to be considered are several. In this feasibility study, on the basis of the data gathered from ICS analysis, a calculation about the overall amount of the cost of ownership of a private vehicle in relation to the distance travelled is presented. ICS analysis used data related to two different categories of vehicles:

- Class 1: vehicles with purchase price between 7,000 and 13,000 euros
- Class 2: vehicles with purchase price between 13,000 and 17,000 euros

The two classes correspond respectively to city cars and compact cars, the most used vehicles for car sharing services.

Different variables must be taken into account to compare the vehicles' costs and those related to the use of a car sharing service, since the cost of use of car sharing depends on the distance travelled and:

- The type of car sharing service offered (station-based or flee-floating)
- The number of travels performed
- The duration of rentals

The above-mentioned parameters also define the most affordable tariff to apply in each case. ICS collected data about rentals from some car sharing operators in Italy and produced a combination of journeys and durations.

[1] Data source: Osservatorio UnipolSai Assicurazioni in https://www.udine20.it/le-abitudini-di-guida-in-fvg-in-media-46- km-e-80-minuti-al-giorno-in-macchina/

The results of this analysis show that station-based car sharing services are the most sensitive to the different variables, since they usually apply per minute rates and consequently the time of rental is the variable that mostly affects the cost of use of the service.

After the comparison of the costs of the two modes of transportation, ICS defined a distance threshold below which a car sharing service is cheaper than a private car. The comparison has been made considering station-based and free-floating car sharing services, both class 1 and 2 vehicles, their age (new vehicle, three-year and nine-year old vehicles) and the distance travelled.

Some relevant outputs are the following:

- There is a significant difference between the two classes considered: for class 1 vehicles the cost-effectiveness threshold related to distance travelled is lower than that of class 2 for a new vehicle (-25%). This difference gradually lowers till a few percentage points as the age of the vehicle increases.
- Although differences between station-based and free-floating services are not consistent, station-based services are more cost-effective than free-floating (10% for a new car and 7% for nine years old vehicles).
- The cost-effectiveness threshold related to distance travelled decreases and varies between 4,000 and 4,500 km/year for three-year old vehicles, and between 3,500 and 3,700 km/year for nine-year old class 1 vehicles. In this case the cost-effectiveness threshold related to distance travelled halves.
- When considering a class 2 vehicle, the affordability threshold related to distance travelled for a new car can exceed 10,000 km, a value that is close to the Italian average distance travelled per year. However, also in this case, as the age of vehicles increases the threshold drops down between 3,500 and 3,800 km, the same values defined as the threshold for the lower class 1.

In conclusion, since the cost of car sharing is directly proportional to the usage time, traffic congestion, which increases the time of rental, penalises the cost-effectiveness of the car sharing service if compared to the use of the private car. On the other hand, the reduction of the use of private owned vehicles and consequently of traffic congestion in urban areas makes sharing mobility more efficient and cost-effective.

# 4 Electric vehicles in Italy

The current situation concerning urban mobility in Italy is characterized by several issues, exacerbated by the growing levels of urbanization which needs to be tackled by implementing sustainable urban and logistics planning actions.

The most recent data show that sustainability influences health and the economy: globally, diseases linked to air pollution cause seven million deaths annually and healthcare costs reach 21 billion dollars every year. In Europe air pollution caused 470,000 deaths in 2015. In this regard, Italy and Germany are the Countries where the worst data concerning air pollution were observed. The Italian situation, as Isfort data show, is critical: the car fleet counts 38 million vehicles, mobility mainly relies on car ownership (88% of travels is made using a private car) and the car occupancy rate is 1.33 person per vehicle for urban travels.

Moreover, referring to the EU Transport – Statistical pocketbook 2017, it is useful to report that in Europe less than one third of all $CO_2$ emissions are generated by the transport sector and more than 70% of these emissions is linked to road transport. From 1990, for instance, the transport sector is the one that measured the least decrease in $CO_2$ emissions, indeed, they have been growing since that date. Mobility demand in Italy is increasingly satisfied by individual mobility, that is the preferred mode of travel; in this scenario, complementary and integrated transport systems must be included in the urban transport strategy, in synergy with the public transport system. Sharing mobility and in particular car sharing services well fit in this strategy for the future.

Other social factors worsen the situation of urban mobility: the difficult replacement of traditional fuel or diesel-powered vehicles with electric or hybrid ones; the lack of availability from consumers to leave their private owned vehicle; the need to relieve traffic congestion in urban areas and to reduce the space occupied by parked cars. In accordance with the guidelines for the design of SUMPs (Sustainable Urban Mobility Plans), urban mobility planning must follow these principles:

(1) A balanced and integrated development of the different typed of modes of transport that promotes low-emission ones
(2) The guarantee of accessibility for everyone
(3) Planning must consider the whole functional area

The approach underlying the above-mentioned issues must consider three evolution pillars, above all for what concerns urban and metropolitan mobility:

- Reduction of internal combustions engine vehicles and the consequent increase of electric vehicles
- Change in the mobility model: shift from the traditional concept of private owned vehicle to a new one based on vehicle sharing mechanisms
- Reduction of private owned car fleet

In the design of a car sharing service is useful to define ex ante which are the most important objective to achieve. First of all, the goal of a car sharing is to reduce the

traffic congestion, particularly troubled in medium-size cities as Trieste. Moreover, car sharing must contribute in solving the problem of lack of parking spots: the service should encourage users to prefer shared vehicles because they assure a free parking spot or dedicated stations where they can leave the vehicle once the rental ends. The issue of the lack of parking spots and the availability, for car sharing users, to easily find a place to park the car, is particularly relevant when considering a free-floating service: in urban areas where parking demand is high, the duration of the travel can increase in a relevant way because of the absence of available parking spots, as well as the cost of the car sharing service (which usually has per minute tariffs). In addition, the increase of rental time decreases vehicles of the car sharing fleet availability, triggering a vicious cycle that leads to an unsustainable use of the resources both for the user and from the car sharing operator. It is fundamental to promote the use of car sharing offering at the same time incentives for the user, as the possibility to freely park the vehicle, or drive in limited access zones (ZTL limited traffic zones).

The social, economic and environmental benefits of a car sharing service are scaled up when considering a car sharing service with electric-powered vehicles fleet. In this regard, it is important to highlight how the modal shift from the use of endothermic-engine vehicles to electric vehicles is linked to energy production and the development of renewable energy, that must be coordinated and coherent with the spread of new mobility models. Electric vehicles must be inserted in a new business model synergistically with the energy and mobility sectors. For instance, the design and integrated management of an innovative urban and metropolitan car sharing service based on the sharing of electric vehicles, should have the following specific objectives:

- Reduction of polluting emissions and traffic congestion
- Use of renewable energy (low environmental impact)
- Use of a mobility system compatible with the urban environment (charging infrastructures, parking spots etc.)
- Digitalization: primary use of ICT technologies, new business models, social networking of users etc.
- Integrated approach: need to adopt a governance that fosters collaboration of both public and private actors.

## 4.1 Case studies of car sharing with electric vehicles

### 4.1.1 BlueTorino by Autolib

BlueTorino, electric car sharing service of the French society Autolib', started its car sharing service in the Italian city of Turin in 2016, with a, initial car fleet of 130 vehicles and 54 stations[2]. BlueTorino experienced a relevant growth during the years and currently it counts a car fleet of 330 electric vehicles (BEV), which are bookable

[2] Source: https://it.wikipedia.org/wiki/Autolib%27

as late as half an hour before the start of the rental, 24 hours per day. Moreover, Turin's territory offers the availability of 560 charging stations and four parking spots at the airport; these are bookable by the user till one hour and a half before arrival and parking is free of charge, also when vehicles are parked in parking charges. This opportunity reduces the cost of rental as well as its duration. BlueTorino gives the user the possibility to choose between different types of registration to the service:

- Offerta 'Giovani' (Youth offer): for people aged between 18 and 25 years old, it has a membership fee of 9.00 euros and per minute tariff equal to 0.165 euros/minute;
- Membership for people aged more than 26 years old or for young drivers (people who own the driving license for less than three years) comprises a membership fee of 9.00 euros and per minute tariff equal to 0.195 euros/minute.

In both cases, the first fifteen minutes of rental are indivisible, this means that the rental has a minimum cost equal to 2.48 euros for 'Offerta Giovani' and 2.93 euros for the other one. Once the rental ends, it is not necessary to leave the vehicle in the same station where it was picked up (round-trip).

BlueTorino car fleet comprises 100% electric vehicles equipped with satellite navigation systems, radio, four seats and automatic transmission. The operational area in which the service is available has a maximum ray of 50 kilometres from the city centre.


**Figure 1**: Car sharing operational area in Turin

Moreover, BlueTorino gives the possibility to citizens who own a plug-in BEV or HEV to charge their car at its charging stations. The charging station and the reserved parking spot can be booked, and the cost of parking is included in the charging tariff. It is also possible to subscribe an annual membership at the cost of 15.00 euros and an hourly tariff of 4.00 euros. Each recharge has a minimum cost equal to 1.00 euro and the following minutes cost less than 0.07 euros per minute. BlueTorino, in addition, provides a virtual map in its website, where the user can find in real-time available vehicles, parking spots, charging stations and booth to subscribe memberships.

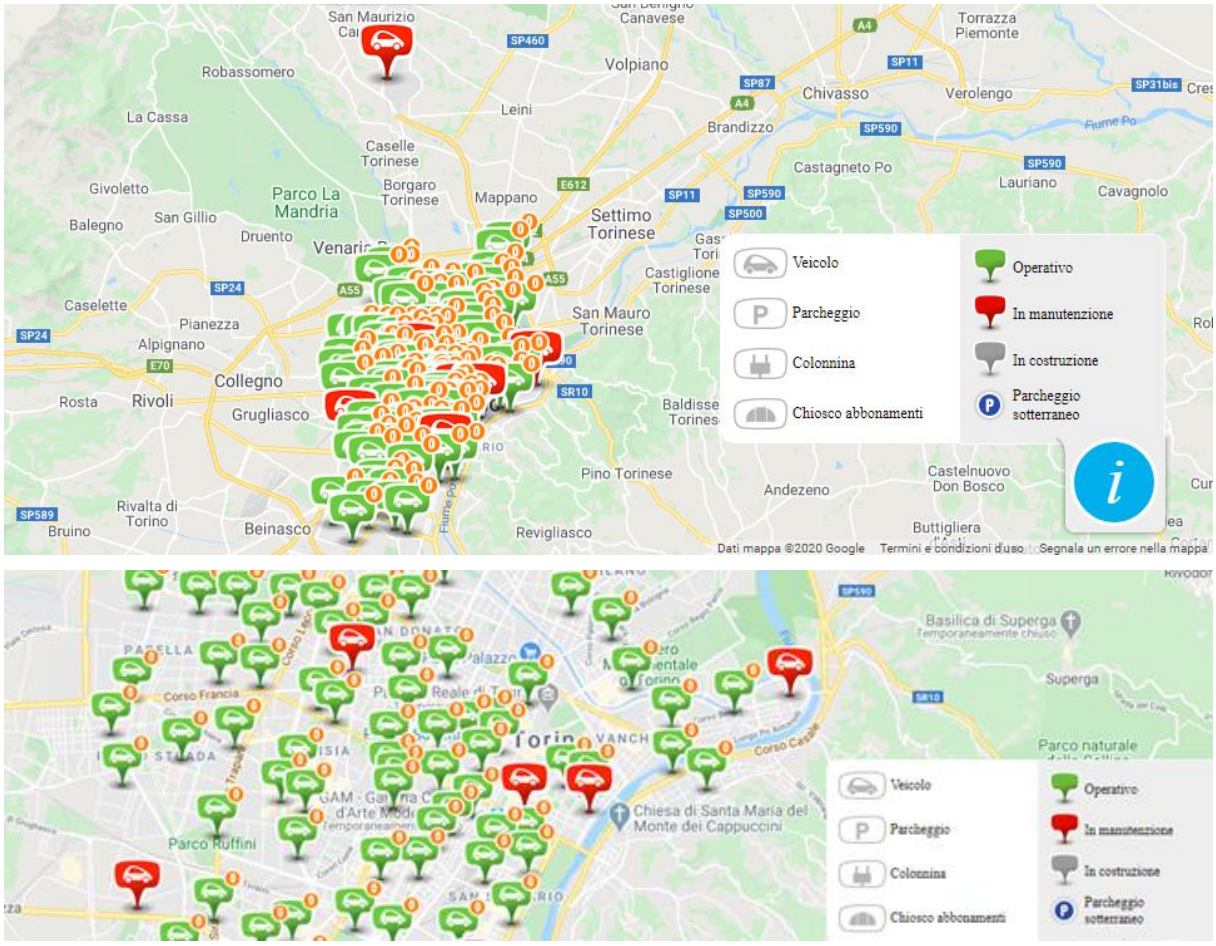


**Figure 2**: Location of BlueTorino stations

The electric car sharing service brought to the city several benefits: occupation, the reduction of environmental and acoustic pollution, the decrease of the car fleet in the urban area and of traffic congestion levels, the contribution in positioning Turin as European leader in the electric mobility sector and the promotion of sharing economy and sharing mobility.

# 5 Main reasons for car sharing service failure

Unfortunately, not every car sharing service launched in Italy reached the success expected, on the contrary, at a certain point, they faced problems and failed. The causes of failure differ and the main ones can be summarized as follows:

- The missed achievement of the number of users expected;
- The strictness of the service: the choice to start station-based car sharing services penalized some societies compared to those who chose the free-floating modality;
- Competition with other operators that offer more innovative services;
- The presence of very efficient public transport systems;
- Expansive and unsustainable operational costs (vehicles and charging stations maintenance, vandalism, etc);
- The failure in the change of habits regarding people transportation modes;
- Scarce use of shared vehicles;
- Lack of support from public administrations;
- Inappropriate marketing;
- Bad financial management and planning;
- Users' demand concentrated only in peak hours.

Currently, it is still difficult to create profits by activating a car sharing service, for this reason it is fundamental that the management is directly or indirectly handled by car manufacturer. Automotive enterprises, in fact, are usually available to invest even if the profit prospects are low, since car sharing is considered as a step forward to the wider change of paradigm from car ownership to mobility as a service. Moreover, automakers see the potential of the service to promote and advertising their vehicles.

# 6 Context analysis

## 6.1 The Friuli Venezia Giulia region and the city of Trieste

People living in the Friuli Venezia Giulia region are 1.2 million and the population is mainly concentrated in middle or small-size urban centres. There are four main cities: Trieste, Gorizia, Pordenone and Udine. Trieste, the capital city, is the most populated one (204,267 inhabitants), is the 15$^{th}$ Italian city as far as population is concerned and its density index is 2,400 inhabitants/km$^2$.

Considering transportation habits of the citizens of Trieste and particularly car ownership, the private car ratio (538 vehicles/1,000 inhabitants) is lower than the Italian average (637 vehicles/1,000 inhabitants) and the public transport is widely spread over the territory and rather efficient. For all these reasons many people already use the public transport to commute and for daily trips.

According to data provided by Osservatorio UnipolSai, in Trieste private cars are used on average only 251 days per year and the distance travelled is 9,888 km at a speed of 31.9 kilometres per hour. The data show that private cars remain unused for 114 days per year and are only used 74 minutes in the remaining days to travel 39.4 kilometres on average. This means that private cars in Trieste remain stationary up to the 97% of the time during the whole year.

Except for Trieste, the population density index of the region is low and this is also one of the reasons why there are no car sharing services available in this area.

It is not easy to assess the possible users of a car sharing service because the demand is influenced by many different factors. Nonetheless, the University of Trieste developed a methodology in 2017 in order to estimate the number of possible users in the Friuli Venezia Giulia region. A simulation has been run based on the general cost of the trip done with different transport modes and calculating the frequency of the situation in which the general cost of the trip including the use of the car sharing is more affordable than the other options. The result pointed out that the only city of the region where a car sharing service could be activated is Trieste.

The editing of the Sustainable Urban Mobility Plan (S.U.M.P.) of the city of Trieste is ongoing and a lot of interesting data can be found in the report showing the outcomes of the preliminary analysis phase. Almost half of the population choose to use a private motorized mean of transport for daily trips and private owned vehicles are the most widely used. For what concerns the occupancy rate of cars, the 68.5% of the cars in circulation have as only passenger on board the driver, the 25.5% carry two people and the average car occupancy rate is 1.4 people per vehicle. The main reasons that drive people in the choice of the mode of transport are comfort, total travel time, lack of a private car, parking difficulties and cost.

Despite there are two peak periods during the day (7:00 – 9:00 a.m. and 4:30 – 7:30 p.m.), the traffic level remains significant and constant during the whole day.

## 6.2 The present public transport service and innovation trend

Public transport network in the metropolitan area of Trieste is wide and diffuse (340 kilometres of lines). There are 59 bus lines and one tram line, which serve 70 million passengers every year, and the average distance between bus stops is 200 metres. In addition, the public transport company, Trieste Trasporti, also provides the maritime passenger transport service in the Gulf of Trieste.

During the planning phase of a car sharing service, the quality and efficiency of the public transport service is relevant because car sharing is not a competitor but complementary and must be integrated with the public transport system, in order to create an interoperable mobility network. In autumn 2019, the public transport company of Trieste tested a service of on-demand bus covering the suburban area. The service was called ‘SmartBus’ and was the pilot of the Interreg Central Europe Peripheral Access project. Users could book their trip through a web platform or a call centre and choose the pick-up bus stop, the destination and the departure or arrival time. The system aggregated routes and gave a feedback to the user. SmartBus served the less populated areas connecting them with two public transport hubs where users could easily access conventional bus lines and reach the city centre.

After having successfully tested the service, the company is willing to activate other on-demand services in some urban areas too, especially during weekend night hours.

## 6.3 Two possible scenarios: urban and metropolitan car sharing

The first scenario we considered in this study considers the possibility of activating an urban car sharing inside the municipality of Trieste. However, after having analysed it, this option was discarded because the area is too small and such a service risks subtracting users to public transport and active mobility, as well as increasing traffic congestion. The main goal of activating a car sharing service, in fact, is to change the modal split in favour of more sustainable forms of mobility, so the main modes to be preferred for trips in the city centre are public transport, micro-mobility and active mobility. The car sharing service should discourage the use of private owned cars to reach the city centre, therefore a car sharing service that allows to better connect the outskirts of Trieste with the areas where the public transport is more easily available or with public transport or mobility hubs is preferred. For all these reasons the second scenario investigated is the best one because it could also incentivize people to multimodality.

The metropolitan car sharing scenario is designed to serve a wide area and connect Trieste and neighbouring urban centres to the airport. It is planned to be a station based one-way car sharing because the cars will be battery electric vehicles (BEV) and the stations will host the charging facilities, but it will also make possible to end the rental in a drop zone of about 200 metres of radius from the station if the battery state of charge of the car is higher than 50% or if the car sharing parking lots are already occupied.

After having analysed the potential demand in all the municipalities of the metropolitan area of Trieste applying the car sharing usage rates per age range on national level provided by ISTAT to the resident population, five municipalities out of seven have been selected to host one or more stations of the car sharing service: Trieste, Monfalcone, Muggia, San Dorligo della Valle and Duino – Aurisina. In these municipalities the ratio of potential users of car sharing compared to the adult population is 1.4% and the number of potential users is 3,045. Moreover, additional users could be airport passengers, whose number is not easy to estimate according to available data. 783,179 passengers went by Trieste airport in 2019 and the daily average number is 2,146. The new intermodal hub is also located next to the airport and it could attract commuters heading to the metropolitan area of Trieste from other origins and car sharing could be a further transportation option for their daily trip. Tourists could be other potential users, but despite the trend of arrivals is constantly growing year after year, the average length of stay is 2.3 days, which means that tourists mainly visit the city centre. Nonetheless, if only 0.5% of tourists would use the car sharing service, there could be about 2.000 additional occasional users per year.

According to the studies consulted, the typical car sharing user is aged under 45 years old, owns a high level of education (graduate or Ph.D) and is environmentally aware.

Car sharing usage frequency has been estimated as well on the basis of national data provided by the 2018 Ernst and Young report. Almost half of users employ car sharing only once a week (44.4%) and only about a quarter (27.8%) more than five times a week. The estimation of the number of people associated to their usage frequency in the metropolitan area of Trieste is shown in table 1.

| Usage frequency | % | Number of users |
|---|---|---|
| Once a week | 44.4% | 1,352 |
| Twice a week | 11.1% | 338 |
| 3 times a week | 16.7% | 509 |
| 4 times a week | 0% | 0 |
| 5 times a week | 0% | 0 |
| more than 5 times a week | 27.8% | 847 |
| **TOTAL** | **100%** | **3,045** |

**Table 1**: Percentage and number of users according to car sharing usage frequency

## 6.4 Hypothesis on car sharing stations positioning and car fleet size

Basing on the potential demand analysis in the municipalities of the metropolitan area of Trieste and on the outcomes of the preliminary analysis of the SUMP of Trieste, it is possible to propose some locations where car sharing stations could be established. The origin-destination analysis is important in order to understand how people move in the area. 80% of people arrives from Italy and 20% from abroad; 68.1% of people coming from Italy arrives from the municipalities located in the metropolitan area (mainly from Muggia, San Dorligo della Valle and Duino – Aurisina). As far as destinations are concerned, 97% of people heads to Italy and 96% of them is directed to the metropolitan area of Trieste. The main destination is the municipality of Trieste, followed by Duino – Aurisina, San Dorligo della Valle and Muggia.

An origin-destination analysis concerning the municipality of Trieste has been conducted in order to understand which places are the major generators or attractors of mobility. The choice of the location of car sharing stations has been made according to the resulting list and considering the idea of the creation of some mobility hubs proposed by the technical consultants who edited the SUMP on the behalf of the Municipality.

Car sharing station location proposal is shown in figure 3: stations are indicated with the red symbols, the light blue one highlights the airport location, purple ones the mobility hubs that have already been planned by the municipality of Trieste within the PrIMUS project and yellow ones are the possible future stations that could be activated in a second phase.

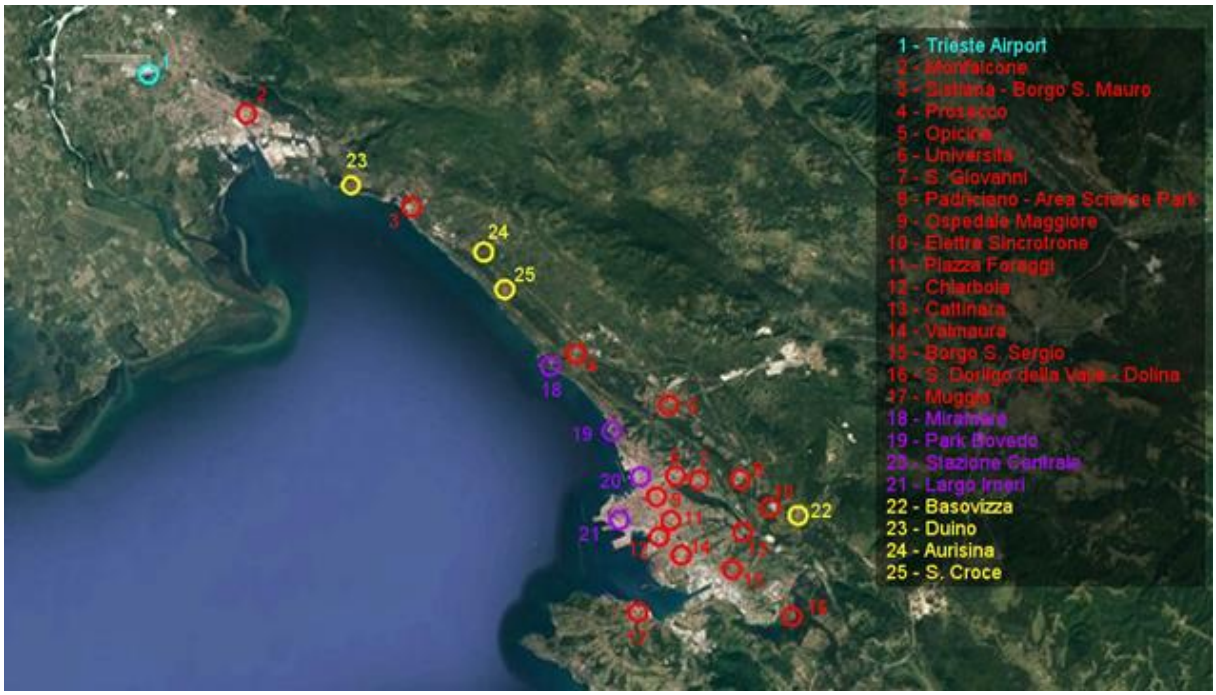


**Figure 3**: Car sharing station hypothesis

Since the car sharing stations are not located in the very city centre of Trieste, an extension of the new bike sharing service towards more peripheric and residential areas of the city would be an option in order to connect the central area of Trieste with the car sharing stations. The proposal of new bike sharing stations is visible in figure 4, together with the main cycling mobility axes of the city and the suggested car sharing stations (red and purple circles).

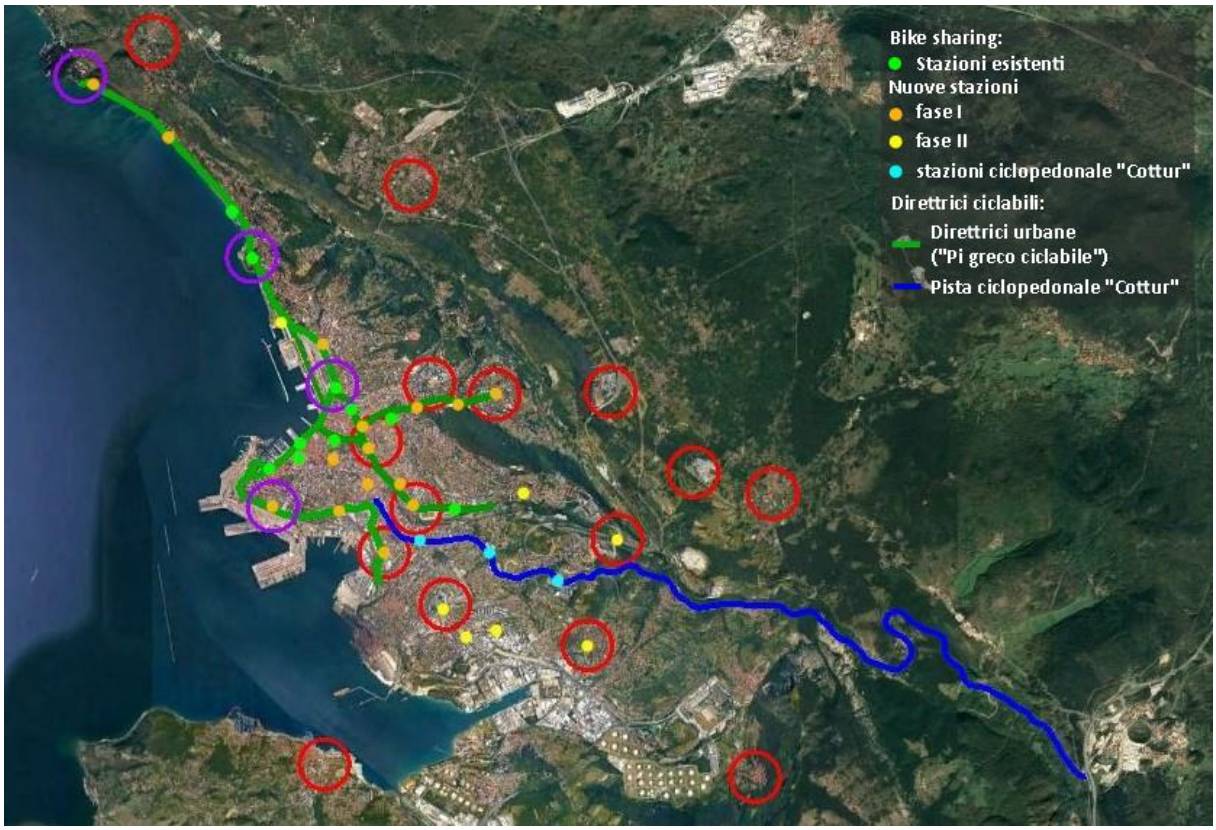


**Figure 4**: Car sharing stations and hypothesis of future bike sharing stations

The estimation of the car sharing fleet has led to the suggestion of 50 vehicles, and 21 stations to be operative when the service will be activated. This solution is reasonable because it aims at providing at least two vehicles at each station and more available vehicles in specific areas where a greater number of people could use the service (e.g. the airport).

On the basis of the already mentioned study conducted by Ernst & Young in 2018, it is possible to estimate the average number of daily users per car.

| Usage frequency | % | Number of users | Daily users/car |
|---|---|---|---|
| Once a week | 44.4% | 1,352 | 3 |
| Twice a week | 11.1% | 338 | 1 |
| 3 times a week | 16.7% | 509 | 4 |
| 4 times a week | 0% | 0 | 0 |
| 5 times a week | 0% | 0 | 0 |
| more than 5 times a week | 27.8% | 847 | 14 |
| **TOTAL** | **100%** | **3,045** | **22** |

**Table 2**: Car sharing usage frequency

## 6.5 Cost analysis and possible rates

The tariff type pointed out for the car sharing service is timely (per minute tariff) because it resulted being the most cost-effective for clients and the pricing system that incentivizes more people to use the service. In order to estimate the price, some assumptions have been made:

- The time frame considered in the cost-revenue analysis is 10 years
- The number of users grows from 0.1% (225) to 0.9% (2021) of adult population living in the area where the service will be provided and the frequency of use grows from once a month to once a week
- The fleet is made of 50 electric cars which are not owned by the car sharing company but are long-term rented
- The cost of operations is considered low, since it is mainly a station-based car sharing and vehicles reallocations should be kept at a minimum
- The average rent duration is considered 20 minutes, average speed 40 km/h and distance travelled 13 km
- Electric vehicles' energy consumption is considered 0.2 kWh/km and electric energy cost 0.20 €/km

- Fixed costs are:
  - rental fees for 50 vehicles
  - purchase and set up costs of 50 on-board computers (una tantum costs)
  - purchase and installation costs of 25 charging infrastructures for electric vehicles (22 kW power)
  - municipal public space occupation fee (COSAP) costs of 50 reserved parking bays for charging
  - staff costs
  - vehicle cleaning and reallocation costs
  - 24/7 client support (i.e. call center) costs
  - administrative office rental cost
  - Marketing costs

- Variable costs are:
  - Vehicle charging costs
- 5% of all previous costs has been added to the overall cost in order to tackle possible unexpected events (e.g. acts of vandalism)

Eleven scenarios have been developed to assess the possible variation of the per minute tariff according to different service configurations and external supports:

- Number of vehicle types (both compact citycars and citycars or compact citycars only)
- Vehicle rental fees discount (-10% or -20 %)
- Municipal public space occupation fee (COSAP) payment exemption
- Public support (e.g. free of charge provision of the administrative office, annual financial support)

| | | | | *private* | *public* | | |
|---|---|---|---|---|---|---|---|
| **Scenario** | **Tariff** | **Vehicle type** | **Break even point** | **Vehicle rental fees discount** | **COSAP** | **Annual public support** | |
| **1** | 0.40 €/min | 2 | 8th year | 0% | 100% | - € | *no external support* |
| **2** | 0.39 €/min | 2 | 8th year | 0% | 0% | - € | *public space occupation fee exemption* |
| **3** | 0.37 €/min | 1 | 8th year | 0% | 0% | - € | |
| **4** | 0.38 €/min | 2 | 8th year | 10% | 0% | - € | *private support* |
| **5** | 0.37 €/min | 2 | 8th year | 20% | 0% | - € | |
| **6** | 0.34 €/min | 1 | 8th year | 20% | 0% | - € | |
| **7** | 0.33 €/min | 1 | 8th year | 20% | 0% | Office provision | *private support + public support* |
| **8** | 0.33 €/min | 2 | 8th year | 20% | 0% | 50,000.00 € | |
| **9** | 0.32 €/min | 1 | 8th year | 20% | 0% | 50,000.00 € | |
| **10** | 0.29 €/min | 2 | 8th year | 20% | 0% | 100,000.00 € | |
| **11** | 0.28 €/min | 1 | 8th year | 20% | 0% | 100,000.00 € | |

**Table 3**: Scenarios and tariff variation

As shown in Table 3 estimated per minute tariff varies between 0.28 € and 0.40 €.

Some other rate options have been proposed: a 18.00 € fix rate could be paid by users travelling between Trieste and the airport or an automatic (A.I. based) dynamic rate system could be set up in order to balance offer and demand as ShareNow does. A lower rate for users who do a round trip could be considered too.

To conclude, the service could be provided thanks to the creation of different partnerships: one or more private business companies, a public-private partnership involving both local public administrations (i.e. municipal, metropolitan or regional authorities) and private companies (e.g. car sharing, car manufacturer, insurance or breakdown assistance companies, charging point operators and utilities).

## 6.6 SWOT analysis of the metropolitan car sharing service

| Strengths | Weaknesses |
|---|---|
| Urban pollution and GHG emission reduction thanks to electric vehicle fleet<br><br>Noise pollution reduction<br><br>Lower costs for users compared to the private car use<br><br>More ease in parking thanks to reserved parking<br><br>Integration with public transport and active mobility | Costs to reallocate vehicles throughout the metropolitan area of Trieste<br><br>Higher initial cost needed to set up an electric car sharing<br><br>Citizens' lack of knowledge on electric vehicles<br><br>Citizens' lack of knowledge on car sharing<br><br>City dimension (middle-size) |
| **Opportunities** | **Threats** |
| Electric mobility knowledge dissemination<br><br>Private car fleet reduction in the urban area<br><br>Parking space need reduction<br><br>Larger number of potential users thanks to the direct link with the airport (both tourists and residents)<br><br>Possibility of creating synergies with great attractors, institutions and private companies located in the metropolitan area (e.g. corporate car sharing)<br><br>Increase of the number of charging points in the area and possibility of charging private electric vehicles too<br><br>Possibility of using the car sharing booking platform to organise car pooling trips and divide the cost between passengers automatically | Public transport or bike sharing users' reduction<br><br>High average age of the population (48.2 years old)<br><br>Low utilization or refusal of the service by citizens so that it becomes not economically sustainable<br><br>Car sharing perceived as not economically convenient by citizens since they are not fully aware of the total cost of ownership of their private cars<br><br>Need of frequent reallocation of vehicles with consequent increase in costs and possible disruptions for users<br><br>Acts of vandalism |

**Figure 5**: SWOT analysis

# 7 Car pooling

## 7.1 History and different kind of car pooling

Car pooling is a form of ride sharing in which a trip is shared by a group of people who get organised in order to use the same vehicle at the same time. The main objective of car pooling is to reduce the cost of the trip by dividing it between all the passengers.

According to some studies, the origin of this form of sharing mobility dates back to the beginning of the XX Century when the ownership of private cars started spreading. This transport mode became popular especially during all the economic crisis periods and in the last decades, as environmental awareness has risen and it started to be considered as a form of more sustainable and efficient use of existing private cars.

From the beginning of the XXI Century internet, ICT platforms and smartphone applications made easier to offer or find a shared trip and the practice of car pooling grew significantly.

Car sharing is widely used by people who travel for long distances (suburban car pooling) or to go to work (corporate car sharing). However, the contexts where car pooling is more used are work and university.

## 7.2 Car pooling in Italy

Autostrade per l'Italia, the Italian highway company, incentivises car pooling in the Noth-East of the metropolitan area of Milan aiming at reducing traffic congestion generated by commuters in peak hours. Car poolers can use an on-line platform to create groups and organise the shared trip, have a reserved lane at the toll booth and pay a lower price. The company promoted this measure to try to reduce the traffic jams when the construction of new lanes will start.

Car pooling Roma, active in the capital city, promotes car pooling in the metropolitan area of Rome and in the surrounding regions and use the same platform developed by Autostrade per l'Italia.

The Municipality of Milan promotes car pooling too, providing a platform (BePooler) and free reserved parking to commuters.

Beside these local initiatives there are several car pooling communities all over Italy based on digital services provided by private companies: BlaBlaCar, Clacsoon, JoJob, UP2GO and Zego.

## 7.3 A proposal for Trieste

Car pooling and car sharing bring benefits both to users and to the overall society. Users can reduce their mobility costs, find a parking spot more easily and often free of charge. On the other hand, the community could benefit from a reduction of environmental negative impacts deriving from the massive use of private owned cars in urban areas, of traffic congestion and the need of parking space.

These benefits would be further increased by the integration of car pooling and car sharing. The higher car occupancy rate of car pooling would reduce the number of vehicles and car sharing would reduce the time vehicles are not used as well as parking space need. The car sharing platform could allow users to organise car pooling trips both with shared and private cars, and therefore automatically divide the cost of the trip between passengers.

The best solution to integrate all the different forms of mobility available in the metropolitan area of Trieste (car pooling, car/bike sharing, public transport, micro-mobility and active mobility) and to promote multimodality is the creation of a single digital mobility platform that can suggest the most efficient transport mode and allow users to easily buy all the tickets or pay fares needed for the whole trip.

### 7.3.1 Incentives

The most effective way to incentivize citizens to do the car pooling is to reserve some parking areas or allow them to park free of charge. The car pooling platform could generate a digital certificate for car pooling trips linked to the vehicle license plate, time and place where the trip ended and the owner of the car can get the benefits through a smart contract.