



Developing waterborne urban transport services: a benchmarking overview towards the implementation of viAmare project

Valentina Costa ^{1*}, Ilaria Delponte², Tommaso Filì¹

¹Italian Excellence Centre for Logistics, Transport and Infrastructures, University of Genoa, Italy

²Civil, Chemical and Environmental Engineering Department, University of Genoa, Italy

Abstract

Multi-modality and green technologies are keywords driving mobility strategies both on a EU and national level; sea-borne transport plays a pivotal role, as well, in term of EU market competitiveness and economic development, thus representing a relevant challenge as far as service feasibility and sustainability are concerned.

Significant efforts have been made in this direction by Metropolitan City of Genoa, in Northern Italy, to develop *viAmare* project -a research funded by Italian Ministry for Infrastructures and Transport, and conducted with scientific support by the University of Genoa- in order to design a short-sea-shipping service to make local transport system more resilient both for commuters and tourists.

Following previous contribution on the initial steps of service design¹, present work will focus on the benchmarking of waterborne urban transport best-practices to support local administration choices concerning fare-policy and service management for the new solution to be implemented within the Genoese area.

Keywords: Maritime transport, Short-Sea Shipping, Multi-modal transport integration.

1. Introduction

Making European mobility smarter, greener and more resilient are the main targets for EU transport policy (European Commission, 2020). Strategy implementation involves indeed the need to act on several issues. Being transport sector responsible for a significant share of polluting emissions -approximately 37% of the global production (IEA, 2021), main goal is represented by the implementation and spreading of green technologies able to cut GHG impact. Reducing fossil-fuels dependency through modal

* Corresponding author: Valentina Costa (valentina.costa@edu.unige.it)

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shift and electric-transition would indeed help (Schlögl, 2017) to improve air quality, citizens health and wellbeing.

Nevertheless, targeting a more sustainable and resilient transport system requires to focus on other aspects, as well. Inclusiveness and accessibility, above all.

Transport availability is therefore a pre-condition to access social, economic and personal growth opportunity which need to be granted for everyone living within the EU, being him/her a urban or rural resident, young or old, car-licensed or not (Dodson *et al.*, 2004; Asomani-Boateng *et al.*, 2015; Porru *et al.*, 2020; Stanley and Stanley, 2017).

It is necessary though to support a widespread mobility supply able to meet different kinds of demand. Multi-modality represents indeed the answer to cope with various territories, urban and infrastructural asset, way of living urban and rural areas. Moreover multi-modality constitutes the key element to support the implementation of a redundant, thus more resilient transport supply able to cope with the challenges related to climate change and consequent extreme events (Mattsson and Jenelius, 2015; Zhou *et al.*, 2019; Tamvakis and Xenidis, 2012).

Similar considerations led indeed European policy-makers to support short-sea-shipping solutions in order to reduce traffic-flows related congestion phenomena within urban centres and implement an integrated transport system provided both on terrestrial and maritime-side (Perčić *et al.*, 2020; Raza *et al.*, 2020; Santos *et al.*, 2022).

According to this strategy, Italian Ministry for Infrastructures and Transport funded several initiatives to support sustainable mobility transition. Among these, Metropolitan City of Genoa is currently implementing the design of a short-sea-shipping service, the so-called *viAmare* project, to enlarge local mobility supply and provide users, being them residents or tourist, with a maritime alternative to cross the city using hybrid-fuelled boats. University of Genoa is providing scientific support to define service features and pre-requisite to assure its feasibility and sustainability.

An initial analysis was conducted to assess potential quays and routes, in order to favour integration and inter-modality with local terrestrial transport supply and network, considering a necessary pre-condition of an effective and relevant modal-shift (Delponte and Costa, 2023). In particular, three routes and relative stops were identified -on a urban, metropolitan and regional scale- providing an assessment as well of their potential referring to park-and-ride facilities, bus network stops and railway stations.

Present work has the aim to bring forward this analysis, through the collection and benchmarking of 11 waterborne urban transport services, to highlight relative fare-policies and management models. This consequent step provided interesting insights to define potential service scheme granting feasibility and sustainability to the Genoese maritime service to be.

In the following section, applied approach to case-studies collection and benchmarking will be introduced (Section 2) and later implemented referring to European and International case-studies (Section 3). Finally, findings and results concerning fare policies and service management schemes will be discussed (Section 4) and conclusions will be drawn in relation to the transferability for Genoese *viAmare* hypothesis (Section 5).

2. Materials and Methods

To frame case-studies selection and collection, some premises should be made referring to which kind of waterborne transport services are considered comparable to *viAmare* targets and features.

Several overviews on urban waterborne transport services have already been conducted to highlight shared features and local peculiar aspects (Cheemakurthy, 2017; Janjevic and Ndiaye, 2014). Nevertheless, present benchmark analysis targets the aim to investigate service-management schemes and fare-policies of existing similar experiences to assess potential elements to be implemented within Genoese experience. To address present research, several assumptions were drawn:

- First choice was to include passenger services only. Freight sea-borne urban transport indeed has been deepened by several scholars (Grosso et al., 2010, Hallock and Wilson, 2009; Paixão Casaca and Marlow, 2009) nevertheless it goes beyond the purposes of *viAmare* project that focuses on the potential of maritime travel to support and integrate sustainable urban mobility shift.
- Moreover, as far as passenger seaborne urban transport are concerned, services that are required, and thus financed by Italian Government to guarantee islands' accessibility (Italian Republic Constitution, art 119) were not included in benchmarking analysis, as well. This assumption was to be made in order to investigate service feasibility independently by State direct funding.
- Third assumption was to include point-to-point services only, in order to assess service potential and competitiveness to urban terrestrial transport network. Only when several frequent stops and a widespread waterborne transport supply are present, similar solution may be considered as solid and interesting integration to traditional local mobility framework.
- All waterborne services were considered, being they implemented for lake, rivers or sea basins. This consideration was due to the fact that a similar short-sea-shipping service, is supposed to sail nearshore -for a large part of the route even within the breakwater- so that sea conditions may be compared to river and lake ones without the need for further specifications.

Following these hypothesis, as stated before, case-studies were selected and assessed to highlight service management and fare policies, in particular, considered variables were:

1. Service details and fares

- a) Is this service provided as Public Transport?
- b) Is its mobility provider a private, public, or private-public subject?
- c) Is it subsidized or not?
- d) Which is the seaborne service/terrestrial alternative ticket price ratio?

In order to assess fare competitiveness some detail concerning boats fuel, passenger capacity and service frequency were investigated, as well.

2. Boats features and service frequency

- a) Which is fuelling applied technology?
- b) Which is boats' capacity?
- c) Which is peak hour travels' number?

Investigating similar features helped indeed to frame not only most frequent schemes among seaborne urban transport services, but to highlight as well, which may prove to be more effective and suitable for Genoa metropolitan area, according to context's analysis previously developed in the initial part of *viAmare* project (Delponte and Costa 2023).

3. **Case-studies' overview**

According to similar premises and approach, 11 case studies coming from National, European and International experiences were selected.

In particular, following passenger waterborne transport services were analysed:

1. NYC Ferries, New York
2. Waterbus Service, Rotterdam
3. River Bus, London
4. Waterbus Service, Dubai
5. CityCat service, Brisbane
6. CGN, Lake Geneva
7. SGV, Lake Lucerne
8. Navigazione Laghi, Lake Maggiore
9. Tigullio Gulf Ferries, Tigullio Gulf
10. Paradiso Gulf Ferries, Paradiso Gulf
11. Bodensee Schifffahrt, Bodensee

Even though all types of water infrastructures were included, according to general classification of similar services, case-studies may be clustered whether insisting on river, lake or maritime basins for a further deepening of case individual features:

River Services

- Waterbus Service, Rotterdam
- River Bus, London

Lake Services

- CGN, Lake Geneva
- SGV, Lake Lucerne
- Navigazione Laghi, Lake Maggiore
- Bodensee Schifffahrt, Bodensee

Maritime Services

- NYC Ferries, New York
- Waterbus Service, Dubai
- CityCat service, Brisbane

- Tigullio Gulf Ferries, Tigullio Gulf
- Paradiso Gulf Ferries, Paradiso Gulf

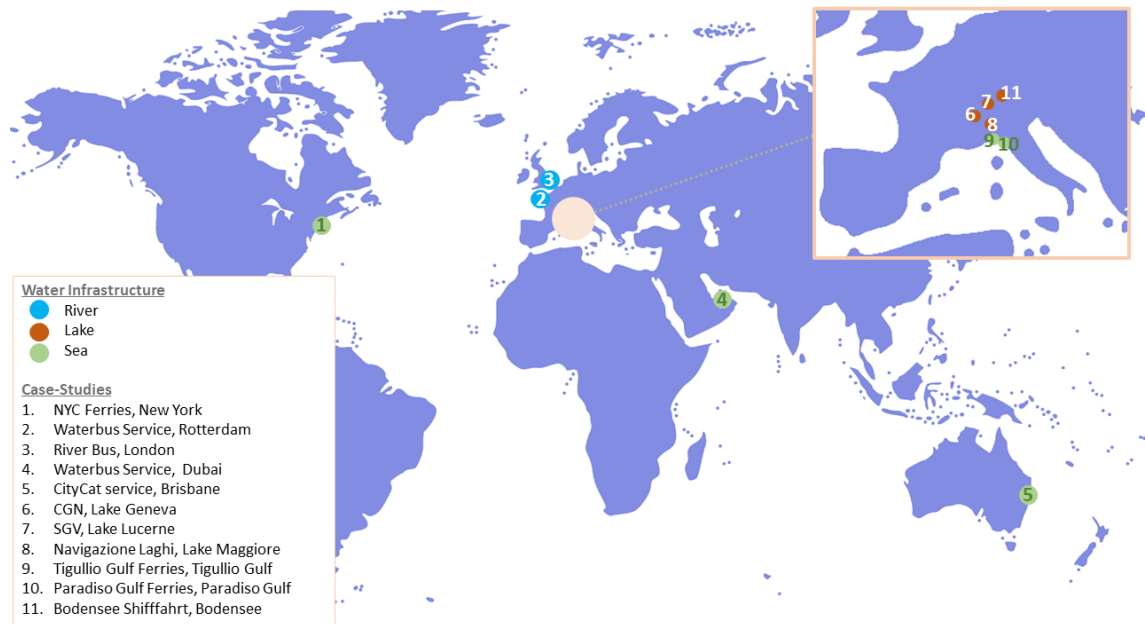


Figure 1: Case-studies localization.

Source: Authors' own.

Table 1: Case-studies analysis-Service details and features

	<i>PT Service (Yes/No)</i>	<i>Private/Public/Private- Public Service Management</i>	<i>Subsidized (Yes/No)</i>	<i>Waterborne/Terrestrial Ticket Price Ratio</i>
CityCat service, Brisbane	Yes	Private-Public	Yes	5,00 \$ / 5,00 \$ 1
Waterbus Service, Rotterdam	Yes	Private-Public	Yes	12,00 € / 5,10 € 2,4
River Bus, London	Yes	Private-Public	Yes	8,00 £ / 1,75 £ 4,6
Waterbus Service, Dubai	Yes	Private-Public	Yes	25,00 AED / 25,00 AED 1
NYC Ferries, New York	Yes	Private-Public	Yes	4,00 \$ / 2,75 \$ 1,5
Bodensee Schifffahrt,	Yes	Private-Public	Yes	6,00 € / 6,80 € 0,9

Bodensee				
CGN, Lake Geneva	Yes	Private-Public	Yes	43,00 CHF / 2,40 CHF* 17,9
SGV, Lake Lucerne	Yes	Private-Public	Yes	29,00 CHF / 3,70 CHF* 7,8
Navigazione Laghi, Lake Maggiore	Yes	Private-Public	Yes	8,90 € / 3,20 € 2,8
Tigullio Gulf Ferries, Tigullio Gulf	No	Private	No	4,50 € / 1,80 €* 2,5
Paradiso Gulf Ferries, Paradiso Gulf	No	Private	No	2,50 € / 1,80 €* 1,4

*Fares were selected as representative of point-point routes available both on terrestrial and waterborne sides, though a wide range of prices for this service is present.

Table 2: Boats features and service frequency

	<i>Fuelling Technology</i>	<i>Boats Capacity</i>	<i>Peak Hour Frequency</i>
CityCat service, Brisbane	Hybrid	Max. 170 pax.	4
Waterbus Service, Rotterdam	Full electric	Max. 150 pax.	2
River Bus, London	Hybrid / Full electric	Max. 220 pax.	3
Waterbus Service, Dubai	Gasoline	Max. 50 pax.	8
NYC Ferries, New York	Diesel	Max. 350 pax.	3
Bodensee Shiffahrt, Bodensee	Hybrid	Max. 1000 pax.	2
CGN, Lake Geneva	Heat and steam engine	Max. 1200 pax.	2
SGV, Lake Lucerne	Hybrid	Max. 900 pax.	2
Navigazione Laghi, Lake Maggiore	Diesel/Hybrid	Max. 1100 pax.	4
Tigullio Gulf Ferries, Tigullio Gulf	Diesel	Max. 400 pax.	1
Paradiso Gulf Ferries,	Diesel	Max. 350 pax.	1

Paradiso Gulf			
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Present international case studies' overview revealed several elements of interest for the new service implementation of waterborne urban transport within Ligurian context. Some common and punctual aspects need therefore to be highlighted.

1. Service details and features

- Except from Ligurian tourist-oriented services, selected case-studies mainly constitute Public Transport services, provided through Public/Private management schemes; tourist-only options are evidently delivered as fully-private transport services;
- As far as Public Transport services are concerned, according to national legislation, State subsidies are usually provided;
- More than three out of four considered case-studies have *Waterborne/Terrestrial Ticket Price Ratio* under 3; London, Lake Geneva and Lake Lucerne represent the exceptions, while most services provide fares that may compete with terrestrial options, thus benefitting from comfort and better travelling conditions.

2. Boats features and service frequency

- Approximately half of the selected case-studies provide waterborne services through hybrid vehicles, full-electric services are delivered only in London and Rotterdam, the other half still implies traditionally fuelled boats;
- As far as boats capacity is concerned, great variability is present: Swiss lakes case- studies use larger boats and capacity spans between 900 and 1200 passengers, more urban services' vehicles (such as Brisbane, London, Rotterdam, New York ones), as well as tourist-oriented services in Liguria, vary from 150 to 350 passengers' capacity;
- Peak-Hour Frequency is clearly strongly related to boats capacity; in Dubai more rides (8) are provided using smaller vehicles, while Swiss Lakes provide a couple of them through larger boats. Most of the considered services span between 2 and 4 hourly rides.

4. Results

Similar considerations led indeed the design process towards first *viAmare* operational hypothesis.

Additionally, design process was supported by the recognition and analysis of local transport demand, according to a double layered approach:

- Firstly, mobility patterns on the metropolitan level were assessed through the elaboration of Origin/Destination Matrix starting from Italian National Statistics Institute (ISTAT, 2011) data on study and work commuting-related mobility, as well as on tourism-related flows data collected by reference Regional Observatory (Osservatorio Turistico Regionale, 2018);

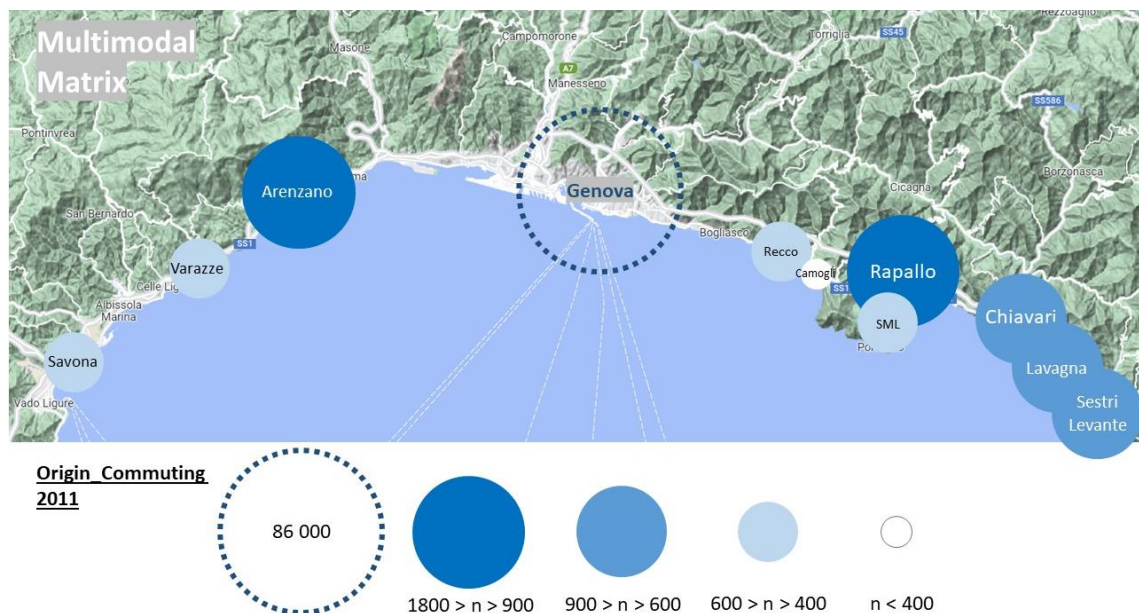
- Secondly, dedicated surveys were provided to statistically representative sample, in order to assess potential users' service acceptance and *willingness-to-pay*.

Chosen transport demand assessment methodology, was mainly due to:

- ISTAT Origin/Destination Matrix dates back to 2011, while Tourism-related data to 2018. Information update was therefore necessary, according to local evolution of mobility patterns having taken place in the last decade, both due to technology and social changes, as well as to post-Covid new transport behaviours (Delponte and Costa, 2023);
- Being the *viAmare* service quite innovative and disruptive within Ligurian and Genoese context, additional Stated Preference survey was considered particularly relevant to properly address users' acceptance and attitude (Ho *et al.*, 2020) towards a metropolitan-wide sea-borne service.

Despite not constituting present research focus, in order to frame subsequent service design hypothesis, it could prove significantly interesting to recall main outputs concerning transport demand analysis step.

Starting from the assessment of the metropolitan O/D Matrix, it was possible to visualize territorial distribution of this mobility demand, through the relative weight of assumed stopovers within metropolitan context.



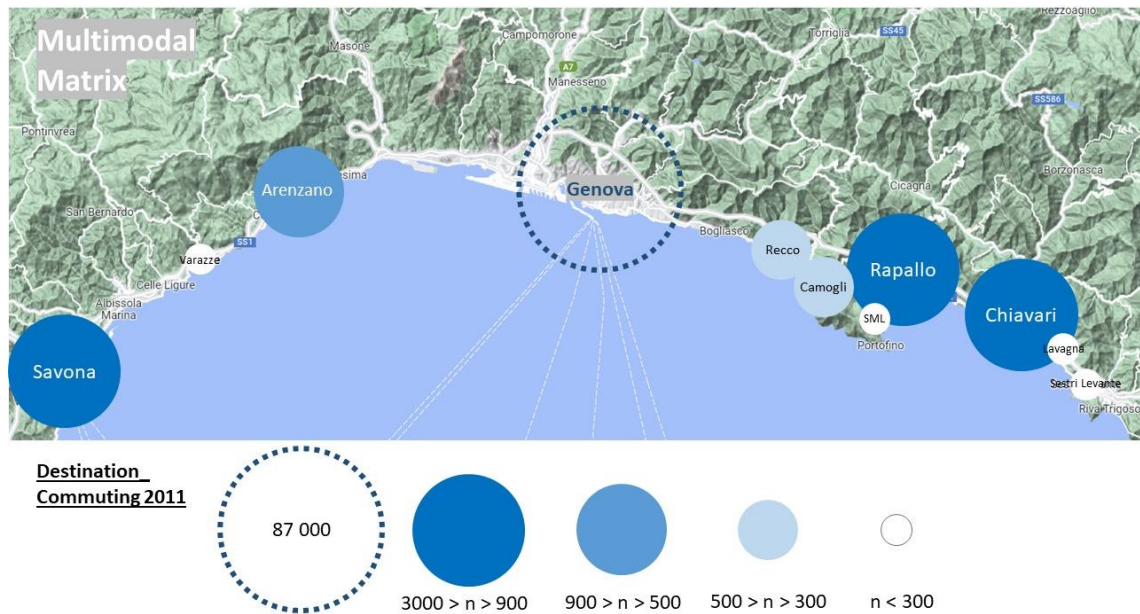


Figure 2: Commuting mobility demand expressed by the municipalities under consideration.

Source: Authors' own

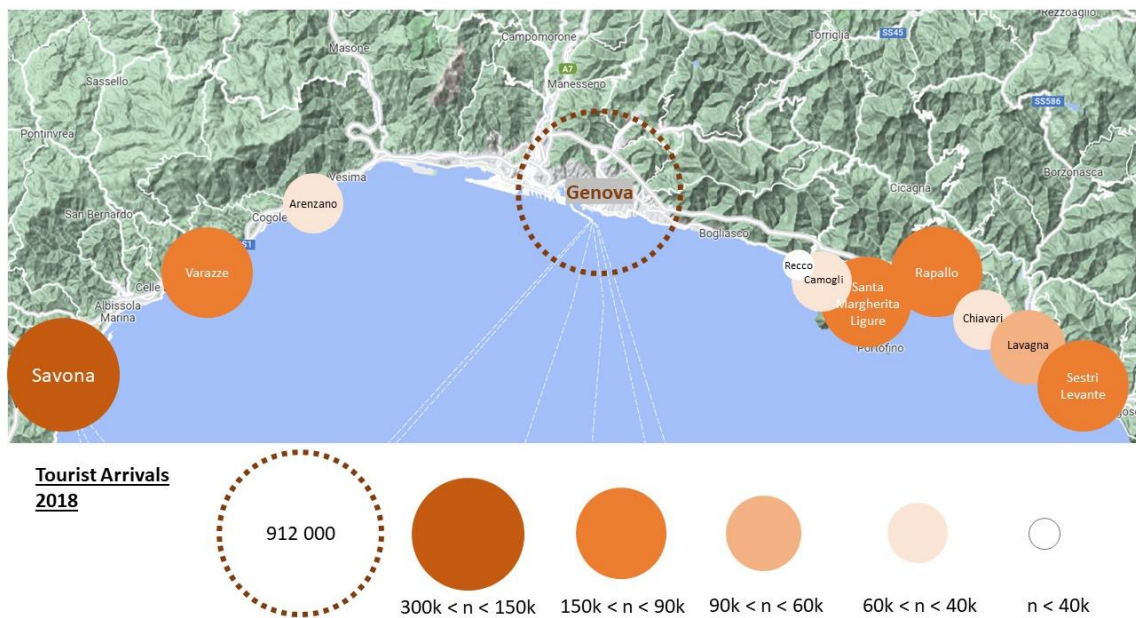


Figure 3: Tourist arrivals in municipalities included in *viAMare* service hypothesis.

Source: Authors' own

From the comparison of these dynamics, some aspects can be noted.

- The attractiveness expressed by Genova, Savona, Rapallo and Arenzano is significant with reference to both commuting phenomena and tourist flows;

- Some centers from Western and Eastern Riviera (such as Varazze, Santa Margherita Ligure and Sestri Levante), turn out to be attractive polarities mainly for tourists on a seasonal basis, while they play a secondary role in attracting systematic demand;
- Genoa constitutes the main destination both for commuters coming from Eastern and Western side, on the contrary flows among the two rivieras (bypassing Genoese center) are not relevant, thus supporting service fragmentation.

As far as subsequent survey was concerned, it was found that mainly people usually choosing private vehicles would shift to sea-borne service more easily, especially in case of congested road networks. At the same time, mainly commuters having journeys longer than 60 minutes would be interested in testing similar alternative. In terms of perceived benefits, travel comfort would be particularly valued by potential users, being the main criticism expressed on public transport actual supply. Due to large use of local Public Transport among respondents, fares would be considered equal to the ones currently provided by metropolitan providers, though corresponding higher comfort levels.

As the authors highlighted in previous work (Delponte and Costa, 2023), following context analysis step, three services were firstly designed within Genoa Metropolitan Area and the bordering Province of Savona.

In details, identified service lines are the following:

- Western Metropolitan Line: metropolitan line running from Savona to the city centre of Genoa;
- Central Urban Line: urban line crossing Genoese Municipality;
- Eastern Metropolitan Line: metropolitan line leading from the Airport to Sestri Levante.

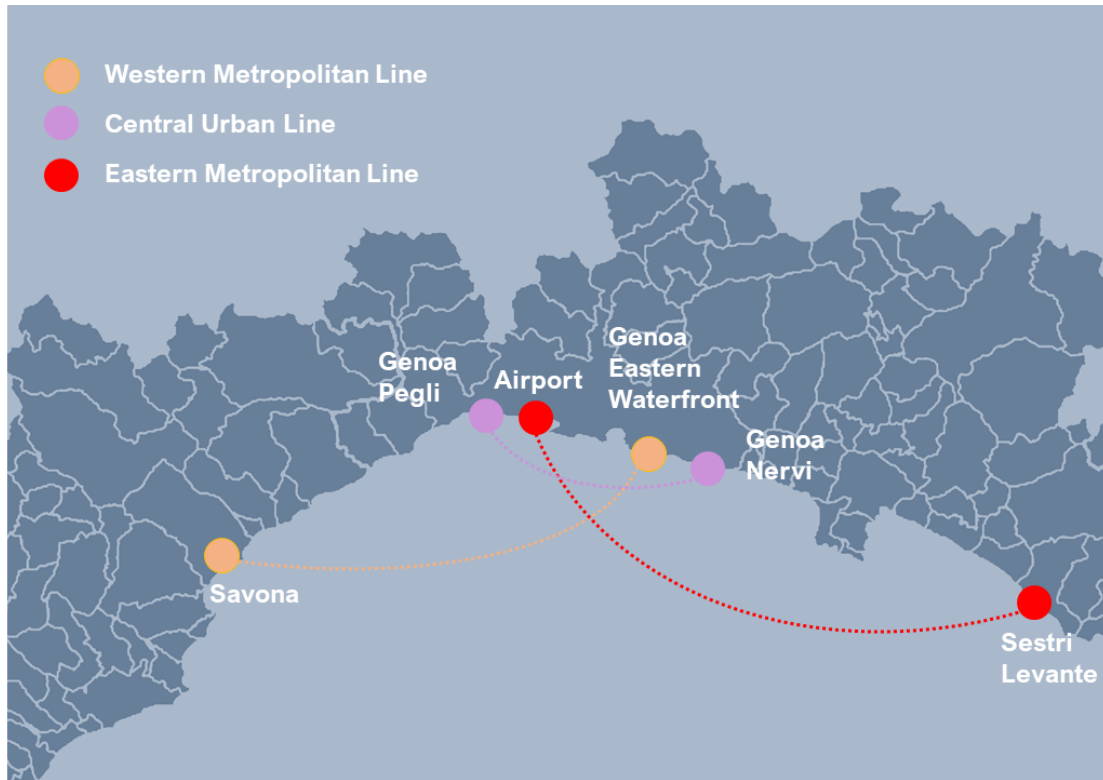


Figure 4: Service lines prefiguration.

Source: Authors' own.

Due to different service lines length and consequent travel times, it was initially thought to use two kind of maritime vehicles.

Nevertheless, three identified lines share some common features:

- Hybrid fuelling to reduce transport-related environmental impacts;
- Solar panels to support energy demand sustainably;
- Bicycle transport equipment to support multi-modal mobility.

As far as peculiar features of boats are concerned, some initial considerations were drawn regarding vehicles dimensions and passenger/bicycle capacity.

Table 3: Boats dimensions and capacity hypothesis

	<i>Urban Line</i>	<i>Metropolitan Lines</i>	<i>Single-Option Scenario</i>
Vehicles Dimensions	Length: 30 m Width: 7 m	Length: 40 m Width: 10 m	Length: 35 m Width: 10 m
Passenger Capacity	240	350	300
Bicycle Capacity	8	16	12

Source: Authors' own

According to present capacity value, targeting the implementation of an effective and frequent transport service able to match local mobility demand assessed through the

context analysis step implies the definition of an adequately numbered vehicles fleet. Especially for urban service, frequency represents a distinctive feature, so that rides are provided every half-an-hour at peak times.

Units' number required to provide *viAmare* service was estimated about 6 units along the urban line and 4 units each for Western and Eastern metropolitan services.

To this aim an additional scenario was defined, aiming at potential economy of scale implementation, where the same kind of vehicle provides both urban and metropolitan services through the differentiation of fuelling schemes and systems.

Moreover, fare policy was discussed, as well.

In details, two main criteria shaped service tickets quantification:

- Fares multi-modal integration needs to be pursued to support modal shift from individual cars, as well as sustainable transition;
- Residents and tourists should be addressed through separate pricing policies, as their willingness-to-pay and their potential use of the service prove to be profoundly different.

Metropolitan residents would be indeed addressed with the local integrated public transport ticket (2.10 €), thus supporting the implementation of *viAmare* service as an additional brick to a wider, more complex and holistic metropolitan supply able to respond to local citizens transport demand through tailored and diverse alternatives.

Non-local users instead would be targeted through a dedicated fare-policy that could be much more consistent (8-12 €), thus integrating other tourist-related attractions/services.

5. Conclusions

Present work enabled authors to build a coherent framework on waterborne urban passenger transport services, in order to assess *viAmare* Project feasibility and features within a more general and structured context. In details, case-studies recognition contributed to highlight some relevant aspects concerning service management and fares policy of the service-to-be:

- Strong integration of passenger transport fares between waterborne services and Local Public Transport (LPT) supply is required, promoting multi-modality within urban areas, not only through single integrated tickets, but through mobility bundles and subscription, as well;
- Waterborne services fare may exceed terrestrial ones, due to higher operational costs, nevertheless it should be reasonably comparable to terrestrial alternative;
- Multi-modal integration should be encouraged through the possibility of boarding (at no additional cost) bicycles, supporting cycle-pedestrian and smart mobility;
- Service needs to be provided mainly through short distance point-to-point, making them more competitive to road and rail transport alternatives; moreover hour frequency of 3/4 terminal calls at the most attractive places should be granted;

- Service needs to be shaped and design matching mobility needs of resident and commuters and local tourism strategy, thus developing dedicated fares and packages;
- Employment of units powered by low environmental impact propulsion or reducing the external costs deriving from powering vehicles service is required to limit transport-related emissions; in this direction, public subsidies supporting the construction of new sustainable units as well as service costs may be needed.

Waterways-based transport contribution is necessary to manage vehicular flows that traditionally affect densely urbanized coastal areas and Liguria case prove to be extremely suitable in this direction. Anyway, the expected results deriving from the implementation of similar passenger transportation solutions cannot constitute standalone key drivers of sustainable mobility, they need to be designed as additional elements of a single integrated urban transport system.

Nevertheless, higher initial and operating costs require a strong commitment -mainly coming from EU, National and local bodies and administrations- in terms of investments supporting green transition of vehicles and sustainable modal shift.

Moreover, waterborne service supply need to represent an appealing alternative for users in terms of frequency, comfort and fares. Private-Public cooperation and partnerships may help in shaping and implementing competitive services matching urban mobility and tourist-related needs.

Green-technology, modal integration, public-private stakeholders' commitment represent indeed main line of action to support local public transport supply differentiation and competitiveness.

In this direction, Genoese context previous experiences should contribute shaping a new, more widespread, integrated and competitive waterborne transport.

Limited local initiatives proved to be interesting for users, thus highlighting several criticalities, as well.

Firstly, the need for more frequent stops to provide more effective and punctual response to Genoese mobility demand, thus offering an alternative able to compete with terrestrial ones not only in qualitative terms (as far as comfort standards are concerned), but in quantitative terms, too: hence the design of three urban and metropolitan widespread lines.

Greener technologies as well could constitute a further booster to urban maritime transport implementation, being capable to attract resources and financing for sustainable transition and transport innovation, thus granting a performing fleet, and an initial support for service launch and implementation. To this aim, present service is designed to reduce transport-related environmental impacts, through the use of hybrid fuelled boats, equipped with additional solar panels to support vehicles energy demand.

Finally, multi-modal integration, being already present among terrestrial and waterborne services, should be further supported both in fares and infrastructural aspects. Similar considerations led to the design of specific target-oriented pricing policies, addressing mainly residents and tourists considering their potential for integration with other mobility and non-mobility services. Particular attention will be paid also to *viAmare*

stops design and accessibility, to enhance modal shift from private cars and integration with urban public transport and sharing services networks.

This element would prove to be extremely relevant as far as Genoese transport system is currently undergoing a paradigmatic transition towards *Mobility-as-a-Service* (MaaS) local implementation, based on seamless multi-modal integration, thus benefitting from a wide range of mobility options and alternatives.

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