



# MAELSTROM

Smart technology for MARine Litter SusTainable  
RemOval and Management

D8.5

## Public summary on Report on Costs Benefits Analysis

31/12/2024



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## General Information

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## MAELSTROM Authoring & Approval

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## History of changes

Version	Date	Author	Description of changes
V1	30/02/2024	Elizabeth A. Nerantzis - ALPHA	Works and update of draft
V2	16/12/2024	Elizabeth A. Nerantzis - ALPHA	First Draft delivered for peer review
V3	20/12/2024	Elizabeth A. Nerantzis - ALPHA , Manuel Scarpa - ISDI	Implementation of comments and revised draft delivered
V4	30/01/2024	Fantina Madricardo - CNR	Final delivery of Document to EC



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## Acronyms

ALDFG	Abandoned, lost, or otherwise discarded fishing gear
ARPAV	Veneto Environmental Agency
BB	Bubble Barrier
CAPEX	Investments – Capital Expenditure
CBA	Cost Benefit Analysis
CMIA	Vila do Conde and the environmental monitoring centre
CNR	Consiglio Nazionale per la Ricerca – Italian National Research Centre
DoA	Description of Action
EEA	European Environmental Agency
EPR	Extended Producer Responsibility
EU	European Union
ICZM	Integrated Coastal Zone Management
kWH	kilowatt-hour
kWp	kilowatt 'peak' power
ML	Marine Litter
MSFD	Marine Strategy Framework Directive of the European Union
Mt	Million metric tons
MVdC	Municipality of Vila do Conde, Portugal
OPEX	Operating Expenses
UNEP	United Nations Environment Programme
WP	Work Package



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## 1 Brief overview of the MAELSTROM project

MAELSTROM - Smart technology for MARine Litter SusTainable RemOval and Management is a project funded under the Topic CE-FNR-09-2020, pilot action for the removal of marine plastics and litter. MAELSTROM strives to provide answers and diversified solutions to the complex question of the removal and sustainable treatment of the marine litter legacy; it contemplates the integration of complementary technologies for marine litter removal in different European coastal ecosystems, compounded with fully-fledged circular economy and society-oriented solutions. In particular, the project:

- sets out a reliable multidisciplinary and scientifically sound approach for the assessment of marine debris distribution and impact on marine life in highly valuable ecosystems and protected areas.
- designs and manufactures scalable, replicable, and automated technologies, co-powered with renewable energy and second-generation fuel, to identify, remove, and sort marine litter.
- evaluates over time the effectiveness of marine litter removal devices along with their impact on local ecosystems.
- integrates different technologies to track, sort and recycle all types of collected marine litter into valuable raw materials for future marketisation.
- assesses the economic and societal impact of MAELSTROM solutions, also providing a comprehensive life-cycle assessment of the technologies and products.
- enhances social awareness on the issue of marine litter and engages citizens and stakeholders in MAELSTROM activities.
- interplays with similar projects to maximize innovation uptake for marine litter removal within and outside the EU.



## MAELSTROM 2 MAELSTROM Consortium

The MAELSTROM project consortium consists of the following partners.

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### 3 Public Summary of the Report on Cost Benefit Analysis

The present document is the summary Cost Benefit Analysis document, which is one of the deliverables foreseen as part of Work Package 8 “Economic feasibility, social and economic Impact”, as main output of Task 8.1 “Cost-Benefit Analysis & Socio-Economic Impact”. The main goal of this document is to develop a comprehensive Cost Benefit Analysis aiming to identify key value-added of the solutions proposed over the currently available technology.

To achieve this objective, the starting point was the definition of a methodology and develop a CBA model suitable for MAELSTROM. To carry out T8.1 activity, several sources of information have been leveraged exploiting Consortium know-how and inputs coming from previous project activities. Besides a dedicated desk analysis (mainly focused on EU Framework Programme for Research and Innovation database/ website, EC publications and Joint Research Centre studies; European Environment Agency Reports; UN Environment Protection Agency Reports; Market and financial reports; and Specialized journals, newspapers and articles, etc.) a joint work with team members has been undertaken in order to perform the CBA exercise, leveraging also the teams’ network for the validation of data.

To perform the analysis, an overview of the context in which the CBA is positioned is provided, identifying the case scenarios relevant to such activity. To make the CBA exercise more effective, and to try to quantify the social-economic impacts, it was decided to perform such analysis on the two pilot areas where MAELSTROM technologies for marine litter collections have been deployed and/or performed rounds of cleaning to test the developed technologies. Hence, **the CBA is tailored on the Venice Lagoon (Italy) and the Ave River estuary (Portugal)**. For each case a short overview on the pilot and information on the ecological assessment is delivered. This sets the local scene of the CBA analysis. (Complete information is included in MAELSTROM D2.3 “Ecosystem state and ML pollution assessment in the two demo sites (Lagoon of Venice and the Porto region)”).

The cost analysis presents the current expenses for marine litter management carried out by the Municipality of Venice and the Municipality of Vila do Conde as well as the expense related to the adoption and operation of MAELSTROM technologies under examination i.e., Seabed Cleaning System and the Bubble Barrier (incl. solar panel system).



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The baseline scenario highlights that current efforts are not enough to tackle the problem and actions to enforce proper collection, transport, and disposal of waste the uptake of enhanced technologies that can support such process is of paramount relevance. Private organisations, Volunteer Associations, Non-Governmental associations etc. are of support when it comes to manual removing activities, yet major efforts need to be made, also in view of the growing awareness on issues caused by the mismanagement of waste and the dimension of the marine litter influencing the public opinion.

**For the Venice Lagoon case**, current operating mode is via on spot manual cleaning. Marine litter removal are assigned to "Associazione Gondolieri Sub" a volunteer association that operates in full collaboration with the Venice Municipality's "Development, Promotion of the City and Protection of Traditions and Public Green" Department. The disposal of litter is carried out by Gruppo Veritas, the municipality co-owned company for waste removal and remediation.

So far "on-spot" remediation activities, have an average expense of €8,000 per cleanup-day only for litter collection (i.e. divers and related equipment for operations). This entails the cleaning of 1 or 2 small areas at a time. This means that looking at annual expense figures with 12 cleanups amounts of €276,000, by which approximately €96,000 for labour and €180,000 for waste disposal (by Gruppo Veritas) (details in section 4.1.1). Additionally, it is worth noting that – in this context – the expenses related to the volunteer work done by local associations for regular beach cleanups in the area is not taken into account, given the type of technology deployed.

Item	Current modality	MAELSTROM Seabed cleaning system*
Average estimated expense per cleanup day (in €)	€8,000/day	€11,000/day
Average litter collected per cleanup day (in kg)	900/day	1000/day
Area covered for cleanup day	1 – 2 small areas per time	280sqm
Number of cleanup days performed	12/year	30
*considering 30 working day cleaning (1,5-month operations)		

*Table 0-1 Current way versus utilization of MAELSTROM solution (based on 30 working days)*

Yet, the Seabed cleaning system is slightly more expensive than current modus operandi (+€5000/day more) but it overperforms in comparison to current methods, reducing the efforts, and the putting at risk, of the number of divers involved in the operations. Also, ways to further reduce the expenses for the operations of the MAELSTROM system are being investigated to enable to lower the costs and, hence,




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be more competitive in the market for marine litter collection and remediation. Several benefits have been identified such as, reducing the health risks of key personnel involved in cleaning operations, environmental benefits as the amount of litter collected exceeds 1,000 kg on average as well as the increased size of the area of operations, including general enhanced environmental conditions.

**Ave River estuary case.** Current modalities are expensive and are supported by private sector expenses as they have obligations to clean the riverine and beach areas of competence. A comparison was drafted (details in section 4.1.2) presenting marine litter remediation expenses in terms of "season", one year and ten years (reduced estimates for lifespan of the BB system and solar panels – for worst case scenario).

Current operations modality <sup>1</sup>	Costs (in €) per season (5 months)	Costs (in €) per 1 year	Costs (in €) per 10 years
<i>Municipality expenses</i>			
Costs for personnel involved in cleaning activities	160,650	160,650	1,606,500
Expenses for litter disposal resulting from cleaning activity	3,375,000	3,375,000	33,750,000
<i>Sub-Total</i>	<i>3,535,650</i>	<i>3,535,650</i>	<i>35,356,500</i>
<i>Private sector expenses</i>			
Cleaning activity by private businesses	47,500	47,500	475,000
Expenses for litter disposal by private businesses resulting from cleaning activity	40,000	40,000	400,000
<i>Sub-Total</i>	<i>87,500</i>	<i>87,500</i>	<i>875,000</i>
<b>Total</b>	<b>3,623,150</b>	<b>3,623,150</b>	<b>36,231,500</b>

*Table 0-2 Expenses for marine litter removal with current modalities of management*

Hereafter a summary of the expenses for the BB and solar panel system, including as well the ones for litter removal and disposal. Maintenance costs will not be covered by the MAELSTROM project.

Item	Detail	Initial costs / Cost per season (in €)	Costs (in €) per 1 year	Costs (in €) per 10 years
BB system cost	Equipment	408.996,41		
	ManPower/ hours	242.674,25		
	Travels	15.850,00		
	Totals	667.520,66		



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BB maintenance	Without the catchment system maintenance		49,000	404.300,00
	With the catchment system maintenance		69,000	434.300,00
	Totals (Average of both options)		59,000	419.300,00
Solar panel system	Solar panels system powering the BB system	101.243,72		
	ManPower/ hours (preliminary data)	-		
	Solar panels system maintenance (e.g. cleaning and regular checks)		5.000,00	50.000,00
	Totals	101.243,72		
Litter collection and disposal	Foreseen expenses for litter disposal resulting from activity (2 disposals per month)	1484,53	2.969,04	29.6904
	<i>Actual disposals performed to date (#)</i>	<i>10,00</i>		
	<i>Current cost for litter disposal (without taxes)</i>	<i>123,71</i>		
Energy	Total energy costs for energy consumption (actual prices)	16.982,78	33.965,57	33.965,57
TOTAL		787.231,68		
TOTAL without expenses covered by the MAELSTROM project		18.467,30	100.934,61	

Table 0-3 Expenses for MAELSTROM BB and solar panel system including litter disposal and energy costs

The deployment of the bubble barrier and solar panel system immediately brought direct improvement of environment by having an immediate environmental impact reducing the amount of litter floating towards the ocean, without harming fauna and flora of the area. This may reflect on reduction of litter discharged at sea, and nearby beaches. As a cascade effect, this could have impacts on the amount of riverine and marine litter collected in the area.

For example, even if there is a small variation of the litter that ends up on the beaches, this can lead to savings for the municipality - and private businesses - as cleaning services would require less time and required personnel.

As the implementation of the MAELSTROM solution does not eliminate the obligations for beach cleanings, yet, it is expected to reduce the amount of litter that



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unfortunately falls through and reaches the ocean and, hence, reduce the expenses for litter disposal resulting from cleaning activity due to reduced quantities of litter on the beach as well as a reduction of the expenses to cover the costs for personnel involved. This translates in economic monetary savings, considering and impacting the current expenditure for regular cleaning activities. Currently the total litter collected amounted of over > 1300 kg (Details provided in MAELSTROM D5.4 "Final Report on operation of the surface and water column removal technology in the Porto region"). Estimates of **marine litter variate between  $19.180 \pm 5.859$  kg/month. In this context, plastic litter is estimated of  $17.244 \pm 4.399$  kg/month.** The amount of litter collected is highly correlated with precipitation and water currents, as there is higher marine litter / organic matter ratio during the winter months.

Some of the actions that are suggested in order for the Municipalities to continue to do their part in tackling the marine litter issue are:

- Developing and enforcing effective waste management policies and practices, such as waste prevention, reduction, reuse, recycling, and recovery, as well as proper collection, transport, and disposal of waste.
- Participating in a [network of coastal cities against marine litter](#), which facilitates the exchange of knowledge, experiences, and best practices among local stakeholders, as well as the development of common strategies and actions.
- Conducting regular monitoring and assessment of the marine litter situation in their coastal areas, using standardized methodologies and indicators, and sharing the data and information.
- Implementing extended producer responsibility (EPR) schemes for marine litter management would be beneficial, especially as there are many industries established in the Municipality's area.
- Organizing and supporting local initiatives for marine litter removal, such as beach clean-up campaigns, involving citizens, volunteers, fishermen, and other actors.
- Raising awareness and educating the public and the relevant sectors about the causes, impacts, and solutions of marine litter, as well as promoting behavioural change and responsible consumption.

Having stated this, among the actions to enforce proper collection, transport, and disposal of waste the uptake of enhanced technologies that can support such process is of paramount relevance, as the actual methods in place are costly and not fully efficient.



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Finally, some conclusions were drafted for:

Venice Lagoon pilot case:

- The Seabed cleaning system is slightly more expensive but overperforms in comparison to current methods, reducing the efforts, and the putting at risk of the number of divers involved in the operations. Also, ways to further reduce expenses for the operations of the MAELSTROM system are being investigated to enable to lower the costs and, hence, be more competitive in the market for marine litter collection and remediation.
- Several benefits are identified such as, reducing the health risks of key personnel involved in cleaning operations, environmental benefits as the amount of litter collected exceeds 1,000 kg on average as well as the increased size of the area of operations.

Ave river estuary pilot case:

- Current modalities are expensive and are supported by private sector expenses as they have obligations to clean the riverine and beach areas of competence. The implementation of the Bubble Barrier powered by solar panel system, enables to have immediate environmental impact reducing the amount of litter floating towards the ocean, without harming fauna and flora of the area. This may reflect on reduction of litter discharged at sea, and nearby beaches.
- As a cascade effect, this could have impacts on the amount of riverine and marine litter collected in the area, decreasing the cost related to its collection and disposal and decreasing the persons needed to clear the area (both for Municipality as well as private businesses).

Even a small variation of the litter that ends up on the beaches, can lead to savings for the Municipality - and private businesses - as cleaning services would require less time and required personnel. Hence, this translates in economic monetary savings, considering and impacting the current expenditure for regular cleaning activities.

- Since implementation of the BB, real estate prices in the area have risen and the tourism level in the city have increased.
- The reputation of the Municipality has also been increased thanks to the involvement of the project activities and thanks to the awareness activities related to the beach cleanups.

Despite the challenges in managing a variety of public stakeholders that are involved, from the analyses and estimations provided, it appears clear the key advantages



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brought by the possible adoption of MAELSTROM waste removal solutions and technologies. However, despite the advantages, the benefits are provided in terms of immediate environment remediation action, potential savings for the municipalities and increase of municipality's reputation in view of the perception of citizens.