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STM Validation Project: Estimating the financial and social impact on safety, efficiency and environmental sustainability

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Abstract

The shipping industry is constantly looking for sustainable alternatives to reduce its carbon footprint as well as to decrease accidents and incidents at sea. STM Validation Project proposes to push the maritime industry towards more collaborative and digitalised operational environments; enabling the transition of the sector to the “Industry 4.0” paradigm, where digital and real time connectivity is the driver for increasing efficiency, safety and environmental sustainability. The implemented maritime and port services have been analysed in depth in large-scale test-beds that have been carried out during the project and they have facilitated the basis of calculation of the Cost Benefit Analysis. The goals of the project have been deeply analysed in terms of social impact through the estimation of externalities as well as the increase of port calls and their potential growth of freight traffic associated for both port terminals and Port Authorities thanks to the efficiency gains.

Keywords: Sustainability; digital technologies; emission reduction; safety; ports; investments.

1. Introduction

This paper presents the results of the Financial Analysis and Economic Analysis (CBA) of the “STM Validation Project”. The CBA has been carried out following the methodology included in the Guide to Cost Benefit Analysis of Investments Projects (Sartori, Davide, et al, 2015) elaborated in December 2014 by DG Regio.

The project overall performance has been measured by the appropriate financial and economic performance indicators: Financial and Economic Net Present Value (FNPV and ENPV) and the Financial and Economic Rate of Return (FRR and ERR) expressed in monetary values. These indicators have been calculated in order to measure welfare effects of the action.

The specific objectives of the STM Validation project is to push the maritime industry towards more collaborative and digitalised operational environments, enabling the transition of the sector to the “Industry 4.0” paradigm, where digital and real time connectivity is the driver for increasing efficiency, safety and environmental sustainability.

STM is a concept for sharing secure, relevant and timely maritime information among authorized service providers and users, enabled by a common framework and standards for information and access management, and interoperable services. STM relies on four concepts, as follows:

- Port Collaborative Decision Making (PortCDM). The overall goal of PortCDM is to support just-in-time operations within ports and vis-à-vis other actors coordinated by an efficient and collaborative port. It is a way of establishing not only a common view of all available information, but also of using this information as a tool to create a common situational awareness and support the particular actors in making efficient collective decisions. Port CDM relies on continuous interactions among the maritime actors involved in a port call.
- Voyage Management (VM). VM concerns strategic, tactical and operational decisions about a voyage, such as planned and executed routes of a certain ship and its interaction with nearby ships in a given position. It focuses on the initial planning phase of any sea voyage and the ability to monitor the execution of that plan. VM supports improved route planning, route exchange, and route optimization before and during the maritime voyage. Especially in this phase, VM connects ships, adds intelligent processes and new tools to enable all stakeholders to increase their situational awareness during the voyage, providing faster, more secure and transparent information exchange.
- Flow Management (FM). FM supports the optimal coordination of multiple vessels in congested geographical areas. FM will support both VTS control and ships in optimizing overall traffic flow through areas of dense traffic or those with particular navigational challenges. FM’s objective is to improve the overall flow of maritime traffic through superior information sharing and coordination. VM builds common situational awareness and enhances decision-making with information and advice about traffic and safety.
- Sea System Wide Information Management (SeaSWIM). SeaSWIM provides a framework for the harmonization of data formats and standards for information management and operational services. SeaSWIM includes the use of the newly established Maritime Connectivity Platform for identity and service management. SeaSWIM will support collaborative decision-making processes using efficient and end-user applications to exploit the power of shared information in STM operational services.

Several services have been developed and implemented during the project for both ports perspective and maritime navigation dimension. The implemented services have been analysed in depth in large-scale test-beds that have been carried out during the project and they have facilitated the basis of calculation of the CBA. In addition, some of them have been analysed with simulations to check their functionality, applicability and to receive feedback from stakeholders.

Regarding the financial analysis, four groups of services have been designed in order to facilitate the proper calculations. The four scenarios have been defined according to the agents involved, the functionalities of the services included and the potential savings calculation hypotheses.

1.1. Identification of the project: Scenarios, services and main agents involved

The groups are described as follows:

- Port Call Coordination –The calculation hypotheses are related to an operational optimization of the ship port call management where the agents involved have been Port Authorities, Port Terminals and Nautical Services (mooring, towage and pilotage).
- Port Call Synchronisation – This scenario has been calculated taking into account the potential improvement related to the information exchange between the agents, which should enable the application of the Just-in-time arrivals and departures concept. The updating of the ETA (Estimated Time of Arrival) from ships will lead to a better resource management in the port and to a reduction of the fuel consumption during navigation due to the speed adjustment. Therefore, the reduction of GHG emissions has been an impact taken into account in the economic analysis as externalities. The agents involved in this scenario are the Shipping Companies, Port Authorities and Port Terminals.
- Ship-to-Ship Route Exchange - This service improves the OOW (Officer of the Watch) on board operations, facilitating the management of potential close quarter situations in a more expeditious way. The digital communication and exchange of data between ships will avoid misunderstandings and will enhance safety and security from an economic point of view. The agents involved in this service are the Shipping Companies, specifically ship crew.
- Ship-to-Shore/Service Provider: the services included in this scenario are described below and their specific agents involved as well. The financial analysis regarding this scenario is the addition of all of them:
 - Enhanced Monitoring Service - This functionality provides accurate information to make navigation safer in complex situations. The information exchanged with the shore centres is crosschecked and this aspect makes more efficient the calculation of the safest route in certain difficult navigational areas. It has a strong economic dimension by encouraging the reduction of accidents such as groundings and collisions. The agents involved in this service are shore centres (including VTS) and Shipping Companies (ship crew)
 - Nordic Pilot Route service - This service deals with validated information on safe routes before the arrival at ports and during navigation through inland waters by the Pilots of the Baltic area. The focus is on saving time in calculating the safest route in port approach. The agents involved are Maritime Administrations and Shipping Companies.
 - Baltic Navigational Warning Service - Information about unexpected events or situations in coastal navigation in jurisdictional waters is responsibility of the National Maritime Administrations. The fact that the information is automatically sent to the ships bridges saves time for planning the voyage plan, proposing an alternative of reliable navigation with the most updated information. It has a strong economic impact avoiding possible collisions and all types of accidents at sea. The agents involved are National Maritime Administrations and Shipping Companies.
 - SSPA Route Optimisation Service – In this service, the potential savings are restricted to bunkering consumption and hence bunker costs for the sailed route. Optimizing the route has a strong impact in the OPEX costs regarding fuel and it is translated into GHG emission savings. The main agents and beneficiaries are Shipping Companies and the Service Provider, in this case, SSPA Sweden AB.
 - SMHI Route ETA Forecasts – The service is providing a more probable time of arrival for each waypoint on the route as well as a calculated time-window for the estimated time of arrival. This fact is reducing workload on board regarding the management of weather routing information from NAVTEX and is providing a tool to enhance the mandatory operational procedures on the bridge. The main agents and beneficiaries involved are Shipping Companies (ship crew) and the Service Provider, in this case, SMHI (Sveriges Meteorologiska och Hydrologiska Institut)
 - Winter Navigation Service - The service enables accurate information on available navigable routes through ice waters. It provides simpler and more reliable on-board operational calculation models as well as real time information to calculate the voyage plan. The agents involved are National Maritime Administrations and Shipping Companies.
 - STM Search and Rescue - The functionality of this service aims to simplify and improve the information shared from the MRCC (Maritime Rescue Coordination Centre) with the SAR units that collaborate in rescue operations. The information shared is more efficient and reliable. From a safety point of view, time saved when searching for and saving human lives in danger at sea,

could represent a significant economic impact. The agents involved are National Maritime Administrations and Public Bodies in charge of Search and Rescue at sea.

1.2. Technical feasibility

The test-beds planned in STM Validation Project are the result of several interaction between different units included which are ships, ports and shore centres. This previous design of the test beds took into account the the mission of Analysis and Evaluation in the framework of the STM Validation project that is to facilitate the validation through the quantification of the benefits associated with the STM Implementation. With this aim, the requirements for data collection and the methods for evaluation were assessed and defined within an entity called "Information Environment".

The main source of data were STM Test Beds and the main sources came from three specific entities that are:

- PortCDM in eight European ports (including port authorities, calculated average port terminals and port services stakeholders). Some of the data produced was processed in order to quantify the number of calls as an input in the Cost Benefit Analysis
- Voyage management testbeds about 300 compliant ships associated with two scenarios in the Mediterranean and the Baltic Sea. Those ships were classified into 4 different categories
- Six shore centres that were able to interact with STM compliant ships navigating in their area of influence and that were producing qualitative and quantitative data for the analysis.

This is the baseline on which the demand that has served to calculate the financial and economic analysis. As long as the technical part is sufficiently described, in this section only the demand analysis has been deeply studied.

1.3. Demand analysis

As stated in the project, this action aims at building the necessary infrastructure to facilitate and make possible the exchange of updated information through intra and inter port collaboration, ship-to-port collaboration and ship-to-shore/service provide.

To build the demand has been taken into account after three dimensions in the following terms:

- Port calls during 2018 linked with ship-to-port metrics during the project for 8 ports in 5 countries which are:
 - Gothenburg, Umea in Sweden
 - Vaasa in Finland
 - Stavanger in Norway
 - Valencia, Sagunto y Barcelona in Spain
 - Limassol in Cyprus
- STM ships selection taking into account the port calls mentioned above and metrics collected in the test beds for ship-to-ship and ship-to-shore. The ships have been divided into four main types of services in order to select the proper :
 - Regular services
 - Tramp services
 - Cruise services
 - Other services
- Shore centers' and service providers metrics :
 - Horten, Kvitsoy in Norway
 - Gothenburg in Sweden
 - Aarhus in Denmark
 - Tallinn in Estonia
 - Tarifa in Spain

One of the most important elements to be able to identify the benefits of STM from the ship-to-port dimension has been to calculate the number of STM ships calling at the eight ports included in this analysis. Those ships that have the STM module installed on-board can facilitate information on their ETA. Moreover, the total number of port calls collected by the PortCDM tool has an impact on Port Call Coordination service from a financial point of view. A total of 42,658 calls were logged during the project for the eight ports selected. The following table lists all STM ships per type of ship and percentage included in the test beds. Therefore, a selection of those potential ships that could be improved due to the implementation of STM services has been carried out:

Table 1: Potential STM ships eligible and affected by STM implementation included in the test beds

SHIP TYPE	NO. OF STM SHIPS	% PER SHIP TYPE
CHEMICAL/PRODUCTS TANKER	81	30.22%
CONTAINERSHIP	50	18.66%
GENERAL CARGO	32	11.94%
RO-PAX	26	9.70%
CAR CARRIER	23	8.58%
PAX	16	5.97%
CRUISE	13	4.85%
LPG TANKER	11	4.10%
RO-RO	9	3.36%
CEMENT CARRIER	5	1.87%
BULK CARRIER	2	0.75%
TOTAL	268	100%

Table 2: Total calls selected for the STM Validation project Cost-Benefit Analysis

TYPE OF STM SHIP	NO. OF CALLS APPLIED IN THE ANALYSIS
CONTAINERSHIP	247
RO-PAX	3,158
CAR CARRIER	33
PAX	32
RO-RO	209
STM SHIP CALLS	5,291
STM SHIP CALL SELECTED	3,679

According to the total number of port calls, a classification of ports into three types has been established:

- Big-sized port - The ports are Gothenburg and Stavanger
- Medium-sized port - The ports are Valencia, Barcelona and Limassol
- Small-sized port - The ports are Sagunto, Umea and Vaasa

The classification has also served to establish an average number of terminals per port size in order to carry out the calculations. The average number of terminals for a big-size, medium-size and small-size port is 8, 7 and 5 terminals respectively. Finally, this classification has an impact on the time dedicated to deal with port call planning in Port Coordination service but also in the total investments of several actors included in the study.

The information about ship-to-ship interaction has been collected in the Voyage management test-bed that provides the following inputs for analysis:

Table 3: Inputs for the Ship-to-Ship route exchange service calculations

2018	TOTAL NUMBER OF ROUTES EXCHANGED DURING THE PERIOD BETWEEN SHIPS
JANUARY - MARCH	13
APRIL - JUNE	84
JULY -SEPTEMBER	2,011
OCTOBER - DECEMBER	3,482
TOTAL	5,590

The following table shows the number of requests sent to each Shore Centre participating in the test-beds during 2018. This information will be used to calculate the costs saved by using Enhanced-monitoring service.

Table 4: Inputs for the Enhanced monitoring service calculations for the six shore centers

2018	NUMBER OF REQUESTS FOR ENHANCED MONITORING SERVICE
GOTHENBURG SC	4,020
HORTEN SC	256
KVITSOY SC	137
TARIFA SC	1,069
TALLIN SC	530
AARHUS SC	877
TOTAL	6,889

The other services included in the analysis have been logged in terms of total requests received. The amounts are shown in the following table trying to provide some figures to carry out the calculations of the revenues and the operating costs saved.

Table 5: Input for the other services included in the ship-to-shore/service provider analysis

2018	TOTAL REQUESTS RECEIVED	TOTAL REQUESTS ATTENDED
SMHI WEATHER ETA SERVICE	3,604	691
SSPA ROUTE OPTIMISATION SERVICE	8,760	6,134
NORDIC PILOT ROUTE SERVICE	2,987	2,987
BALTIC NAVIGATIONAL WARNING SERVICE	2,629	2,629
SAR SERVICE	2,140	2,140
WINTER NAVIGATION SERVICE	1,724	51

2. Financial profitability

The Financial Net present Value result of the STM Validation project has a positive figure of 2,792,060 € with a FRR of 8.77% and a payback of 9 years. This means that the project is profitable and the investment is retrieved within the timespan of project that is 10 years.

The following figure shows the financial results per agent involved in percentage according to the total calculation of the financial net present value:

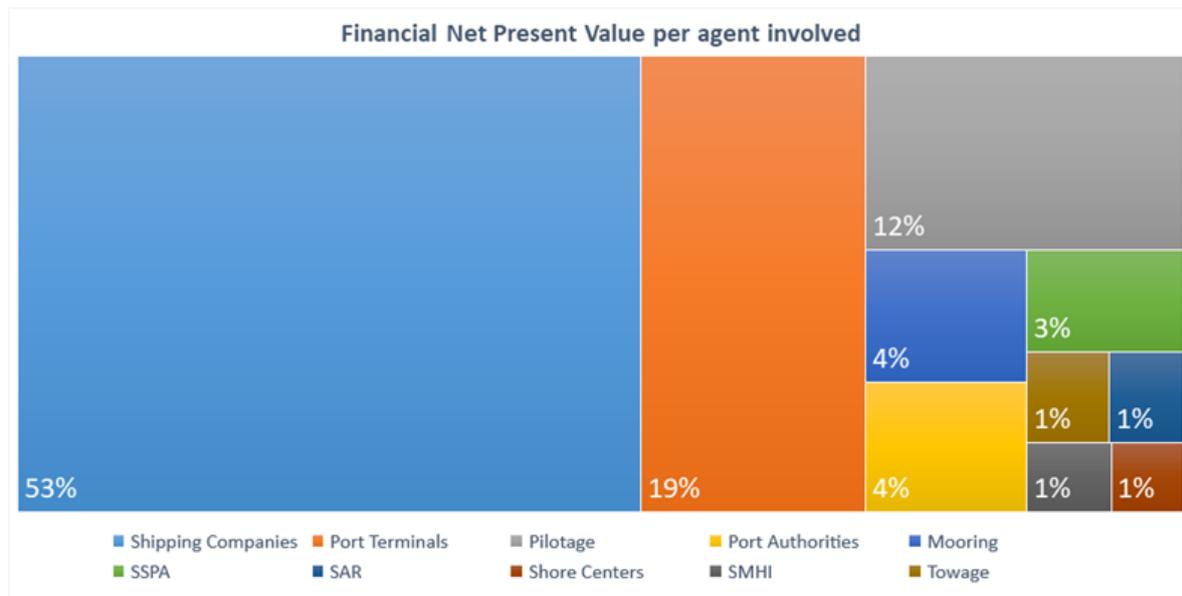


Fig. 1 Percentage of Net Present Value per agent involved

As can be seen from the results, the positive financial result of 73% is for Shipping Companies and Port Terminals while 21% comes from Port Authorities and Port Services. This represents an impact of 94% on the shipping sector compared to only 6% for Service Providers and other agents. This is a clear example of the tangible benefit in favour of the competitiveness of the European Union's Port-Maritime Sector, which has an impact on external and intra-European trade and therefore on the consumers. Without these funds, it would not have been possible to achieve these benefits and the potential future benefits if the introduction of STM became a reality for the European Union.

3. Economic analysis

The economic Net Present Value has been calculated as well. In this sense, the social discount rate has been applied according to Annex III of the Implementing Regulation on application form and CBA methodology. The European Commission recommends that the social discount rate of 3 % should be used for major projects in Member States. The main variables analysed have been mainly the externalities, the consumer's surplus and the gross producer's surplus, corrected investments, and operating and maintenance costs.

3.1. Consumers' surplus

The calculation of the consumers' surplus has taken into account the shipper as the main customer to be focused in this analysis. The calculation tries to reflect how the final consumer is benefited thanks to the implementation of STM. Currently, shipping companies offer a certain frequency according to their schedules. In order to evaluate the improvement of the capacity of the ports, the STM project offers a solution that optimizes port calls and gives the possibility to receive additional calls.

This has an impact on the shipper, the final customer, who has more alternatives to load/unload their cargo. From the point of view of passengers, these have more availability of Passenger ships calls to be carried that can result in a less price to pay for the ticket.

Following this argument, thanks to a better synchronisation of the calls, the number of additional calls from the second year onwards have been estimated.

The same assumptions that were taken into account in the calculation of traffic increases in the financial analysis serve to estimate both the number of calls affected and the number of average movements for each additional port call of STM ships.

The calculation is completed by multiplying the additional number of port calls by the average number of goods/passenger movements (measured in TEU, cars, lorries or passengers). The resulting amount is multiplied by the average revenues per unit load (in the case of passengers a ticket 1€ less price than usual) and by the average percentage improvement in logistical and storage costs thanks to a scenario with more port calls, and therefore possibilities for the shipper. This percentage is 0.50% of improvement costs. The total amount is 71,582€ for the whole timeline.

3.2. Gross Producer surplus

The producer surplus, defined as the revenues accrued by the producer (i.e. owner and operators together) minus the costs borne. The change in the producer surplus is calculated as the difference between the change in the producer revenue (e.g. rail ticket income increased) less the change in the producer costs. This might be particularly relevant for public transport projects or toll road projects, especially if the project is expected to feature significant traffic (generated or induced) or a substantial change in fares.

In this case, the project is expected to change traffic volumes or when transport-pricing strategies are introduced or expected to be changed, the fares paid by users will not be cancelled out. Therefore, the Gross producer surplus is the sum up of revenues for Port Authorities and port terminals, calculated in the financial analysis. The total amount is 4,214,968€ for the whole timeline.

3.3. Externalities

An externality arises from a particular action that has happened and produces either a positive or a negative effect, which is not internalised in the price of the service or product for sale, for instance air pollution from road transport services. This includes any cost or benefit that results from the project, which affects other parties without monetary compensation. As externalities are not included in the financial analysis, they need to be estimated and valued in the economic analysis. In the process of financial calculation of the STM Validation Project, two externalities have been identified and calculated:

- Savings in GHG emissions (CO₂, NO_x, SO_x and PM_x) calculated from the savings deducted in the financial analysis for 10 years and valued in monetary terms as suggested in the EU CBA Guide. The results are derived from applying Port call Synchronisation and Route Optimisation services
- Saving in potential accidents and incidents at sea, mainly due to collisions and groundings according to the EMSA statistics 2016-2018, which are valued in monetary terms (Gibson G., et al, 2014). It has been translated into lives saved and less injured crew at sea

3.3.1. Air pollution

CO₂ and SO_x emissions are related to the fuel used by ships, which in this case has been simulated as consuming MGO, fuel that complies with the restrictions produced in the Baltic Sea (one of the STM testbeds) and that would comply with the 2020 scenario in which the SO_x emissions limit must be lower than 0.5%. It is important to highlight that for NO_x and PM_x the calculation is related to the engine that each ship is equipped with, in terms of power delivered, engine characteristics, etc. In this case, average emission factors have been considered for all ships included in STM and those that cover regular SSS and *cabotage* routes in Europe, included in VESSL tool (Fundación Valenciaport European Short Sea Shipping Lines Database).

Table 6: Average emission factors for STM ships

AVERAGE EMISSION FACTORS IN MARITIME TRAFFIC T/T	
CO ₂	3.2038
SO _x	0.0020
PM _x	0.0015
NO _x	0.0783

Table 7: Social costs of emissions

MONETARY VALUE FOR EMISSIONS (IN EUROS/TONNES)	
CO₂ emission allowances	25.89
SO_x damage costs	17,240
PM_x damage costs	6,080
NO_x damage costs	3,790



Fig. 2 Total GHG emissions tons savings in Euros per type of pollutant

It should be noted that the tonnage savings calculations have only been calculated for a percentage of STM ships that effectively optimise their routes or synchronise their calls at STM ports. This conservative perspective helps to grasp the potential savings that would be achieved by introducing STM services at European level.

3.3.2. Accidents and incidents at sea

Another of the externalities that have been calculated, in line with the objectives of the STM Validation Project, is the social cost of accidents and incidents at sea that would potentially be avoided thanks to the implementation of various project services. In order to carry out this analysis, the different STM services that could help to calculate this externality have been specifically studied in safety issues. The services that do offer an improvement in account to that case are the following:

- Route Exchange Ship-to-Ship - allows two ships to know their true intentions and not be involved in close quarter situations. Getting into a complex manoeuvre, in certain weather conditions, at night, etc. where you have to apply ColReg is not always easy. It depends on a radio communication between two people who give each other instructions by radio and who sometimes only have the radar and the ECDIS to resolve the situation. These situations, in a very small percentage, end in collision and the possible consequences of the collision are significant.
- Port Call Synchronisation – Most of the operations in which Just-in-time is applied in port waters have not been deeply analysed. One of the main problems is the maritime traffic management near the port. Minimum safety and security standards would include stress in “on time” operations and this would lead to some risks. The approach of this service does not change regarding the port services operations; therefore, the risk associated to this service has not been studied.
- SMHI – Weather ETA – The service is not related to safety. There is a circumstance when the ship is assisted during extremely conditions during navigation but has not been the approach of the analysis for this services related to safety.
- Enhancing monitoring – VTS are aware of specificities of those areas monitored and controlled. The concept is that a ship shares its voyage plan to be assisted onshore. Those ships often are not navigating

through those areas in which some casualties arise. The shore centre assists the ship and suggests a route with safe waypoints. This could result in less casualties, mainly groundings.

- Navigational warnings - This case solves the non-updating of the nautical charts as for the possible dangers that there are in jurisdictional waters of the Member States. In addition, it provides updated information on events at sea that are temporary and could pose a risk to navigation. Normally this information arrives by NAVTEX, and now it arrives at the ECDIS. Groundings and collisions could be avoided in some way.
- Baltic Exchange Pilot route – It is similar, but it offers "safe" waypoints from experts in a maritime area (usually pilots) to make approaches to port or crossing geographic areas with shallow waters like Oresund. This service could avoid groundings.
- Search and Rescue service – Optimising and make it reliable and automatic on board SAR units would lead to less time to start searching. Human lives saved can be the result of this optimisation of operations in search and rescue situations.
- SSPA Route Optimisation, Port Call Coordination do not have a safety implication and are not included in the assumptions.

The total number of lives that could be saved in 10 years is 4, while 10 severely injured people and 27 slightly injured could be avoided

The following table summarizes the average social cost by type of casualty that will serve to quantify the value of this externality in the economic analysis.

Table 8: Social costs of accidents at sea per severity range (Gibson, 2014)

AVERAGE SOCIAL ACCIDENT COSTS, AT MARKET PRICES (PPP) IN EUROS (2010)		
FATALITY	SEVERE INJURY	SLIGHT INJURY
1,870,000 €	243,100 €	18,700 €

In order to draw up the following table, EMSA (European Maritime Safety Agency) statistics from 2016 to 2018 have been analysed taking into account only the accidents categorised as collisions and groundings in the area of STM testbeds. These accidents have been accompanied by statistics of loss of human lives, serious injuries and slight injuries. Data have been extrapolated for the total project time series and the suitable reduction percentages have been applied. In the case of loss of human lives, a reduction of 5% has been considered, while in the case of injured people a reduction of 10%.

Table 9: Number of fatalities avoided in STM scenario and average economic costs

YEAR	NUMBER OF LIVES SAVED IN 10 YEARS	NUMBER OF INJURED PEOPLE SAVED IN 10 YEARS	NUMBER OF SEVERE INJURED PEOPLE SAVED IN 10 YEARS	NUMBER OF SLIGHT INJURED PEOPLE SAVED IN 10 YEARS	AVERAGE ECONOMIC COSTS OF FATALITIES AND PEOPLE INJURED (IN EUROS)
2018	0	0	0	0	- €
2019	0	2	0	2	37,400 €
2020	1	2	0	2	1,907,400 €
2021	0	2	0	2	37,400 €
2022	1	3	1	2	2,150,500 €
2023	0	3	1	2	280,500 €
2024	1	4	1	3	2,169,200 €
2025	0	6	2	4	561,000 €
2026	1	7	2	5	2,449,700 €
2027	0	8	3	5	822,800 €

3.4. Overall results

The socio-economic analysis shows that the project is generating a positive welfare change and therefore the funds received by the EU for its implementation are profitable. The ENPV is the most important and reliable social CBA indicator. The present amount of the net benefits is calculated as the difference between the total discounted social benefits and costs. The results of the economic analysis shows the interest of the projects in terms of its benefits for the society that amounts in an ENPV of 17,876,814 € and an ERR of 18.31% with a payback of 6 years for the whole STM Validation Project.

4. Conclusions

Finally, it is key to highlight that applying the real market costs of the required investments to the total ports, the ships operating in the European Union and port terminals for SSS and *cabotage* traffic would be translated into a huge financial and economic impact. The adoption of STM services by the sector would have a very substantial impact in savings costs and a remarkable reduction of externalities

The methodology employed follows the recommendation of the Guide and includes the following steps: description of the context; definition of objectives; identification of the project; technical feasibility and environmental sustainability; financial analysis; economic analysis and risk assessment.

The Action covers the long-term development project affecting the European waters, containing 8 ports analysed (Valencia, Barcelona, Sagunto, Stavanger, Gothenburg, Limassol, Umea and Vaasa) of 5 countries, 6 shore centres in Norway, Spain, Estonia, Denmark and Sweden and 268 STM ships of more than 30 different companies. The objective is to know the potential impact of STM project in the European Union. The estimations have been carried out from a conservative point of view and with the results of testbeds during the STM project development phase.

The total investment needed to carry out the project amounts to 23,691,484 Euros, to be completed by 2027.

The STM Validation project presents a Financial Rate of Return on investment of 8.77%, and a positive Financial Net Present Value of €2,792,060. This means that the project will cover the costs and European Union co-financing is clearly needed to be able to make possible the project and obtain the very positive economic impact that it will generate.

An economic analysis has been carried out in order to complete the financial analysis and include the effects of the project on the general welfare. The results of the analysis show the interest of the project in terms of its benefits for the society, that amounts to an ENPV of € 17,876,814€ and an ERR of 18.31%.

All the data, from a conservative point of view, offer positive results for society in terms of reduction of GHG emissions as well as the reduction of accidents at sea which has a very important impact on the reduction of environmental costs due to accidents during navigation.

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