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Advanced Noise Control strategies in HarbOuR

Figures of Merit

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Content

1. Executive Summary

The report on the Figures of Merit shows how the present port concession policy of Norther Tyrrhenian Sea Port Authority System (hereinafter ADSP MTS) can be adapted to a more environmental friendly port governance, by stimulating the port operators to curb noise emissions. In the first paragraph, a brief introduction on the role of the ADSP MTS and the main noise issues of the port are described, with current and past measurement of noise levels.

In the second part of the report, the possible indicators, which are mainly quantitative, are presented to incentive port operators to reduce the actual level of noise emissions. In this respect, a possible method of stakeholder involvement is also highlighted, in order to ensure that these measures are effectively put in place by competent players.

2. Port Introduction and current noise levels

Pursuant to the Law Decree no. 160/2016, Port Authority Systems are established in Italy for planning and developing main commercial ports in Italy. For instance, the Port Authority System of Northern Tyrrhenian Sea regroups the port of Livorno, Piombino, Capraia Portoferraio, Rio Marina and Cavo and it is therefore responsible for delivering on the Port Master Plan and the Operational Plan for these ports.
As such, the ADSP MTS has no operational task and has no right to operate even indirectly port operations. Nonetheless, the Port Authority can influence and support the development of private-managed port operations, which are defined by the law as handling, loading, unloading and storing of cargo, along with embarking and disembarking of passengers.
More in detail, the Port Authority has to:

- Authorize port services delivered to freight and to passengers;
- Grant into concession port areas, where port operations and services can be performed and where a single operator has therefore the right to exploit berths and a yard on multi-annual agreement.

Both concessions as well as services are operated on the basis of techno-economic plan, which is delivered by the operator and which reports on expected traffic volumes, foreseen employment and equipment needed to carry on operations. Apart from pure economic figures, such as revenues, return on investments, assets and liabilities, along with technical information, little information is paid to other issues, such as the environmental concerns and in particular measures to reduce the impact of port operations on the environment.
The Port Authority gets concessions and services fees for the economic exploitation of port land and activities. These revenues, which

totaled 12.5 million euros in 2018, are an important source of income for the Port Authority and are collected on a mainly real estate model, that is on the assessment of property value plus some abatement in case of certain investment level reached. For instance, concession fees are determined on the basis of surface area (covered or opened), with reduction if the concessionaire invests on new port facilities, refurbishment of port equipment. Current port concession policies allows also the recovery of costs for the environmental certification EMAS or ISO 14001, up to 50% investment costs. As widely known, these costs can reach 1,500 euros for bigger companies; the Port Authority does not foresee other kind of supporting schemes than refunding these costs and the EMAS certification is per se of little interest for transport and logistic Companies.
In the following, we will explore the path towards the identification of possible Figures of Merit for ADSP MTS, through the GR G4 guidelines already adopted by the Port Authority of Goteborg, Sweden, and in particular:

- Identification of main issues affecting environmental sustainability and port competitiveness;
- Prioritization, that is the sharing of environmental issues and measures to tackle them;
- Validation, that is to have the Figures of merits validated by relevant stakeholders and competent bodies of ADSP MTS.

This process ensures that the highlighted Figures of Merit match with local undertakings potential environmental enforcement, along with the incentives schemes that the Port Authority can effectively put in place. Moreover, in accordance to Directive 2002/49/EC (Environmental Noise Directive - END), it is also essential to bear in mind the key provisions and thus the guiding principles for setting out noise abatement measures:

- Noise levels and their effect on the surroundings should be made publicly available;
- Noise abatement and mitigations interventions should be set forth in the Operational planning of the Port Authority;
- Action plan for lowering noise levels, including the private led measures, should be explicitly set forth by the Port Authority and listed in its acts and regulatory plans.

The Figures of Merit concept is also referable to the “Polluter pays” principle, even if there port operators are not legally bound to respect noise emissions levels and Figures of Merit functioning is more related to preventing rather than fining noise pollution. Moreover, it is often hard to identify noise source and hence the polluter. In this sense, the difficulty to detect the exact source of annoyance makes it efficient to promote actions and environmental-friendly behaviors with general measures as the Figures of Merit are.

2.1 Current port noise

The issue of port noise has been only partly addressed in past years, the focus being rather on atmospheric and water pollution.
The past LIFE project NOMEPORT has listed these main sources of noise, which will be taken into account when delivering the Figure of Merits:

- Port services and facilities
- Terminals (cargo handling, warehousing)
- Industrial areas
- Machinery, workshop
- Vessel repair or maintenance
- Shunting yards
- Vessels when berthed (engine noise)

Besides these activities, we should point out other important sources of noise, notably the traffic ones:

- Roads
- Railway

In the port of Livorno all these activities are performed, as shown in the map below:

The map displays the current layout of the port which, especially in the southern parts, is closely located next to urban settmelements. Some 40.000 inhabitants are affected by port noise.

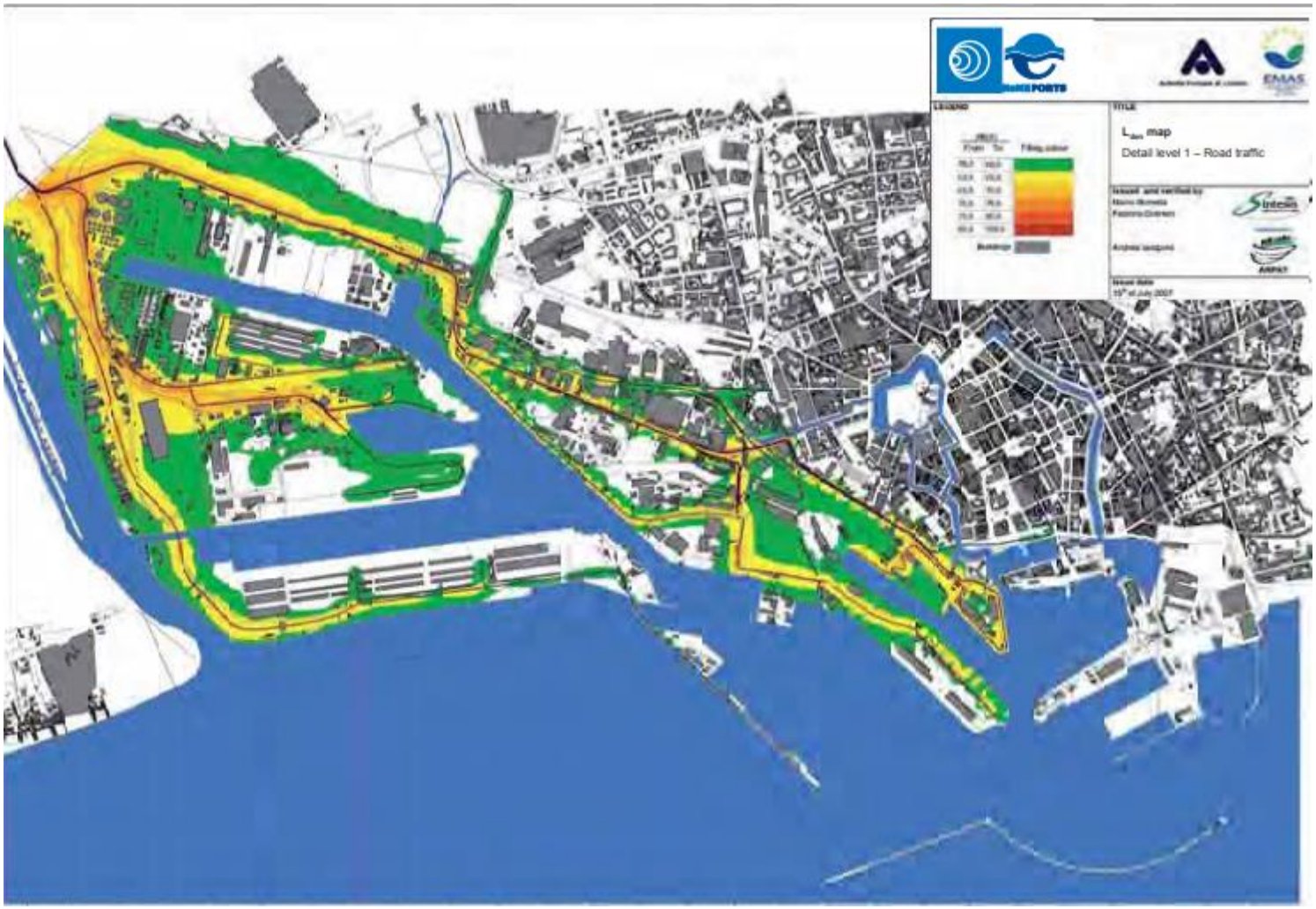
Nonetheless, at least in the port of Livorno, noise detection has been made when major infrastructural development have been planned and set forth. Among the last noise measurement we may quote the monitoring made around the ship yard and leisure port area in 2007, as the zone was undergoing an important transformation from the production of ferries and ships to the manufacturing of yachts and leisure boats. Port noise reached at that time a maximum of 76.5 LDay in the vicinity of shipyards, but other critical points where also located along main port access routes, as urban and port traffic mixed. Overall port areas are listed as zone 5 or 6 in Noise classification, what implies the threshold values below:

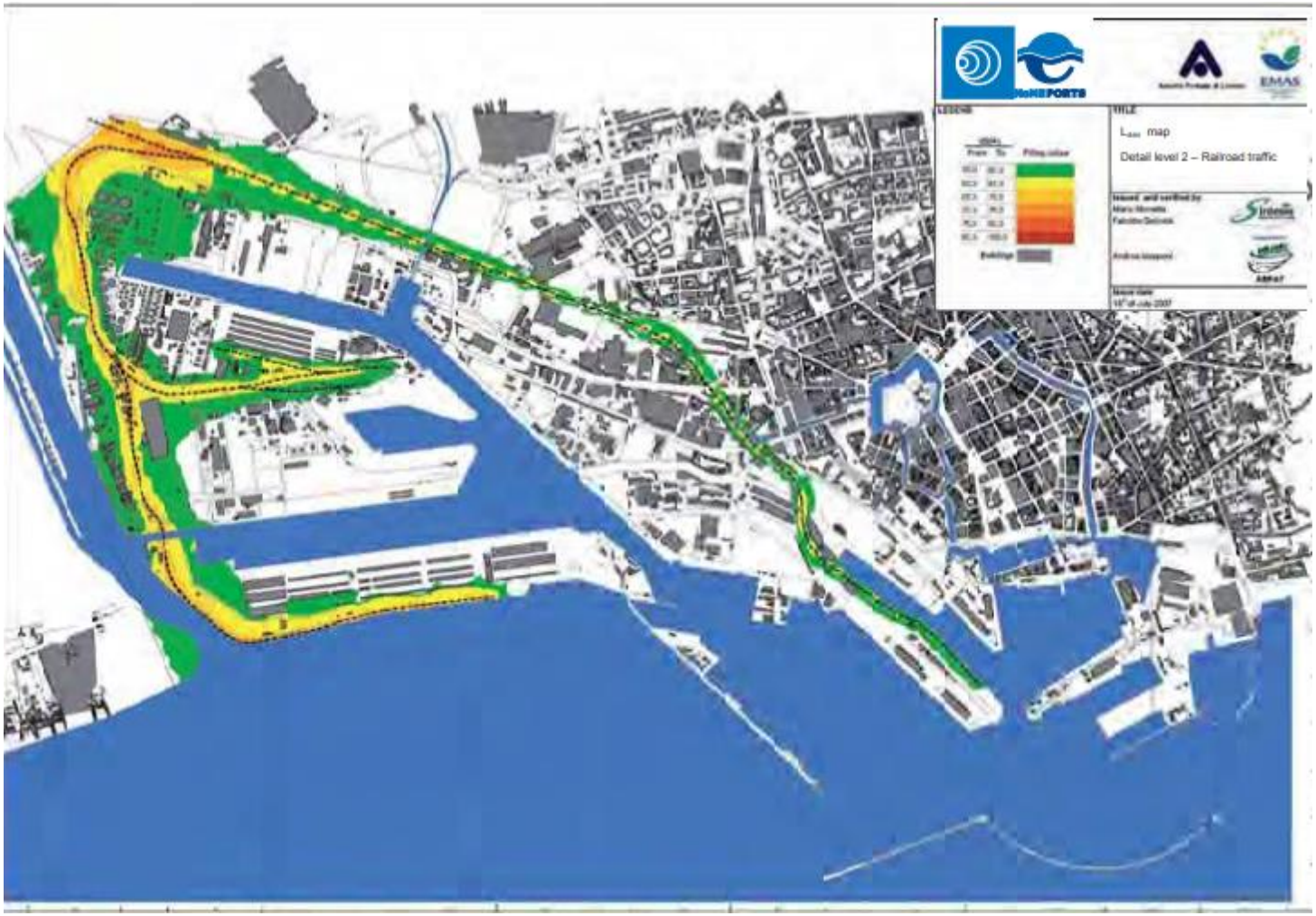
- Mostly industrialized areas, Lden 65, Lnight 55;
- Only industrialized areas, Lden 70, Lnight 65

With these values, exceeding thresholds rarely occurs in the vicinity of settlements and inhabited areas.
Another survey has been recently made, as the Port Authority is planning a major port extension through land reclamation. In this case, monitoring has been made within the commercial and industrial port, where plants and factories are located as well, to assess the potential environmental impact of the new large port infrastructure, called Darsena Europa (Europe Dock).
The values retrieved from this monitoring are reported below:

[insert table here]

The maps below, drawn from the NOMEPORT project, highlight the noise impact of road, railway and global noise in the port of Livorno:


TITLE
L_{den} map
Detail level 1 – Road traffic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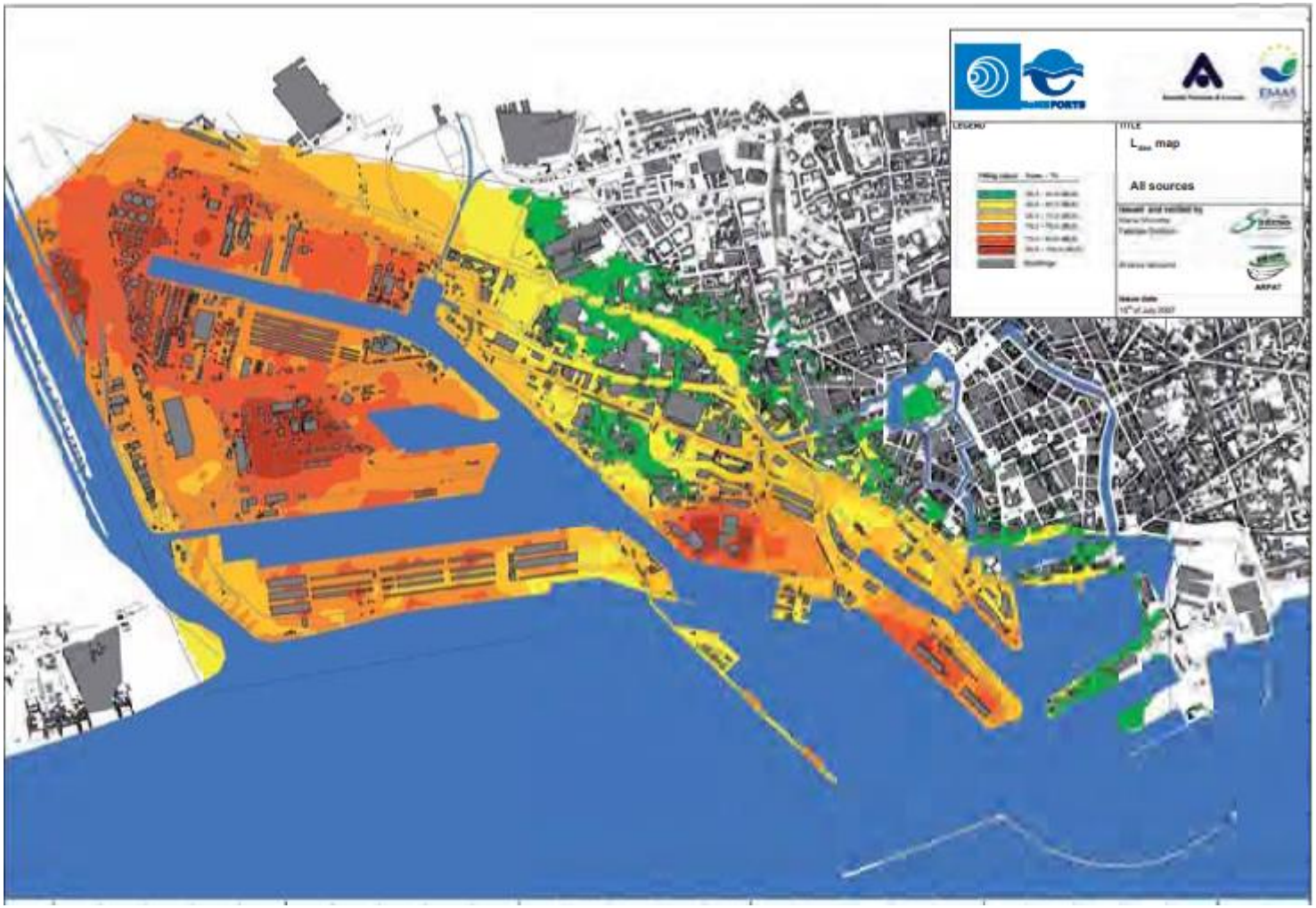
Lden map
Detail level 2 – Railroad traffic



With respect to the past Nomeports project, the priority area, once linked to industrial activities, should be reviewed in the light that

some industrial plants have been dismissed, and in the meanwhile the Ro-ro traffic has grown, reaching a total 14 million tons in 2018. Priority should be given then to handling activities, road and railway traffic, as well as ship berthing, especially during nighttime.
The past Nomeports project identified the following mitigation measures:

- Reducing structure-borne sound radiation
- Silent equipment (low noise versions cost little extra)
- Reducing the speed of putting down a container
- Low noise driving (ECO-driving) distance from surface of opening a bulk grab.
- Automatic positioning of the spreader
- GPS of containers so you can reduce sound peaks
- Silent exhaustion pipes
- Electricity in stead of diesel or diesel-electric moving equipment
- Planting trees as a barrier
- Use water cooling instead of air cooling
- Use softer ground where activities allows (e.g. quiet asphalt)

As for Ships, we may list these mitigating measures:

- Silent exhaustion pipes and ventilators
- Prevent loud speakers at berth
- Supply ship-shore energy during berthing

We can hence correlate these measures to specific traffic categories:

Measure	Traffic category
Reducing structure-borne sound radiation	All terminals
Silent equipment (low noise versions cost little extra)	Container terminal
Reducing the speed of putting down a container	Container terminal
Low noise driving (ECO-driving) distance from surface of opening a bulk grab.	Dry Bulk

Automatic positioning of the spreader	Container terminal
GPS of containers so you can reduce sound peaks	Container terminal
Silent exhaustion pipes	Container terminal, Ro-Ro terminal
Electricity in stead of diesel or diesel-electric moving equipment	Container terminal, Ro-Ro terminal
Planting trees as a barrier	All terminals
Use water cooling instead of air cooling	All terminals
Use softer ground where activities allows (e.g. quiet asphalt)	Container terminal, Ro-Ro terminal
Silent exhaustion pipes and ventilators	All terminals
Prevent loud speakers at berth	All terminals, especially passenger terminals
Supply ship-shore energy during berthing	Passengers terminals

Ad depicted in the above, not all traffic categories can undertake the same interventions to tackle noise emissions. Figures of Merit should therefore duly take into account that incentives schemes and support to private investments have to match with actual capabilities of port terminals and operators for mitigating noise emissions.
The match between listed port terminal and mitigating measures is essential for the prioritization of noise reductions interventions, which can be also listed as follows:

Measure	Small/Bigger investment-effort
Reducing structure-borne sound radiation	Smaller investment
Silent equipment (low noise versions cost little extra)	Smaller investment, in case of purchasing new equipment
Reducing the speed of putting down a container	Smaller investment, with impact on container terminal productivity
Low noise driving (ECO-driving) distance from surface of opening a bulk grab.	Smaller investment
Automatic positioning of the spreader	Smaller investment
GPS of containers so you can reduce sound peaks	Smaller investment
Silent exhaustion pipes	Bigger investment
Electricity in stead of diesel or diesel-electric moving equipment	Bigger investment
Planting trees as a barrier (dune)	Bigger investment, up to 10,000 euros per meter barrier
Use water cooling instead of air cooling	Bigger investment

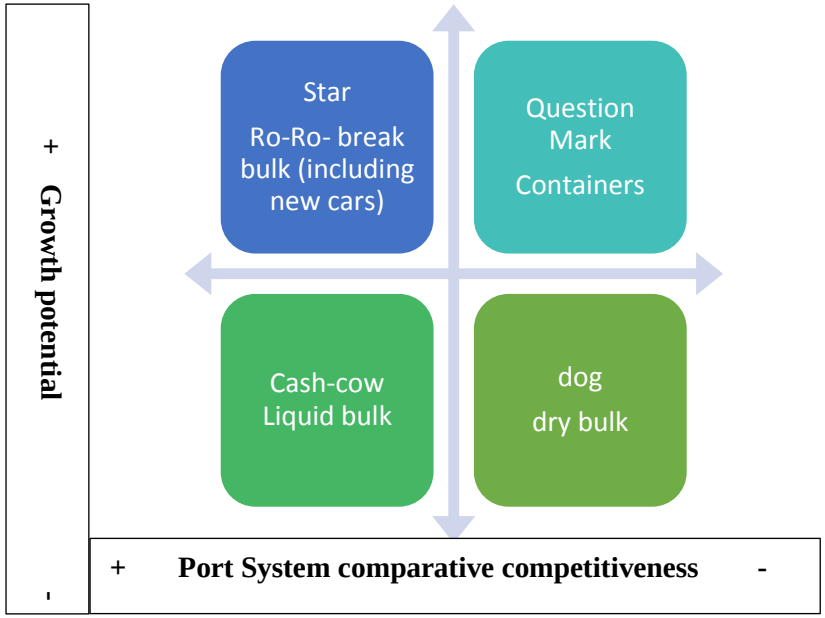
Use softer ground where activities allows (e.g. quiet asphalt)	Bigger investment, some 200 euros/meter for a dual carriage way
Silent exhaustion pipes and ventilators	Bigger investment
Prevent loud speakers at berth	Smaller investment
Supply ship-shore energy during berthing	Bigger investment

Some of the above mentioned Measures are rather efforts, actions with low economic impact, even if their result on the overall terminal productivity or competitiveness can be questionable. One example is the reduction of container handling speed, which lowers noise and fuel consumption but has an impact on container productivity, measured on crane moves per hour. Other measures have instead bigger economic impact , such as planting trees as a barrier (see dune), deployment of quiet asphalt or supply ship-shore energy and are moreover beyond private operators financial reach or legal competencies. As for the Figures of Merit, the Port Authority can nevertheless envisage that the private operator either ensures maintenance or the highest use possible of provided facilities. One example in Livorno is the electrified quay Sgarallino, which has been set up by the Port Authority in 2015, with voltage span from 6kv to 11 kv and has not been used ever since. A suggested Figure of Merit could subsequently deal with incentives to foster the use of this facility by the private operator whom has been granted into concession that quay.

2.2 Identification of main issues affecting port noise and port competitiveness

The results of above-mentioned monitoring show that the most important source of noise in the port and its surroundings is road traffic, since the port of Livorno is the biggest Italian port for Ro-Ro traffic and it is also a leading ferry port, with annual linkages to islands. Owing to the current port layout, with different traffics widely dispersed in many port areas, road traffic and thus noise affects a large part of port surface. In addition to this, some 70 km of internal railway network contribute to local noise emissions for train shunting.

On the other hand, Ro-Ro traffic is also a key asset for port competitiveness, and port operators have limited influence for curbing noise emission related to traffic. Energy transition towards more environmental friendly vehicles may in this field help to reduce pollutant emissions, including noise emissions. Other traffic categories, and their relevance for the ADSP MST, are displayed in the chart below, the well know Boston Consulting Group Matrix:



As depicted, the Ro-Ro and other break bulk traffic is strategic for the Port System, while other flows, such as the dry bulk, play a little role in the global Port competitiveness. This is also important to point out as the policy measure to tackle noise emissions should be also tailored on the potential impact of different port activities and traffics on the overall throughput. We can therefore summarize this information in the table below, which correlates port activities with noise levels and thus priorities to reduce emissions:

Port traffic category	Relevance in the port competitiveness	Correlation to noise levels
Ro-Ro	High (Livorno top ranking)	High- all traffic on road
Break bulk	High (Livorno top ranking as for forestall products and new vehicles)	High

Container	Medium (Livorno not amongst top players)	High, as 84% of container traffic is transported on road
Liquid bulk	Medium (some important facilities, but not among leading ports)	Medium, freight stored and transported through pipelines
Dry bulk	Low (marginal traffic)	Low, marginal traffic

3. Figures of Merit – Proposal and impact on port concession policy

In this section we deal with a list of proposed Figures of Merits, that can be listed in port concession policy. The Figures of merit should in principle:

- Be accountable, i.e. they should be compliant with the strategic planning of the port, the overarching environmental goals set forth for the logistic and port industry by National and European legislation;
- Be measurable, i.e. they should be clearly measurable through economic or technical sources, or even through direct observation
- Be effective, by direct linking port operator's behavior to incentives schemes in a simple and transparent way.
  We may list the possible Figures of Merits in the table below:

Figure of Merit	How to determine it	Type	How to measure it	Traffic category
Low Impact Handling	Handling speed (Crane moves per hour/spreader cycle)	Quantitative- impact on port operations	Direct observation of declared values	Container
Low impact structures and facilities	Verification on purchased equipment/ works, Business plan to be evaluated	Quantitative- impact on operator's costs	Desk verification (Business plan); direct observation of declared values	All categories
Electricity instead of diesel or diesel-electric	Verification on purchased equipment/	Quantitative- impact on operator's costs	Desk verification (Business plan); direct	All categories, more relevant for Container

moving equipment	Business plan to be evaluated		observation of declared values	traffic
Use of supply energy ship-shore	Number of ships using electrified berth	Qualitative	Data from Harbour master	Passenger terminal
Interventions to mitigate noise impact	Verification of works	Quantitative- impact on operator's costs	Desk verification (Business plan); direct observation of declared values	All categories

Of course, we should bear in mind how noise polluting each of these sources is: for instance a Gantry Crane for container operations can reach as much as 110-115 db during normal activity (source: Port of Long Beach); likewise ships generators have noise levels up to 110-115 db. A lorry driving through the lane at average city speed reaches 80 db.

It is crucial to assess how to support private operator investments or environmental-friendly practices within the framework of port concession policy. In other words, how the Port Authority can reward the commitment during the submission phase (when the Business plans are delivered for its evaluation) and, in the following, foster private investments to lower noise emissions.

In this respect, concession fees and concession time span are the most important tools the Port Authority has to encourage private operators' commitment in tackling acoustic annoyance of operations. Another tool, which can be used at the very beginning of the concession phase, is the evaluation of proposed Business plans. In this step, the ADSP MTS has to assess who is the best operator to be awarded the concession, and the evaluation is made in accordance to publicly-known criteria and thresholds, which should include also noise related issue. The Port Authority should therefore correlate evaluation, the fees due or the concession length to take into account the financial efforts, the higher costs or lower revenues related to greener operations.

Figure of Merit	Impact	Incentive	Means of verification
Low Impact Handling	Lower revenues	Lower fees	Business plan, Balance sheet
Low impact structures and facilities	Higher costs investment costs	Lower fees, extend concession length	Business plan, Balance sheet
Electricity instead of diesel or diesel-electric moving equipment	Higher investment costs	Lower fees, extend concession length	Business plan, Balance sheet

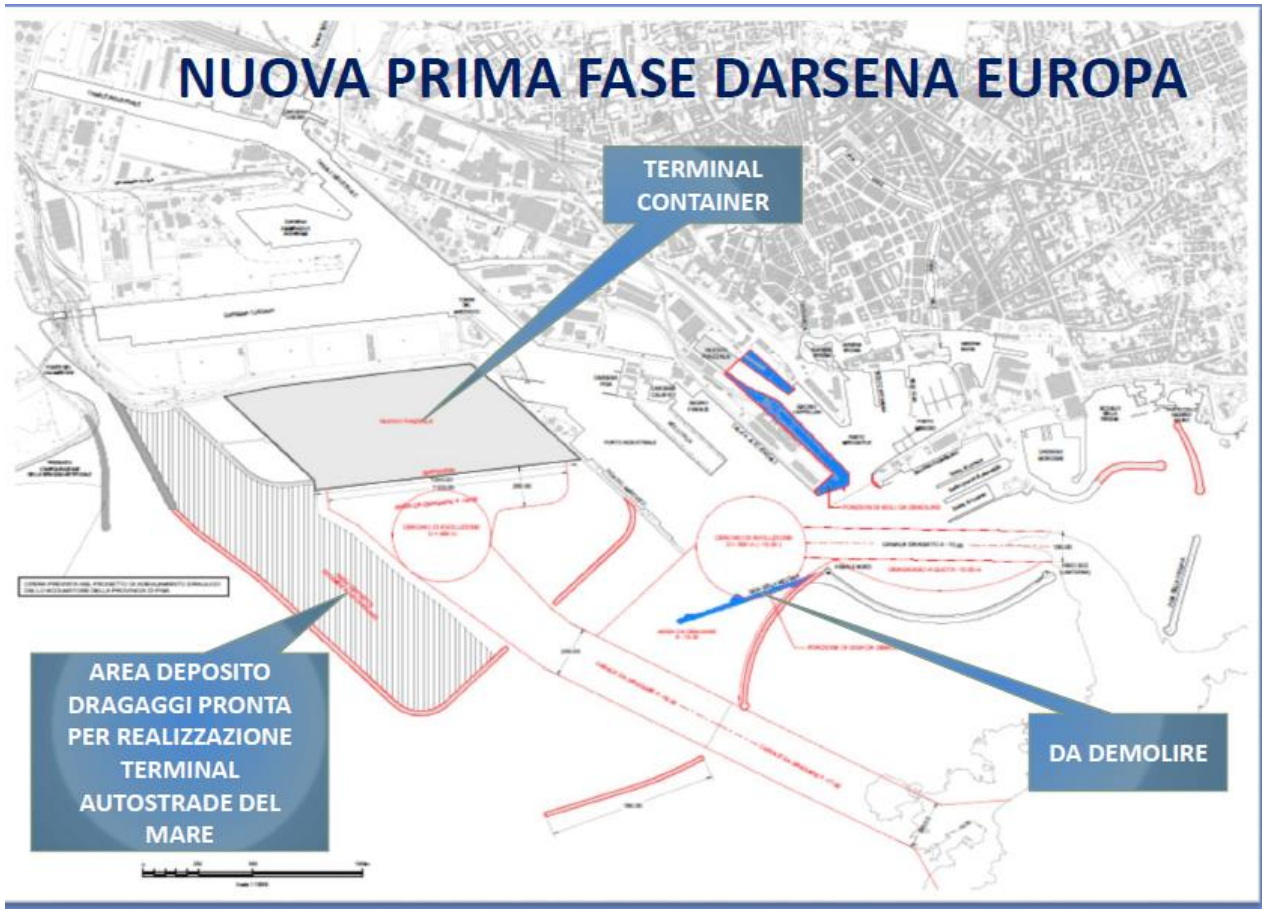
Use of supply energy ship-shore	No economic impact on the concessionaire; marketing actions to reach new customers- for shipping companies installing transformers and other equipment on vessels can cost up to half million euros	Better evaluation of the business plan	Business plan
Interventions to mitigate noise impact	Higher costs investment costs	Better evaluation of the business plan, extend concession length	extend concession length

Figures of Merit are also values, thresholds, to be taken into account to incentivize operators. We can subsequently identify the values:

Figure of Merit	Value	remarks	Verification
Low Impact Handling	Voluntary diminution of container lifts per hour of 5, not lower than 20 lifts per hour; Voluntary diminution of spreader cycles (quay crane) per hour of 5, not lower than 35 cycles per hour	Need to balance acoustic impact with port productivity; hence the identification of minimum output per hour and threshold of voluntary diminution	Direct observation; acoustic monitoring of the Port Authority
Low impact structures and facilities	Number of structures and facilities transformed		Direct observation from data declared in the Business plan and Balance sheets of the terminal operator

Electricity instead of diesel or diesel-electric moving equipment	Number of Electric cranes and handling equipment put in place	Shift from diesel propelled solutions to electrified equipment	
Use of supply energy ship-shore	Number of vessels berthed and supplied with electricity at quay	Installing transformers and other equipment on vessels ca cost up to half million euros	Self declared data from terminal operator; Port Monitoring System
Interventions to mitigate noise impact	Number of interventions		Direct observation from data declared in the Business plan and Balance sheets of the terminal operator

For the time being, it deserves mention that the biggest container terminal in the port, Terminal Darsena Toscana, has eight electric quay cranes, 13 Rubbed Tyred Gantry cranes, which are propelled with conventional fuels, 8 reach stackers. In this respect, the potential for converting handling equipment to more sustainable solutions is related to pure yard equipment. The other container terminal, Terminal Lorenzini, has 10 cranes, all fueled with diesel. Silent handling equipment could be here also deployed. These data have been retrieved through direct surveys: the concessionaire is not legally bound to invest in silent handling equipment, and, until the concession expires in 2029, this obligation cannot put into force. However, as the Port Authority tenders a new important concession for the planned Darsena Europa, Figures of Merit can be used for upcoming concession procedures, which may have a great impact on the environment too.



The map in the above shows the planned facility of European Dock (Darsena Europa) which will result in a major development for the port of Livorno, by adding two new terminals and some 72 hectares to the port. Figures of Merit should therefore be applied to future concession schemes of Darsena Europe, or at least to new concession procedures of the port. In this sense, Figures of Merit might be also modifiable in accordance with specific features of port activities and terminal. In the following, we will analyze how to adapt Figures of Merit to different ports and operations.

3.1 Figures of Merit - possible application in other ports

Figures of Merit should be not applied only to the port of Livorno, albeit by far the biggest one in the System, but should include also different types of port activities and ports. Nonetheless, port activities are differently performed in the other two relevant ports, namely Piombino and Portoferraio. In these two ports, operations are not made by terminals, and generally the port area is not lent in concession. Most of port activities are directly performed by shipping companies and port services providers, although in the port of Piombino a new activity of dismantling and scrapping ships has been established as of 2019. Figures of Merit for these ports should therefore take into account mainly Ro-Ro and Ro-pax related activities, the biggest source of noise being road traffic and congestion upon arrival and departure of ships. In the port of Portoferraio, the ADSP MTS is carrying on monitoring of noise related to port traffic (both peak and low season) and results should be available by end July, to be integrated also in this report. In the meanwhile, works are projected to substitute traditional asphalt with low noise emission asphalt, in September 2019, thus contributing to reduce noise from road traffic.

In these two ports, we may therefore focus the identified Figures of Merit:

- Infomobility actions to better streamline arrival/departure of vehicles, thus avoiding crowds and congestion upon ship sailing;
- Operational actions to lower impact of ship berthing while at port, notably lowering hatchback's bump on quay, lowering ships noise while berthing or preventing loud speakers at berth;
- Other mitigating measures, such as barriers, to curb impact of port operations.

It is essential to point out that most of these mitigating measures are rather competency of public bodies, which are planning to solve the issue of noise pollution in the port of Portoferraio. More in detail, infomobility and ICT tools for cargo and passengers are being implemented by the Port Authority, even through EU funded project, and will have an impact on port noise as passengers will know in advance delays and exact time of arrival of ships, contributing to lower congestion at port gates and along access routes. Private operators could nonetheless be supported in cooperating with public bodies in reducing impact of port operations. In the table beneath, we summarize the type of incentive that can be envisaged for smaller ports such as Portoferraio, where the most of traffic is mixed Ro-pax:

Figure of Merit	Target	What	How to verify it
Support to better road traffic management and ships schedule	Shipping companies	Availability of ships schedule data for infomobility, port operations planning Availability to berthing ship to reduce noise	Direct control by Port Authority
Actions to reduce acoustic harm from ship operations	Shipping companies	Interventions to reduce noise from operations: Electrification (when electrified berth available) No loud speakers Hatchback bump at berth- rubber insulations of ramps	Direct control by Port Authority- port monitoring
Physical interventions	Port Authority – support by private operators	Availability to support Port Authority in lowering noise impact	Port Authority balance sheet