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"Guideline for the realization of noise monitoring system for urban ports"

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Author(s): Konstadinos Konstadakopoulos, Vasileios Kantzaris, Vasiliki Baoustanou (MUPAT)

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1. Executive Summary

The deliverable on "Guideline for the realization of noise monitoring system for urban ports" defines the methodology and goals of of the Action B2 "Design of a Smart Port Noise Monitoring System (SPNMS) and application to Patras port".

This system, named Smart Port Noise Monitoring System (SPNMS), will allow the sound pressure level real - time measurement and reading recorded at selected locations inside port area, in correspondence of main noise sources and at most disturbed receivers. The monitoring stations network will transmit data via wireless transmitters to a remote server located at MUPAT. Data will be processed and made available for real-time reading via project and website. The system will be able to receive reports from disturbed citizens and to send alerts to port companies whose noise emissions exceed defined threshold levels. Furthermore, SPNMS will automatically inform registered users (via e-mail, SMS or social media) before the starting of disturbing events.

2. Introduction

The main objective of this Deliverable, called as "Guideline for the realization of noise monitoring system for urban ports", is to contribute to the sustainable development of port infrastructures of Urban Ports through the definition of assessment tools that allow to advance in the elaboration of the diagnosis and the action plans to minimise the acoustic pollution generated by the ports operation.

The current deliverable implies the design of the Smart Port Noise Monitoring System (SPNMS) of the Port of Patras, as well as the analysis of its possible application in other port surroundings. In addition it implies the definition of a methodology for the assessment of the noise levels produced by the port activities, with its corresponding application in the other Mediterranean Ports.

In second phase on this deliverable will be based the provision of the necessary instrumentation for the implementation of noise levels monitoring system in the Port of Patras.

3. What is a Smart Port Noise Monitoring System (SPNMS)?

Basically, it consists of a set of terminals of sound levels gathering, connected all of them to a central unit, with a multiple function to store, analyse and to serve the information processed in suitable formats.

The specific objectives of a SPNMS are defined considering aspects such as:

• Determination of the degree of fulfilment of noise levels according to applicable legislation.

• Observing trends of the evolution in the time

• Determination of alert situations

• Evaluation of injurious effects on the people

• Informing people, etc.

Exactly, on the case of Port Activities, the election of the equipment of the Monitoring System would be based on the fulfilment of the double objective of:

• Represent the sound levels of a set of operations developed in the port area, which can characterise the acoustic environment of a certain area at any time of the day or the night.

• Establish a control system that in conjunction with a Noise Map alerts of the possibility of an acoustic impact in the residential zones when the measured levels associated to a certain activity of the port overcome the sound limits

4. General Criteria for the Location of the SPNMS

From a point of view of the needs, the three following possibilities represent an obvious visualisation of the aspects that have been exposed previously and that identify a SPNMS.

a) If there is a precise problem in a certain area and with a certain source, the location of two synchronous equipment in the proximities of the source and in the proximities of the affected zone, could serve to determine the overcoming of a limit and associate it to a certain moment of the process. Therefore, corrective and/or sanctioning measures can be applied.

b) If there are multiple problems, the same process of point a) can be applied, extending it to each case. In this point, the use of mobile equipment seems to be the most recommendable acting.

c) If there are not specific problems (identifying the problems as the complaints of the surrounding population of the Port), the SPNMS could be oriented towards the travelling control of the noise sources closest to the population or zones of future residential development, in order to control that noise levels remain in a range where they don't originate complaints.

Once the objective of the SPNMS and its general location are identified, from a practical point of view, a set of indications concerning acoustic and operative issues can be given, in order to decide its concrete location.

a) Natural and artificial screenings have to be avoided, i.e. the vision between the microphone of the monitoring station and the source has to be direct.

b) It is preferable to select high locations to allow the fulfilment of the previous point, and to allow the establishment of relations with sound levels at other points, because without the presence of the elements at ground floor (buildings, materials...) it is easier to establish these relations.

c) The presence of reflecting elements in the surroundings of the microphone has to be avoided. The influence of the façade of the building will be considered, taking into account the appropriate corrections in case of being required by the applicable norm.

d) Whenever it is possible, the influence of sources from outside the port will be avoided, orienting the microphone.

e) The monitoring equipments in continuous have batteries that allow to work during limited periods of time with no connection to the network. The batteries are only used as preventive solution in case of a cut in the electrical provision. The usual way of operation requires the permanent connection, so an accessible and safe tension point is fundamental.

f) Both fixed and mobile equipments have a central unit of reception, storage and transmission of information that is collected in a solid box which is prepared to allow to operate when there are problems. In spite of it, due to the continuous transit of merchandise (trucks, fenwick, trains...), in a port area it is recommendable to protect this box, placing it in high point.

5. General Criteria for the Acoustic aspect of the SPNMS

The acoustic monitoring, the first major differentiation that must be faced is that concerning the purpose of the survey:

- short-term measurements (spot), which is usually carried out using sound level meters, for the production of punctual reports on noise conditions.
- long-term monitoring, which can be carried out with fixed stations consisting of cabinets, power supply units and sound level meters, for a broader analysis and the creation of "global" maps on noise trends.

Our intention should be to carry out constant monitoring, therefore in the long term, with tools that provide the values measured in real time, differentiating the results according to: thirds of octaves, frequencies, sound levels.

For the study and analysis of SPNMS, some essential characteristics that define the environment and the noise present are to be considered.

- the analyzes carried out previously and the technical literature define the port context comparable to building construction activities, therefore with “typical of a construction site” noise;
- The sound level is very wide and the vehicles operating in the port reach noise values of around 120 dB for certain quay cranes;
- the noise emitted by the ship, with low frequencies (typical for example of vibrations), is able to propagate to greater distances, especially in night conditions with a lower basic noise.

An important aspect, which differentiates the acoustic environment from the previous one, is that there are no acoustic sensors, but they are always sound level meters with different technical characteristics, often also on the software side. The sound level meter is only an "electronic ear" that measures the sound level (and all the technical aspects intrinsic such as frequency or other) in a given environment and all the analyzes, for example regarding the origin of the sound, the source, etc., are made later on the software side.

6. General technical specifications on the SPNMS equipement.

General in the field of sound level meter specifications, the most important technical reference is given by the international standard IEC 61672 which provides tolerance limits for the frequency response of the device, auto-generated noise and linearity. Two main classes of precision instruments are defined, with the related specifications:

i. Class I: maximum linearity error of ± 1.1 dB for approximately 1 kHz, the linear operating range must be at least 60 dB and the linear amplitude deviations must not exceed ± 0.6 dB.

ii. Class II: maximum linearity error of ± 1.4 dB for about 1 kHz, the linear operating range must be at least 60 dB and the linear amplitude deviations must not exceed ± 0.8 dB.

The Class I (precision) must be used for accurate sound measurements in the laboratory and in the field, while Class II (General Purpose) could be used for general measurements in the field.

The growing availability of low-cost devices on the market leads to a generation of sound level meters of always different quality with "intelligent" characteristics of connectivity or display of the data of each supplier. Furthermore, smart and low-cost systems are indicated as those that can allow the realization of a widespread and continuous acoustic monitoring, even if the maintenance of this instrumentation must be frequent to ensure that the level of certified sensors is maintained. In practice, the discriminant occurs in the field of microphones chosen within the sound level meter Proposed technical specifications :

Measured quantity:	*Leq A fast, 1/3 octave spectrum*
Trigger audio recording:	*yes*
Acquisition time base:	*1 second*
Measurement range:	*35 – 120 dB(A)*
Data transmission:	*GPRS, 3G*
Powering:	*solar panel*
Operation:	*continuous h24*
Internal battery:	*yes*
Rain shield and windshield:	*yes*
Mounting:	*lamp post, wall*
Data transmission frequency:	*programmable*
Box dimension:	*20 x 12 x 9 cm*
Solar panel dimensions:	*33 x 30 cm*
Protection:	*IP67*
Weight:	*2 Kg*
Microphone:	*½ inch mems system*
Long term drift:	*less than 0.2 dB/year*
Temperature and frequency response:	*IEC 61672 Class I specifications*