Co-funded by the Erasmus+ Programme of the European Union

Erasmus + Project No 598241-EPP-1-2018-1-RS-EPPKA2-CBHE-JP

Strengthening Educational Capacities by Building Competences and Cooperation in the Field of Noise and Vibration Engineering

S E N V I B E

Report on Needs Analysis and Gaps Detected in Educational Capacities and Cooperation in the Field of Noise and Vibration Engineering in Serbia

Activity 1.7

Date: 22/11/2019

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1 Introduction

The project SENVIBE 'Strengthening Educational Capacities by Building Competences and Cooperation in the Field of Noise and Vibration Engineering' (598241-EPP-1-2018-1-RS-EPPKA2-CBHE-JP):

https://senvibe.uns.ac.rs/

was approved for financing under the call Erasmus+ Capacity Building in Higher Education EAC/A05/2017, and will be coordinated by University of Novi Sad, Serbia during the period 15 November 2018 – 14 November 2021.

The wider aim of the SENVIBE project **is to improve and build national educational capacities, cooperation and competences in dealing with environmental and occupational Noise and Vibration** (No&Vib) engineering issues in accordance with the ongoing EU integration strategies and the needs identified in Serbia.

The motivation behind the SENVIBE project is the recognized and urgent need to undertake such activities, especially related to Chapter 27 (Environment and Climate Change)[1] in Serbia's EU accession negotiations and the recommendations of the European Commission in their recent reports from 17 April 2018[2] and 29 May 2019[3].

The SENVIBE project engages academic and non-academic partners. Among the academic ones are: University of Novi Sad (UNS) – coordinator, and three other Serbian universities: University of Nis (UNI), University of Kragujevac (UniKG) and EDUCONS University, Sremska Kamenica (UESK) as well as two European universities: Kungliga Tekniska Högskolan, Stockholm, Sweden (KTH) and University of Southampton, Institute of Sound and Vibration Research, Southampton, United Kingdom (UoS-ISVR). Non-academic partners are: Provincial Secretariat for Urban Planning and Environmental Protection, Novi Sad (SUPEP), Union of Employers of Vojvodina, Novi Sad (UPV) and Institute for Occupational Health, Novi Sad (IOH). The Associate partners are: Chamber of Commerce and Industry of Serbia (CCIS) and Young Acousticians Network (YAN).

During the first year of the SENVIBE project, certain preparation activities were undertaken, including the survey and comparative analysis of relevant university programmes and courses on No&Vib in EU in Serbia, mainly for the sake of matching and benchmarking. Learning outcomes, contents, teaching methodologies and resources available and needed have been of interest in three separate analyses:

i) courses for undergraduate students of different engineering departments, as such courses will be developed and implemented during the SENVIBE project;

ii) Life Long Learning (LLL) courses, which will also be developed and implemented during the SENVIBE project, and

iii) MSc programmes in Vibro-Acoustics/Sound&Vibration, one of which is planned to be developed, accredited and implemented for the first time in Serbia during the third year of the project. In addition, this preparation phase comprises matching the EU trends with the needs in Serbia with respect to a No&Vib Hub - a unit launching and facilitating strategic cooperation among the key stakeholders engaged in No&Vib management, such as academia, local

[1] http://www.pregovarackagrupa27.gov.rs/dokumenti/, accessed 4 October 2019.

[2] https://ec.europa.eu/neighbourhood-enlargement/sites/near/files/20180417-serbia-report.pdf, accessed 4 October 2019.

[3] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=2ahUKEwi4lMn5zqrlAhU7SxUIHSGHBLYQFjABegQIBBAC&url=https%3A%2F%2Fec.europa.eu%2Fneighbourhood-enlargement%2Fsites%2Fnear%2Ffiles%2F20190529-serbia-report.pdf&usg=AOvVaw0GrCW4bxuz-L1KuGCDregH, accessed 4 October 2019.

industry and local and national authorities. The SENVIBE No&Vib Hub is expected to be established during the second and third year of the SENVIBE project.

An important deliverable of the previously conducted surveys and analyses is this report on the needs analysis and gaps detected through comparative research. This report is compiled based on the previously mentioned reports, all of which are published open access on the website of the SENVIBE project, and also summarized in the subsequent sections:

1) Survey and comparison of Serbian and EU education in Noise and Vibration[4];
2) Report on Tailor-Made Learning Goals and Outcomes (Learning goals and Outcomes for Students of six Engineering Departments)[5];
3) Report on Tailor-Made Learning Outcomes for LLL courses[6];
4) Review and Analysis of the Existing MSc Vibro-Acoustic Engineering Programmes in EU[7];
5) Report on Learning Outcomes for an MSc Vibro-Acoustic Engineering Programme[8];
6) Linking Stakeholders in the Field of Noise & Vibration in the EU via Different Forms of Hubs: Examples of Good Practice[9];
7) No&Vib HUB: Matching the EU Trends with the Needs in Serbia[10].

This report is seen to be a document of national interest, as this type of an overview and comparison have never been done in Serbia in the No&Vib field so far. It is hoped that this document and the activities conducted will pace a way for the successful achievement of the **project wider aim**.

[4] https://senvibe.uns.ac.rs/2019/01/22/report-on-survey-and-comparison-of-serbian-and-eu-education-in-novib-task-1-1-completed-22-january-2019/, accessed 4 October 2019.

[5] https://senvibe.uns.ac.rs/2019/04/24/report-on-tailor-made-learning-outcomes-for-students-of-six-engineering-departments-24-april-2019/, accessed 4 October 2019.

[6] https://senvibe.uns.ac.rs/2019/08/28/report-on-tailor-made-learning-outcomes-for-lll-courses-25-august-2019/, accessed 4 October 2019.

[7] https://senvibe.uns.ac.rs/2019/04/04/review-and-analysis-of-the-existing-msc-vibro-acoustic-engineering-programmes-in-eu-completed-2-april-2019/, accessed 4 October 2019.

[8] https://senvibe.uns.ac.rs/2019/07/15/report-on-learning-outcomes-for-an-msc-vibro-acoustic-engineering-programme-completed-15-july-2019-the-full-version-of-the-report-will-be-available-upon-the-accreditation-of-the-programme/, accessed 4 October 2019.

[9] https://senvibe.uns.ac.rs/2019/10/29/linking-stakeholders-in-the-field-of-noise-vibration-in-the-eu-via-different-forms-of-hubs-examples-of-good-practice-29-october-2019/, accessed 4 November 2019.

[10] https://senvibe.uns.ac.rs/2019/04/16/report-on-novib-hub-matching-the-eu-trends-with-the-needs-in-serbia-15-april-2019/, accessed 4 November 2019.

2 Survey and comparison of Serbian and EU education in Noise and Vibration

Task 1.1 contained a survey of No&Vib education in Serbia and EU, focusing on undergraduate education, but also including some information on higher levels of education (see footnote 4).

The survey for Serbia covered only accredited universities in Serbia (members of the Conference of the Universities of Serbia KONUS) in the field of technical and technological sciences, under the following studying programmes: Civil Engineering, Electrical Engineering, Environmental Engineering, Mechanical Engineering, Traffic Engineering and Occupational Safety and Health. Although KONUS has 18 members, only 11 of them have faculties in the scope of this study. Distribution of the faculties included in this study per universities is show in Figure 2.1, whose caption contains the legend for the acronyms used for the universities. The State University of Novi Pazar is currently the only integrated university in Serbia and only its Department of Technical Sciences (UNP-DTN) fits into the subject of this study. Its integrated organization is the reason why it is not included in Figure 2.1.

Besides the existence of courses and programmes, their content was also of interest as well as teaching methodologies, resources available/used for teaching purposes, literature and lab facilities.

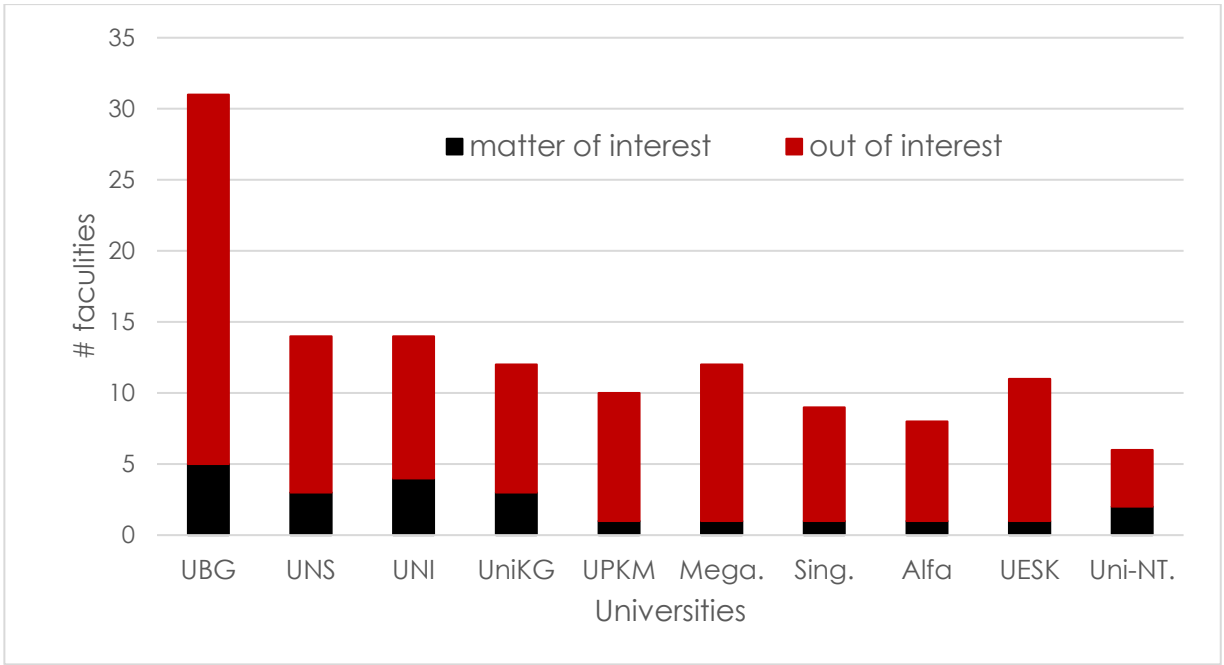

Figure 2.1. Number of faculties, within the subject area of the project, per university. Legend: UBG – University of Belgrade, UNS – University of Novi Sad, UNI – University of Niš, UniKG – University of Kragujevac, UPKM – University of Prishtina with provisional headquarters in Kosovska Mitrovica, Mega. – Megatrend University, Belgrade, Sing. – Singidunum University, Belgrade, Alfa – Alfa University, Belgrade, EUSK – Edukons University, Sremska Kamenica and Uni-NT – University 'Union-Nikola Tesla', Belgrade.

One main conclusion and the main gap detected through this study was that there is no continuous track in formal academic education in No&Vib/Acoustic and Vibration/Sound and Vibration throughout the three-cycle system in Serbia. **Neither is**

there a Bachelor programme for Vibro-Acoustics/Sound and Vibration, nor such Master programme in Serbia. This is a very important issue to address by the SENVIBE project.

The survey conducted for Serbian universities has shown three types of courses for undergraduate students of the investigated engineering departments:

i) courses not related to No&Vib Engineering or Technical Acoustics, and therefore out of the scope for the related report;

ii) courses related to No&Vib Engineering;

iii) courses having weak links with No&Vib Engineering or Technical Acoustics. This third group of courses is not listed in this report. However, it has been noted that these courses, among which are, for example, courses in Physics or Engineering Mechanics, are usually taught at the beginning of academic studies. As such, they cover larger number of students with respect to the courses under ii) and provide a good basis for widening the pool of the students that can be introduced to the subject, contributing to the improvement of national educational capacities in the No&Vib fields. These courses are seen as suitable for sustainability.

At the completion date of the related report (see footnote 4), 33 courses were identified within basic academic studies, which directly, or at least to a non-negligible extent, deal with or contain aspects related to No&Vib and Technical Acoustics (type ii as described above). These courses are given at the accredited universities in Serbia, at the targeted study programmes in the field of technical and technological Sciences as illustrated in Figure 2.2.

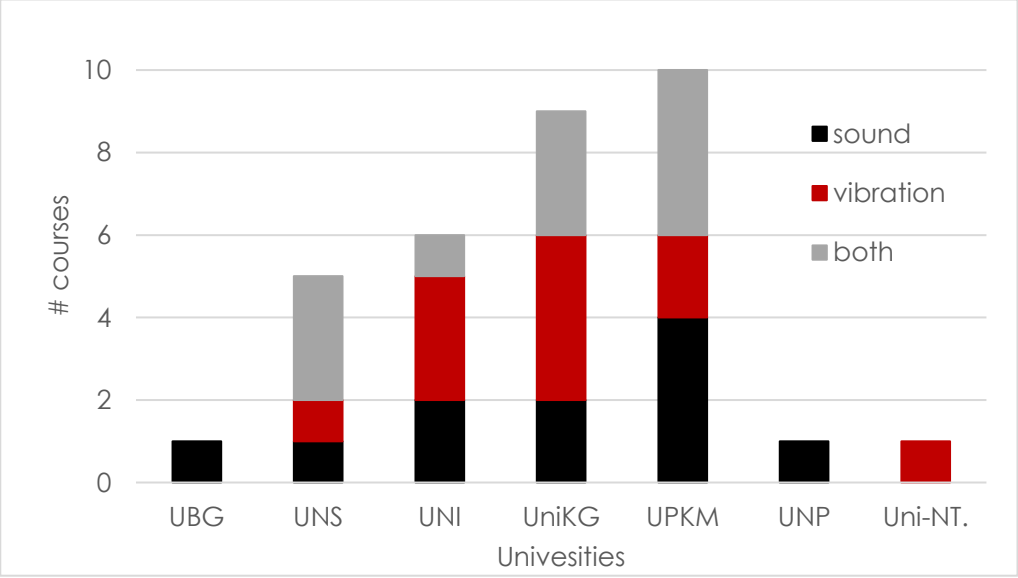

Figure 2.2. Distribution of No&Vib courses per universities in Serbia. Legend: UBG – University of Belgrade, UNS – University of Novi Sad, UNI – University of Niš, UniKG – University of Kragujevac, UPKM – University of Prishtina with provisional headquarters in Kosovska Mitrovica, UNP – State University of Novi Pazar and Uni-NT – University 'Union-Nikola Tesla', Belgrade.

It can be noted that the largest number of courses in No&Vib are at the UPKM. It is surprising that UBG, as the oldest and biggest university in Serbia, offers only one course in No&Vib field and it is related only to acoustics. However, the reader should have in mind that many of courses weakly related to the No&Vib are excluded from this study. It is important to point out that most of these courses are elective. Thus, it is not known how many students attend these courses, which introduces an additional question mark

about the level of education in the No&Vib fields in Serbia among undergraduate students. The educational system would certainly benefit if a larger number of these courses would be compulsory. At the completion date of the survey, only one mandatory subject had been detected in academic studies at accredited universities in Serbia in the field of technical and technological sciences, directly related to the field of No&Vib. The number detected is surprising and deserves the attention from related authorities.

It should also be emphasized that a **strikingly large number of directions and modules has been detected, where there are no courses dealing with the theme of No&Vib, although it is clear from the nature of the study programme that those courses should exist**. For example, on accredited study programmes in the field of Traffic and Transport Engineering at the Serbian state universities, there is no course in the basic studies on the subject. The absence of such a subject is also apparent in the study programmes that have many modules and are expected to deal with No&Vib, but they do not include it. Such are the modules of the University of Belgrade (Faculty of Civil Engineering, modules: Hydraulic and Environmental Engineering, Road, Railway and Airport Engineering, Management, Technology and Informatics in Civil Engineering, Structural Engineering) and modules of the University of Novi Sad (Faculty of Civil Engineering in Subotica, modules: Structures, Hydraulic and Water Engineering, Roads, Architectural Engineering, Geodesy). This finding also deserves attention in future activities of the SENVIBE project, at least to alert the relevant authorities about it, its potential consequences or likely effects.

A detailed overview of the courses whose contents include No&Vib (or their aspects) at accredited universities has been tabulated and presented in the report under footnote 4. One can find therein the table containing the detailed content of the courses, their outcomes, teaching methods, the name of the university and the faculty or the study programme, as well as the source used for this survey. It would be worth analysing in the future which of them could be modernized/restructured.

The most descriptive overview of the European education in Acoustics and Vibration Engineering is given by the EAA Schola map (European Acoustics Association) https://euracoustics.org/activities/schola/ shown in Figure 2.3, which is also presented in the report footnote 4.

Figure 2.3. European Acoustics Association Schola map (downloaded on 17 January 2019).

The EAA Schola map is an online study guide of Acoustics in Europe. Representatives from universities, faculties, departments, schools, institutes, called 'Schola Editors', insert the data of their courses, specific fields of acoustics research, and exchange programs. The map was downloaded from the EAA Schola map (Accessed on 17 January 2019). The existence of a relatively dense representation in Europe, especially in the northern and central continental Europe, has been noticed. It has been also found that there are countries in EU with a continuous higher education in No&Vib/Acoustic and Vibration/Sound and Vibration through all three cycles, such as in the UK and France. There are quantitative indicators implying that there is:

- very high interest among students to study these programmers;
- very high satisfaction of them with respect to what they acquired during studies;
- very high employability of them as researchers, technicians, engineers, and entrepreneurs, companies, control offices, etc.

Three universities that offer representative undergraduate programmes in these fields have been analysed, two of which are from the countries mentioned previously (the UK and France) and one is from Denmark. All three representative undergraduate programmes have a high international reputation. They include: University of Southampton, Southampton, UK; University of Le Mans, Le Mans, France; and Technical University of Denmark, Lyngby, Denmark. Their programme structures have been analysed in detail.

In general, the first year provides a background in Physics and Mathematics and basics of Acoustics and Vibration. As the study continues, the level of specialization increases. This specialization is realized not only through the compulsory courses, but also via elective courses, a practically-oriented individual project and engineering-related work placements (internships). What is also striking is a very rich list of test facilities/pieces of equipment that students have at their disposal at these universities. **Thus, establishing good and rich test facilities is one of the lessons learnt for Serbia and is also a fact to be presented to higher local, regional and national authorities.** A list of courses related to No&Vib has been created for these three representative EU programmes, and its structure is shown in Figure 2.4. Besides for modernizing courses and modules during the SENVIBE project, they can be used for introducing new courses in these fields in due course.

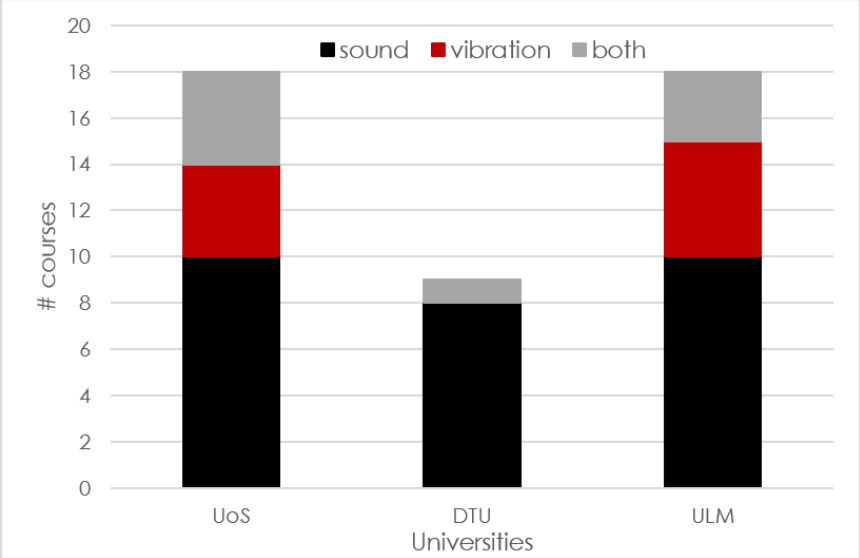

Figure 2.4. Distribution of No&Vib courses per selected universities in EU. Legend: UoS – University of Southampton, DTU – Technical University of Denmark and ULM – University of Le Mans.

The above mentioned SENVIBE project results can be summarized as the following 'Gaps detected' and 'Recommendations':

Gaps detected:

- Unlike in the EU, neither a Bachelor programme for Vibro-Acoustics/Sound and Vibration, nor such a Master programme exists in Serbia;
- A majority of students from the field of interest, have at their disposal only courses dealing with the very basics of No&Vib Engineering or Technical Acoustics;
- Unacceptably large number of programmes and modules has been detected where there are no courses in No&Vib, although it is clear that this knowledge will be necessary in future professional engagement of students. This particularly stands for modules of Civil Engineering and Traffic and Transport Engineering;
- Even where courses in No&Vib Engineering or Technical Acoustics exists, most of them are elective, which implies that smaller number of students will gain knowledge in the field.

Recommendations:

- No&Vib Engineering and/or Technical Acoustics courses should be introduced as compulsory, in programmes and modules in the field of technical and technological sciences;
- General courses should be used as an opportunity. Introducing modules and lessons dealing with No&Vib Engineering in those courses will be the easiest and fastest way for initial increase of knowledge and awareness of students about this topic;
- Decision makers in Serbia, such as the Ministry of Education, Science and Technological Development and the Ministry of Environmental Protection, and the Consortium of Serbian HEIs, should encourage the process of expanding the subject of No&Vib in existing study programmes and introduction of specific programmes which will produce experts in the field. This will be in accordance with the Serbian strategy for EU, especially with Chapter 27. Directive 2002/49/EC relating to the assessment and management of environmental

noise which requires Member States to prepare and publish noise maps and noise management action plans. Training the experts in No&Vib is crucial for implementation of the mentioned Directive.

- Bearing in mind the lessons learned from the EU SENVIBE partners, Serbian Universities need to form laboratories with up to date equipment for No&Vib education. Although some EU funds can be accessed for that purpose, financial support for Universities from the Government and logistic support in applying for EU funds is of crucial importance in that sense.

3 Tailor-made learning goals and outcomes for students of six engineering departments

One of the specific objectives of the SENVIBE project is related to the undergraduate courses of students in six engineering departments/programmes: Civil Engineering, Electrical Engineering, Environmental Engineering, Mechanical Engineering, Occupational Safety Engineering and Traffic Engineering. Four of them have existing courses which will be modernised (Electrical Engineering, Environmental Engineering, Mechanical Engineering, Occupational Safety Engineering) during the SENVIBE project and for two of them new courses will be developed (Civil Engineering and Traffic Engineering). In accordance with this objective, one task of the SENVIBE project comprises the definition of tailor-made learning goals and outcomes for students of these six different engineering departments at Serbian universities that participate in the SENVIBE project.

University of Novi Sad includes all of them; University of Nis includes only one of them but with a considerable number of students; University of Kragujevac includes three of them, but with smaller number of students; while EDUCONS University includes only one of them with a small number of students.

Learning goals and outcomes are developed based on:

a) information about the higher education system in Serbia and education in the No&Vib fields in Serbia, at both public and private universities;

b) information about the higher education system in EU and education in Acoustics and Vibration Engineering, as well as three representative undergraduate programmes in Sound and Vibration in EU;

c) general and subject-specific competencies that students should acquire by completing the undergraduate study programme at the appropriate engineering departments specified by regulation on standards and procedures for study programmes accreditation in Serbia

The learning outcomes have been summarised in the report under footnote 5, which defines the educational goals and outcomes, but also describes the respective teaching methods, especially considering the lab exercises and the possibilities to provide them through e- or b-teaching/learning methodologies. The related report compiled presents tailor-made learning goals and outcomes for students of six engineering departments with a common part of 60% for all six engineering departments and specific parts of 40% for each of them.

The common education goal is to equip students with the knowledge, understanding and application of No&Vib principles and phenomena that underpin prudent use of the corresponding theoretical framework, computer software and experimental techniques, with the common educational outcomes to provide the students with ability to:

- identify and examine real No&Vib issues;
- recognize No&Vib sources and phenomena and evaluate them through measurements;
- suggest measures to solve No&Vib problems.

The specific education goals for each of the engineering departments may be classified in two groups. The first group comprises the departments for Civil, Mechanical and Traffic Engineering, where the educational goal is to enable student to

comprehend the knowledge about the No&Vib sources and measures to reduce No&Vib levels generated by sources typical for those engineering disciplines. The second group comprises the departments for Environmental Engineering and Occupational Safety Engineering, where the educational goal is to enable student to comprehend the knowledge about the measurement and quantification of influences of No&Vib on humans and the environment. An exception represents the Department of Electrical Engineering that has a notably different educational goal, aligned with its specific role in development of No&Vib control measures.

The specific education goals for each of the engineering departments are summarized in Table 3.1.

Table 3.1. The specific education goals for each of the engineering departments of Serbian universities included in the SENVIBE project.

Engineering Department/Programme	Educational goals
Civil Engineering	To enable students to comprehend knowledge of: structural responses to vibration and the effects of vibration on civil structures, as well as to integrate this knowledge into relevant practical applications with respect to the control of structural response to vibration. To enable students to comprehend knowledge of buildings acoustics and to integrate this knowledge into relevant practical applications and solutions.
Electrical Engineering	To enable students to comprehend knowledge of electro-mechanical analogies and to learn about different ways to control noise and control vibration passively or use them to benefit people or engineering systems.
Environmental Engineering	To enable students to comprehend knowledge of: human and structural responses to vibration in environmental engineering, human responses to environmental noise and the effects of No&Vib on environment, as well as to integrate this knowledge into relevant practical applications and noise control in the field of Environmental Engineering.
Mechanical Engineering	To enable students to comprehend knowledge of: typical responses of mechanical systems to vibration, their effects on these systems and correlation between mechanical excitations and noise emission of mechanical systems, as well as to integrate this knowledge into relevant practical applications in the field of Mechanical Engineering
Occupational Safety Engineering	To enable students to comprehend knowledge of: human responses to No&Vib in working environment and their effects on human body, as well as to integrate this knowledge into relevant practical applications in the field of Occupational Safety Engineering.

Traffic Engineering	To enable students to comprehend knowledge of human and structure responses to traffic-induced vibration, human responses to traffic noise, the effects of No&Vib on residential environment, as well as to integrate this knowledge into relevant practical applications in the field of Traffic Engineering.

The specific education outcomes for each of the engineering departments are summarized in Table 3,2.

Table 3.2. The specific education outcomes for each of the engineering departments of Serbian universities included in the SENVIBE project.

Engineering Department/Programme	Educational outcomes
Civil Engineering	• understand the principal structural responses to vibration and building acoustics • recognize and select appropriate standards, recommendations, or regulations in structural engineering
Electrical Engineering	• construct electro-mechanical analogies and understand their oscillatory responses • recognize the possibilities for the design of systems that control noise and control vibration passively in different ways
Environmental Engineering	• understand the principal human and structural responses to vibration, as well as human responses to environmental noise • recognize and select appropriate standards, recommendations, or regulations that apply to particular environments
Mechanical Engineering	• understand the principal responses of mechanical systems to vibration and correlation between mechanical excitations and noise emission of mechanical systems • recognize and select appropriate standards, recommendations, or regulations that apply to industrial environments
Occupational Safety Engineering	• understand the human responses to whole-body vibration, hand-arm vibration, as well as human responses to occupational noise • recognize and select appropriate standards, recommendations, or regulations that apply to working environments. Identify practical measures for human protection and their implementation

Traffic Engineering	• understand the principal human and structure responses to traffic-induced vibration, as well as human responses to traffic noise • recognize and select appropriate standards, recommendations, or regulations that apply to particular transport environments

The report footnote 5 also contains tailor-made learning goals and outcomes for short modules for students of different engineering departments, such as courses on Physics, for example, which are usually given to freshmen, and where the number of students usually is significantly larger than the number of students who attend courses on later years of their study programmes. Thus, these courses are seen as appropriate to educate a larger pool of engineers-to-be.

The specific education goal for short modules is to introduce the physics of vibration using a combination of practical examples and mechanical modelling, as well as to provide basic knowledge of physical concepts of noise, with the common educational outcomes to provide the students with abilities to:

- explain the meaning of the main characteristics of No&Vib and associated phenomena;
- recognize examples where/when they appear, identifying their positive or negative aspects.

The SENVIBE project results can be summarized as the following 'Gaps detected' and 'Recommendations':

Gaps detected:

- The learning contents that concern No&Vib problems and solutions are not harmonized in the existing subjects of different Serbian universities, which is a consequence of a lack of a systematic approach to the education in the No&Vib field in Serbia;
- The specific aspects of No&Vib problems in different engineering fields, as well as different approaches to the solution of the problems are not recognized in the existing Serbian HEI curricula.

Recommendations:

- A set of tailor-made learning goals and outcomes, specific for each of the engineering departments present at Serbian universities, is a need;
- The SENVIBE project developed a proposition of such a set of tailor-made learning goals and outcomes, which consists of 60% of the learning goals being common to all six engineering departments, and 40% of the learning goals being specific for each of the departments;
- The developed set of tailor-made learning goals should be used in the scope of the Work Package 'Development of modules and courses for different engineering departments' (WP3) concerned with the redesign of four existing courses and the development of two new ones on No&Vib for students of undergraduate programmes at Serbian universities that participate in the SENVIBE project.
- The developed set of tailor-made learning goals and outcomes should be made available to the public via the project website and should be presented to all Serbian universities through an active promotion campaign.

4 Tailor-made learning outcomes for LLL courses

One of the specific objectives of the SENVIBE project is to review the provision of LLL No&Vib courses, which are also recognised as courses for Continuing Professional Development (CPD) required by engineers to upskill or retrain in a new discipline area. They can also cover an accredited competence qualification that will legally allow completion work or noise surveys to be officially recognized and accepted.

The report listed under footnote 6 is based on the overview and comparison of the LLL courses in the No&Vib fields in the UK and Serbia. The main conclusions are as follows:

- Courses in Serbia are organized by private companies (with one state-owned company);
- There are no organized courses in Serbia on which trainees will obtain an accredited competence qualification to be officially recognised and accepted in the field of No&Vib;
- Courses in Serbia are typically attended by representatives of local self-government units, official representatives of professional organizations responsible for noise measurement, as well as those planning to develop strategic noise maps, doctors, health technicians, persons dealing with environmental issues, civil engineers, architects - designers, contractors and investors, engineers, and professionals gaining knowledge in vibro-diagnostics;
- Courses in Serbia are of a general nature, meaning that they provide the knowledge of the Law on Environmental Noise Protection and how it regulates the issues of jurisdiction, rights and obligations of economic entities, natural and legal persons, measures and conditions for noise protection and monitoring of activities important for the protection of the environment and human health, and development of strategic noise maps and strategic plans for noise protection. There is a lack for courses including the use of sound level meters, carrying out workplace noise assessments, requirements of current legislation, basic techniques for control of vibration exposure and human vibration assessments. Only few courses deal with measuring and analysing mechanical vibrations on machines;
- Courses in Serbia are mostly oriented on environmental noise, and some courses offer only training for using specific software on No&Vib topics;
- Teaching methods mainly include lectures, practical classes, software use and writing reports in some courses.

Two types of LLL courses in Serbia are proposed to be developed and carried out during the SENVIBE project:

1) Environmental & Occupational Noise and Human Vibration Measurement and Control.

2) Environmental & Occupational Noise and Human Vibration Risk Assessment.

They are described in Table 4.1 and Table 4.2.

The first type of LLL courses has the working title 'Environmental & Occupational Noise and Human Vibration Measurement and Control' and is targeted to groups of professionals in the field of technical sciences (technical engineers, environmental and occupational noise measurement experts, as well as persons dealing with human vibration measurement experts, health and safety consultants, civil engineers etc.). This

type of LLL course will provide trainees with a basic knowledge of the methodology of environmental and occupational noise and human vibration measurement, including knowledge about methodology for No&Vib control and standards and legislation for environmental and occupational noise and human vibration, also knowledge about risk assessment and health effects.

The second type of LLL courses has the working title 'Environmental & Occupational Noise and Human Vibration Risk Assessment', and is targeted to non-technical professionals (health and safety consultants, representatives of national and local self-government units, labour inspectors etc.). This type of LLL course will provide trainees with acoustics and vibration basics, basic knowledge of the methodology of occupational noise and human vibration measurements and environmental noise measurements, knowledge about health effects, knowledge about standards and legislation for environmental and occupational noise and human vibration and risk assessments.

Table 4.1. Review of the first proposed SENVIBE LLL course in Serbia.

Provisional Title	**Environmental & Occupational Noise and Human Vibration Measurement and Control**
Targeted group (s)	• Technical engineers • Health and safety consultants • Environmental and occupational noise measurement expert - official representatives of professional organizations responsible for environmental and occupational noise measurement, as well as persons dealing with noise control • Human vibration measurement expert - official representatives of professional organizations responsible for human vibration measurement, as well as persons dealing with vibration control • Civil engineers
Number of trainees	15 trainees per training course
Learning goals	To provide trainees with a basic knowledge of the methodology of environmental and occupational noise and human vibration measurement, including knowledge about methodology for No&Vib control and standards and legislation for environmental and occupational noise and human vibration, also knowledge about risk assessment and hearing impairment and medical examinations.
Learning outcomes	After completing the course, trainees should be able to: • understand basic acoustic quantities, as well as quantities for describing human vibrations • understand basic principles for No&Vib reduction • understand basic structure of measurement equipment for No&Vib

	• understand basic procedures for measurements of environmental and occupational noise and human vibration • make simple measurements of environmental and occupational noise and human vibration from a variety of sources, according to the requirements of the relevant standards and legislation for environmental and occupational noise; • perform basic calculations involving No&Vib indices appropriate for consideration of environmental and occupational noise and human vibration • understand requirements of the current legislation and regulations in the field of workplace No&Vib protection • carry out No&Vib risk assessment • select suitable personal protection • understand basic structure of measurement report • contribute to creating a new cooperation or participate in the already established cooperation between all participants (industry, local governments and professional agencies) in the No&Vib fields
Teaching methods	12 hours classroom-based instructions 4 hours practically-based instruction and report writing
Duration	Two days in total

Table 4.2. Review of the second proposed SENVIBE LLL course in Serbia.

Provisional Title	**Environmental & Occupational Noise and Human Vibration Risk Assessment**
Targeted group (s)	• Technical engineers • Health and safety consultants • Representatives of national and local self-government units • Official representatives of professional organizations responsible for No&Vib measurement • Labour inspectors
Number of trainees	15 trainees per training
Learning goals	• Acoustics and vibration basics • Basic knowledge of the methodology of occupational noise and human vibration measurements and environmental noise measurement • Knowledge about health effects

	• Knowledge about standards and legislation for environmental and occupational noise and human vibration and risk assessment • Examples, solved problems
Learning outcomes	After successfully completing the course, trainees should be able to: • understand basic acoustic quantities, quantities for describing human vibrations as well as quantities for describing hearing loss • to acquire knowledge and understand health effect of No&Vib • to acquire knowledge, understand and application of standards and legislation for risk assessment • to acquire knowledge and understand the principle of hearing protection • to choose appropriate hearing protectors • to carry out risk assessment from No&Vi, • to be able to contribute to creating a new cooperation or participate in the already established cooperation between all participants (industry, local governments and professional agencies) in the No&Vib fields
Teaching methods	6 hours classroom-based instructions 2 hours practically-based instruction
Duration	One day in total

Recommendations:

- It is recommended to share the learning goals of the certified SENVIBE LLL courses with all stakeholders, government and non-government institutions in Serbia during dissemination events and through other communication ways, to encourage them to educate their professionals in Noise & Vibration field;
- It is also recommended to find a way to make these courses be sustainable after the completion of the SENVIBE project.

5 Review and analysis of the existing MSc Vibro-Acoustics Engineering programmes in the EU

In accordance with the tasks and objectives of the SENVIBE project, a studywas conducted on the topic 'Review and Analysis of the Existing MSc Vibro-Acoustics Engineering Programmes in the EU' (see footnote 7). The related report provides an overview of the structure and content of four representative MSc programmes in Sound and Vibrations offered at two SENVIBE partner institutions:

- MSc in Acoustical Engineering, University of Southampton (Southampton, UK),
- MSc in Engineering Mechanics with specialization in Sound and Vibration, KTH Royal Institute of Technology (Stockholm, Sweden),

and two other representative EU universities:

- MSc in Engineering Acoustics, Technical University of Denmark (Lyngby, Denmark), and
- MSc in Electroacoustics, University of Le Mans (Le Mans, France).

A brief overview of the universities, MSc programs and courses related to No&Vib is presented in Table 5.1 (for detailed information, please refer to the report under footnote 7 and its Appendix I).

There is only one MSc programme in the area of sound and vibration taught at the University of Southampton, which can be studied on a part-time basis. Beside the fundamentals of acoustics and vibration, the programme is oriented towards noise control requirements, characterisation and measurements, description of electrical, mechanical and electroacoustic systems, pressure gradient principles, architectural and building acoustics (legal framework and particular requirements), human response to sound and vibration, numerical methods and applications in signal processing, aeroacoustics, advanced vibration as well as active control of sound and vibrations. There are three possible exit degree titles, namely the title of Acoustical Engineering, and the alternatives – Structural Vibration and Signal Processing.

Students of the KTH Royal Institute of Technology in Stockholm can get a BSc degree after the first three years, and then apply to a Master programme at KTH or another university in Sweden, or in another country. Two additional years are required to obtain a MSc degree. Courses organized during the first three years (BSc studies) are given completely in Swedish. On the other hand, all MSc courses at KTH are given exclusively in English. The programme covers engineering acoustics and acoustical measurements, vibro- and flow acoustics, experimental structure dynamics, numerical and energy methods, non-linear and vehicle acoustics as well as building acoustics and community noise.

Table 5.1. Review of the existing MSc courses related to the No&Vib fields taught on representative MSc programmes in EU.

University	MSc program	Course	Links
University of Southampton, Southampton, UK	Acoustical Engineering	Fundamentals of Acoustics	https://senvibe.uns.ac.rs/
		Fundamentals of Vibration	https://www.southampton.ac.uk/

		Noise Control Engineering	
		Electro-acoustics	
		Architectural and Building Acoustics	
		Human Responses to Sound and Vibration	
		Numerical Methods for Acoustics	
		Applied Audio Signal Processing	
		Active Control of Sound and Vibration	
		Advanced Vibration	
		Aeroacoustics	
KTH Royal Institute of Tech., Stockholm, Sweden	Sound and Vibration	Engineering Acoustics	https://senvibe.uns.ac.rs/ https://www.kth.se/en
		Acoustical Measurements	
		Vibro-Acoustics	
		Flow Acoustics	
		Experimental Structure Dynamics – Project Course	
		Numerical Methods for Acoustics and Vibration	
		Energy Methods	
		Non-linear acoustics	

		Vehicle Acoustics and Vibration	
		Building Acoustics and Community Noise	
Technical University of Denmark, Lyngby, Denmark	Engineering Acoustics	Fundamentals of acoustics and noise control	https://senvibe.uns.ac.rs/ https://www.dtu.dk/english/Education/msc
		Acoustic signal processing	
		Numerical Acoustics	
	Civil Engineering, Architectural Engineering	Building acoustics	
	Civil Engineering, Engineering Acoustics, Architectural Engineering	Architectural acoustics	
	Electrical Engineering, Architectural Engineering, Engineering Acoustics	Environmental acoustics	
	Electrical Engineering, Engineering Acoustics	Advanced acoustics	
	Engineering Design and Applied Mechanics	Advanced vibration and stability analysis	
University of Le Mans,		Acoustics Refresh	https://senvibe.uns.ac.rs/

Le Mans, France	Acoustics and Vibration (Electroacoustics)	Acoustic Project Refresh	http://www.univ-lemans.fr/en/index.html
		Vibration Refresh	
		Acoustics I	
		Room Acoustics	
		Acoustics II-a	
		Continuous Systems Vibrations	
		Vibrations experiments	
		Numerical Vibroacoustics	

A two-year MSc programme is given at the DTU Technical University of Denmark. The programme covers a wide range of topics, including the fundamentals of sound propagation, advanced measurement techniques, and understanding and modelling of the normal and impaired human hearing system. Four categories of courses are offered at this university: general competences, technological specialization, electives, and thesis. Corporate MSc engineering programme is offered as a part-time study.

University of Le Mans covers the fundamentals in electroacoustics and related fields (e.g., basic notations about waves, sound and hearing, their reflection and transmission, spherical and plane wave propagation, vibrations of single and two degrees of freedom and their generalization, fundamental equations of acoustics, modal analysis, room modelling, differential equations, continuous systems vibrations, oscillations and experiments). The courses are organized in four semesters. The fourth semester enables students to practically apply their knowledge during a five months' internship programme in a company or a laboratory.

Most of the courses taught at these four universities comprise a practical component (such as various measurements and laboratory work, practical demonstrations and assignments, problem solving tasks and project work). An overview of the courses mentioned above is given in Figure 5.1. Duration of MSc studies and number of exit title degrees is presented in Figure 5.2.

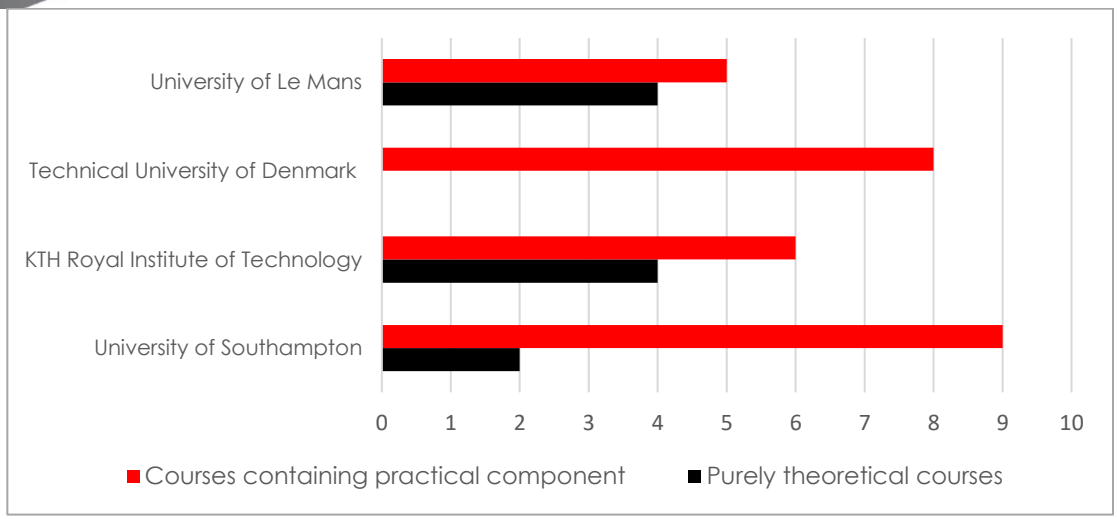

Figure 5.1. The number of MSc level courses: theory vs. practice at four EU universities.

Figure 5.2. Four representative MSc programmes in Sound and Vibrations: Duration of MSc studies in years (red) and number of exit title degrees (grey).

In order to complement the Report on Survey and Comparison of Serbian and EU Education in No&Vib 'Review and Analysis of the Existing MSc Vibro-Acoustics Engineering Programmes in EU' (see footnote 7), MSc courses taught at various Serbian universities are also listed therein, along with their content, educational outcomes, teaching methods and informational links, focusing on six engineering disciplines: Mechanical Engineering, Electrical Engineering, Environmental Engineering, Occupational Safety and Health Engineering, Civil Engineering and Traffic Engineering.

A brief overview of the universities, MSc programs and courses related to No&Vib is presented in Table 5.2 (for detailed information, please refer to the report under footnote 7 and its Appendix II).

Table 5.2. Review of the existing MSc courses related to the NO&VIB fields taught on MSc programmes in Serbia.

University	MSc program	Course	Links
University of Belgrade, School of Electrical Engineering	Audio and Video Communications	Electroacoustics	https://senvibe.uns.ac.rs/ https://www.bg.ac.rs/en/
		Acoustic Design of Rooms	
		Sound Reinforcement	
		Audio Signal Processing	
		Noise Control	
University of Novi Sad, Faculty of Technical Sciences	Civil engineering	Noise, Vibration and Earthquakes in Surroundings	https://senvibe.uns.ac.rs/ http://www.uns.ac.rs/index.php/en/
	Environmental engineering	No&Vib	
	Postal Traffic and Telecommunications	Acoustics and Audio Engineering in Traffic	
University of Nis, Faculty of Occupa-tional Safety	Occupational Safety	No&Vib Control	https://senvibe.uns.ac.rs/ https://www.ni.ac.rs/en/
University of Kragujevac, Faculty of Engineering	Mechanical Engineering	Testing of motor vehicles and engines II	https://senvibe.uns.ac.rs/ https://www.kg.ac.rs/eng/index.php
		Machinery Condition Monitoring	
	Environmental Engineering	Physical parameters of the living and working environment	
	Mechanical Engineering, Environmental Engineering	Traffic and environment	

University of Pristina, Kosovska Mitrovica, Faculty of Technical Sciences	Mechanical Engineering	Vehicle Dynamics - selected chapters	https://senvibe.uns.ac.rs/ https://en.pr.ac.rs/
		Oscillations of mechanical systems	
		Machine construction	
	Mining engineering	Environmental management systems	

At most universities in Serbia, MSc studies are organized in two semesters. The only exception is the University of Kragujevac, specifically the Faculty of Engineering, where BSc studies lasts only three years, and MSc studies lasts two years. Unlike at the four EU country universities included in the study as well as in most EU countries, **there are no MSc programmes in Sound and Vibration, No&Vib or Vibro-Acoustic Engineering in Serbia**, although there are some courses related to Acoustics, Vibrations and Noise at the various MSc engineering programmes, namely

- Electroacoustics, Acoustic Design of Rooms, Sound Reinforcement, Audio Signal Processing and Noise Control at the University of Belgrade, School of Electrical Engineering (Master module: Audio and Video Communications),
- Noise, Vibration and Earthquakes in Surroundings (Civil Engineering and Hydrotechnics/Road Networks study programmes), No&Vib (Environmental Engineering study programme) and Acoustics and Audio Engineering in Traffic (Postal Traffic and Telecommunications study programme) at the University of Novi Sad, Faculty of Technical Sciences,
- No&Vib Control at the University of Nis, Faculty of Occupational Safety (Master module: Occupational Safety),
- Testing of Motor Vehicles and Engines II, Traffic and Environment and Machinery Condition Monitoring (Mechanical Engineering study programme), Physical Parameters of the Living and Working Environment and Traffic and Environment (Environmental Engineering study programme) at the University of Kragujevac, Faculty of Engineering, and
- Vehicle Dynamics - Selected Chapters, Machine Construction and Oscillations of Mechanical Systems (Mechanical Engineering study programme) and Environmental Management Systems (Mining Engineering study programme) at the University of Pristina Kosovska Mitrovica, Faculty of Technical Sciences.

The previously presented SENVIBE project results can be summarized as the following 'Gaps detected' and 'Recommendations':

Gaps detected:

- The number and prevalence (see Figure 5.3) of the existing courses prove there is a clear interest of students as well as economic justification to teach these courses in Serbia as part of the specific higher education MSc level programme bearing in mind the objectives in Serbia-EU accession negotiations. However,

Serbia Skilled Occupation List neither contains a Vibro-Acoustic or higher education Acoustic Engineer nor closely related qualifications.

Recommendations:

- A formal recognition of a **Vibro-Acoustic Engineer as an occupation** in Serbia, designed in a way that corresponds to the existing analogous EU models, is a step of the **highest national importance**;
- This step should be followed by the design of a **MSc programme** which will lead to this qualification and its **formal accreditation** by the end of the SENVIBE project.

Figure 5.3. The number and prevalence of MSc level courses taught in Serbia related to Acoustics, Vibrations and Noise

6 Learning outcomes for an MSc Vibro-Acoustic Engineering programme in Serbia

One of the tasks of the SENVIBE project includes defining learning outcomes for a new MSc Vibro-Acoustics Engineering Programme in Serbia. The report produced in Serbian gives an overview of the learning outcomes. This report cannot be made publicly available until the accreditation process has been finalised, but its brief overview is given below.

The issues of monitoring and controlling No&Vib have become important issues for the modern economy and society. Noise pollution is, according to the World Health Organization[11] , the second largest cause of mortality among environmental risk factors in Europe, just behind atmospheric pollution. The health effects of exposure to environmental noise are mostly "extra-auditory" effects, since they do not have a direct effect on the auditory system, while those effects in the workplace are most often direct. In addition, in many cases, noise is caused by vibrations, or the vibrations themselves are detrimental to humans and the environment.

Studying these aspects of No&Vib covers an extremely broad field, from applied mathematics and mechanics to technical acoustics, various signal measurement and processing techniques.

A new master programme in Vibro-Acoustic Engineering will be established for the very first time in Serbia. It will set a platform for a career in industry, local, regional and national regulatory and control bodies, or provide the basis for subsequent education through PhD studies.

The purpose of the study programme is to educate students in the field of Vibro-Acoustic Engineering in accordance with the basic needs of the economy and society to ensure the acquisition of competencies and qualifications that are socially justified and useful. The aim of the programme is to enable students to master advanced topics in the measurement, analysis and control of sound and vibration effects through a well-balanced combination of theory and practical applications, as well as analytical, numerical and experimental tools used for these purposes. The corresponding academic tasks and goals should result in the education of highly competent personnel in Vibro-Acoustic fields who possess competence, comparability and competitiveness in European and world contexts. Students should also be given the opportunity to develop creative problem-thinking and critical thinking skills, develop teamwork, cooperative skills, and specific theoretical and applied skills. They should gain the necessary knowledge in the basic scientific disciplines (mathematics, physics, mechanics), in order to form a realistic picture of the processes occurring in industrial systems and the environment, as well as classical and special engineering disciplines in Mechanical Engineering, Electrical Engineering, measurement/experimental techniques, signal processing and relevant applied professional scientific disciplines. One of the specific goals is to develop awareness among students of the need for continuing education, sustainable development, environmental protection and occupational safety against the harmful effects of No&Vib.

[11] http://www.noiseineu.eu/en/14-health_impact/subpage/view/page/14, accessed 14 September 2019.

7 No&Vib HUB: matching the EU trends with the needs in Serbia

One of the objectives of the SENVIBE project is to establish a No&Vib Hub – a unit/platform that will ensure the existence of links between the key stakeholders - academic and non-academic ones. Some preliminary aims of this hub are seen to be: to enable their members to provide expert and scientific contributions to the field, both in terms of harmonizing national legislation with EU legislation; to improve their professional capacity in the implementation of this legislation; to enable students in Serbia to realize their internship and thesis through internships and gain relevant and practical knowledge in the No&Vib field; to carry out collaborative projects between academia and industry to mutual benefits, etc. However, in order to provide a firm basis for the establishment of the No&Vib Hub, two separate analyses have been conducted during the preparatory phase of the SENVIBE project: i) an overview of different ways of linking stakeholders in the field of Noise & Vibration in Europe and elsewhere via examples of good practice has been created (see the report under footnote 9), and ii) surveys among certain stakeholders in Serbia related to their interest to participate in the No&Vib Hub have been conducted (see the report under footnote 10).

7.1. Examples of links between stakeholders in the field of Noise & Vibration in Europe and elsewhere: lessons learnt

There is a diversity of 'hubs/network/centres' as units for linking stakeholders in the No&Vib field in Europe. Different rationales, actors and activities characterize hubs. There is no single model or 'one-size-fits-all approach'. They respond to the local context, priorities and needs. Each of them has its own set of key drivers, specific objectives, approaches and expected outcomes. They can have a form of a strategic network or platform with a critical core of actors/stakeholders undertaking diverse activities to achieve their individual objectives as well as collective goals. During the SENVIBE project, an insightful analysis of diverse forms of 'hubs', linking stakeholders in the No&Vib field in Europe has been prepared by the SENVIBE partners: Kungliga Tekniska Högskolan KTH, Stockholm, Sweden and University of Southampton, Institute of Sound and Vibration Research ISVR, Southampton, United Kingdom.

Based on the analysis, some key operational and policy issues and challenges related to the SENVIBE No&Vib HUB development, are briefly outlined as follows:

Recommendations:

- Hub should forge new partnerships between government bodies, industry, academic research and education, as well as a multitude of different stakeholders (SHs) and actors interested in dealing with the No&Vib issues, bringing extensive knowledge, sharing experience, identifying problems that need solutions, road mapping and generating funded projects for innovations and progress that would not happen otherwise;
- Hub should bring together researchers/experts/consultants and companies based on high professional levels of performance and technical competences;
- Hub should also include activities on formation of special interest groups to assist in collaboration and dissemination activities;
- Hub should create an inventory of state-of-the-art capability, identify gaps, build a picture of shared interests across the special interest groups and develop mechanisms for the Hub sustainability;

- Hub should provide high connectivity and create a synergy between all of the SHs/special interest groups involved. Mutual innovation capacity is developed by collaboration on building innovation capacity towards common and shared goals;
- Hub should increase the number of network members and establish working internal and external links with other hubs/networks, nationally and internationally, aspiring to initiate a better cooperation between higher education institutions and other sectors for the sake of improving the current situation in the environmental and occupational noise and vibration engineering fields, as well as for wider benefits;
- Hub should be vital in the generation of needs-driven projects, serving as the partners' main connection point, and being responsible for the project generation process and development of continued education. It should be instrumental in transferring and sharing research assets, knowledge and results;
- Hub should serve as a platform for knowledge and experience exchange, a problem solver, as well as an interaction element between the students and different SHs as 'challenge owners' (local/provincial/national governmental bodies, industry, business, NGO's). Students from different engineering disciplines, with different background and perspectives will work on developing sustainable solutions to the challenges defined by SHs. Students with appropriate supervision will analyse the challenges/problems in dialogue with the SHs, choose and develop approach and methods, develop and present solutions and outline strategies for its implementation. The aim is to generate mutual impact, both in terms of the students' developed knowledge, skills, innovation capacity, professional confidence and network, but also in terms of the developed solutions for SHs when implemented. The learning process and progress and outcomes through study programme will be assessed continuously by supervisors with appropriate competences (teachers/SHs representatives);
- Hub should use its publicity and webpage to offer related multi-disciplinary acoustic and vibration services in all of the areas: commercial, demolition & construction, education & health & justice, industrial & environmental, leisure, entertainment & performing arts, nuisance, planning, residential, transportation and other;
- Hub should host and co-host specialist/non-specialist meetings, workshops, training events/sessions, site visits, summer schools, symposia for skills updating, sharing best practices and examples, promoting different topics, etc.;
- Hub should produce a good practice guideline, encourage professionals to undertake certified LLL courses;
- Hub should be proactive in supporting, developing and giving outreach activities from its membership, as well as giving career advice and developing resources;
- Hub should have a governing body (GB) responsible for hub management, organization and operation, network development and coordination, communication with partners, auditing, project evaluation and reporting. It should be composed of representatives from all stakeholder groups participating in the Hub. At twice-yearly meetings, members help define and review projects of mutual interest and benefits. Between meetings, experts and students carry out project objectives that are reported at the next GB meeting;

- Hub should target different levels of expertise and raise awareness of the issues related to No&Vib;
- Hub should publish newsletters on its open webpage, advertising free working positions and opportunities;
- Hub should collate web-based resources to share data, knowledge, hand-on experience and more;
- Hub should explore the routes to more funded projects, training centres, seminars, conferences, etc.;
- Hub membership should be initially free or based on a member contribution (cash or in-kind contributions specified in agreement/memorandum) or sponsorship by various funding sources in order to provide financial sustainability. Some of the events should be organized to be self-funded or by registration, whilst some funding should be explicitly available for researchers/students for attending training, conference support, etc.;
- Hub should have an easy on-line application for membership;
- Hub should have an open directory on its webpage where consultants/experts/companies can be found searching by name, area or service/expertise;
- Hub should be very proactive in giving advice to public and government and providing opinion on all matters related to noise, vibration, disturbance, housing standards;
- Hub should support the development of the next generation of engineers/consultants/experts by sponsoring awards and presenting them at the Hub annual event (the awards are for projects and work that demonstrate value and quality for the client or collaboration with project stakeholders with further potential to improve future practices).

7.2. Surveys among certain stakeholders in Serbia related to their interest to participate in the No&Vib Hub

Surveys on institutional/professional capacities of Local Self-Governing Units (LSGUs), Professional Organization (POs), the Industrial Sector and the Business Sector in the No&Vib fields in Serbia and their interest in participating in the establishment and activities of No&Vib Hub were carried out. The results of the surveys were described and analysed in the report under footnote 10. Note that the full list of other stakeholders, including those that did not participate in these surveys but might be interested in the results of the SENVIBE project and No&Vib Hub, is created in a separate activity and will be available at the SENVIBE website.

The leading authority of this activity was the Provincial Secretariat for Urban Planning and Environmental Protection, Autonomous Province of Vojvodina (APV).

The surveys conducted covered:

- **Local authorities**: all LSGUs in the territory of the Autonomous Province of Vojvodina were surveyed, a total of 45 of them: 7 cities and 38 municipalities(all 45 respondents of LSGUs submitted completed questionnaires);
- **Professional organizations:** 34 organizations based in the territory of the Republic of Serbia (response to the questionnaire was obtained from 24 professional organizations);

- **Industrial sector:** 37 facilities obligated to obtain an integrated permit in the territory of the APV, except industrial plants for production – plants for fattening poultry and pigs (out of 37 plants, only 4 completed the questionnaire);
- **Business sector:** 2250 business companies based in the territory of the Autonomous Province of Vojvodina were approached (out of 2250 companies, only 50 completed the questionnaire).

The results and conclusions of the surveys conducted for different sectors are presented as follows.

7.2.1 Local authorities

Analysis of results of the conducted survey provided an insight into disadvantages of work, organization and actions of competent authorities of LSGUs in APV, and thus a clearer picture of the necessary improvements and enhancements. Data collected by this survey will serve as a basis for providing initiatives and proposals, taking measures and adequate steps aimed at strengthening the capacity of the competent LSGUs services, improving the effectiveness of work and more efficient application of legislation in practice. Conducting the survey will also contribute, to a certain extent, to a greater transparency in the work of LSGUs, and the data collected through the survey will be available to the public on the web sites (SENVIBE website, SUPEP website).

Results and analysis point to the great lack of interest of LSGUs in completing the survey, both in terms of clarifying potential dilemmas and uncertainties regarding questions asked, as well as in a great number of incomplete, inaccurate, incorrect, one-sided and highly subjective responses. Problems identified in the authenticity of the data, inevitably result in inaccuracy and incompleteness of certain, final data and possible wrong conclusions. The problem with closed-ended questions, which were dominant in this survey, is that in a number of cases, due to their simplicity and limited answers, they do not offer respondents answers that reflect their attitudes. In addition, closed-ended questions do not provide an opportunity for respondents to express their inability to understand a particular question in the survey.

It was also noted that many LSGUs had technical problems in completing the questionnaire (lack of adequate technical equipment and insufficiently computer-savvy respondents), since the survey was prepared as an online survey with the possibility of direct data entry.

Based on the analysis of the survey results, the following can be concluded:

- Environmental protection, as an administrative area, is not an independent organizational unit at the local level, except in cities (in half of LSGUs in APV, it belongs to the department responsible for the field of urban planning, construction and utility activities). Therefore, it is necessary to give higher priority to environmental protection, and to the field of No&Vib at the local level accordingly, along with the strengthening of institutional capacities (financial, personnel, technical, etc.)
- Inadequate and unsatisfactory implementation of competences in the field of No&Vib;
- Insufficient budget funds allocated to the field of No&Vib, which points out the need to allocate additional funds for an efficient implementation of competences (Figure 7.1);

- Inadequate personnel capacity (insufficient number of employees and their unsatisfactory training for the implementation of competences in the field of No&Vib) and an expressed need for education/trainings;

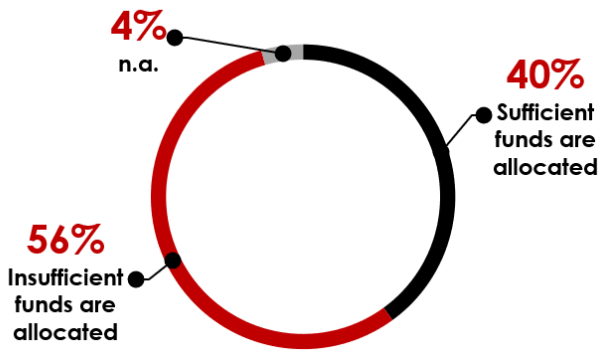

Figure 7.1. Budget funds for implementing competences in the field of No&Vib.

- Only 11% of LSGUs have declared that they are fully familiar with the EU regulations in the field of No&Vib, while 40% of them are partially familiar (Figure 7.2). Compared with knowledge of national regulations (fully and partially familiar with- 89%), there is far less knowledge of EU regulations in this field (fully and partially familiar with-51%), which points to the need for additional training/education in the application of European regulations and practices in the field of No&Vib.

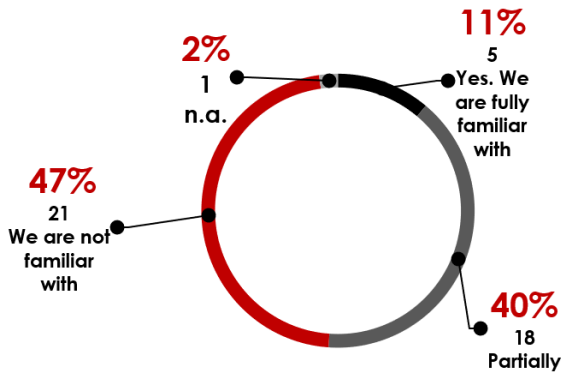

Figure 7.2. Being familiar with EU legislation regarding the field of No&Vib

- As main disadvantages of legislation inapplicability of legal regulations and unclearly formulated competences were stated, therefore a revision of laws and bylaws in the field of No&Vib as well as their harmonization with EU regulations are necessary (Figure 7.3).

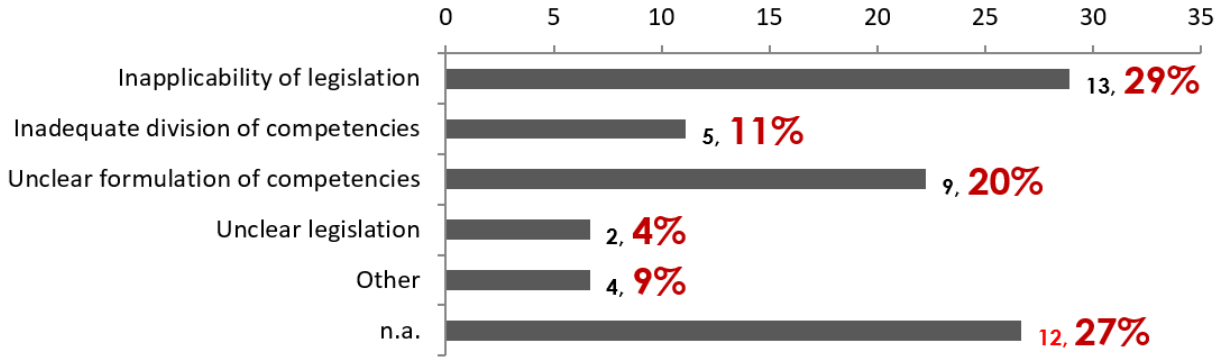

Figure 7.3. Disadvantages of current legislation.

- Lack of financial resources, inability to understand priorities and inadequate decision-making were highlighted as a key problem in the implementation of competences (Figure 7.4).

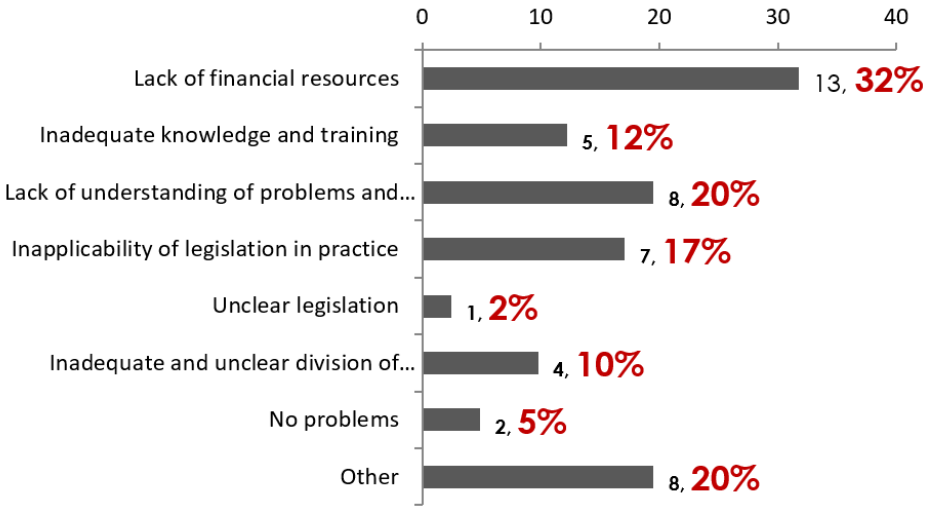

Figure 7.4. Problems related to the implementation of competencies.

- Cooperation between governing bodies is not entirely satisfactory (horizontal and vertical level), therefore it is necessary to improve and establish more active cooperation at all levels;
- Informing the public about the field of No&Vib is unsatisfactory and it is necessary to intensify these activities through targeted campaigns and through the development of promotional / educational materials;
- Great interest in participating in the SENVIBE No&Vib Hub, especially through the following forms of cooperation (Figure 7.5)**:**
    - Strengthening capacities in the field of No&Vib through education trainings of professional personnel;
    - Defining, analysing and solving local issues in the field of No&Vib;
    - Availability and exchange of information, knowledge and practical experience in the field of No&Vib;
    - Better access to different sources of funding;

Involvement in the partnership will bring numerous benefits to LSGUs - it will intensify the strategic cooperation of all key actors in this field through the networking of academic and non-academic sectors (improvement and exchange of expertise and experience, improvement of work and linking of governing bodies, businesses and higher education, raising public awareness ...).

- More than half of LSGUs are interested in the realization of practice and master theses of students.

The conducted survey represents a kind of 'umbrella survey' and provides the basis for developing more detailed surveys in the field of No&Vib. Also, the coverage of this survey can be extended to other LSGUs in the territory of the Republic of Serbia (RS). This way, useful comparative data on the work and views of employees in the competent bodies of LSGUs in certain areas/regions in RS, with the aim of comprehensive strengthening of institutional capacities in the field of No&Vib.

Based on the functioning of LSGUs, it is possible to determine and evaluate the actual reach of the functioning of public authority, as well as its ability/capability to fulfil the obligation of harmonizing the situation with European standards. Results of this survey can serve to assess institutional capacities and the functioning of competent local authorities and local self-governments in the field of environmental protection, particularly in the field of No&Vib in the environment.

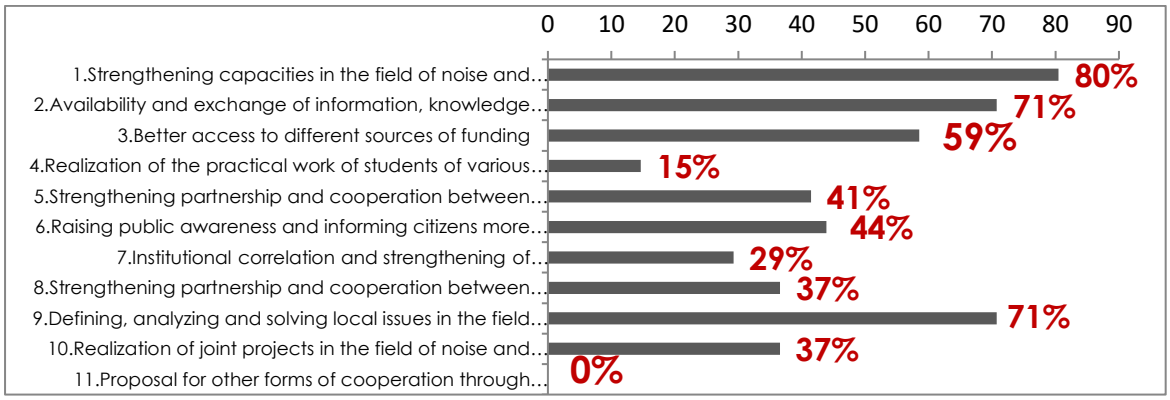

Figure 7.5. Interest in different forms of cooperation through SENVIBE platform-LSGUs (%).

7.2.2 Professional organizations

Given the presence of No&Vib in all sectoral policies, it is necessary to strengthen capacities of POs in order to acquire and expand accreditations for the activities of No&Vib testing (Figure 7.6).

In order to reach European frameworks and significant noise impact on the health of the population, it is necessary to significantly increase personnel capacity, especially in state health institutions (Figure 7.7).

Technical capacity is very low. According to provided data, more than 80% of POs have 1-2 sets of measuring equipment (Figure 7.8), which indicates that it is not possible to fulfil users' requests for more frequent noise measurements and/or on multiple measurement sites at the same time. Furthermore 70% of measuring equipment is older than 5 years (Figure 7.9), which indicates the need for the modernization of measuring equipment itself in accordance with the latest European and national standards. Increasing competitiveness on the market and improving the quality of noise measurement services in the environment in accordance with European standards will be achieved through the modernization of measuring equipment in order to obtain

reliable data, which as such can be used for the development of strategic and planning documents.

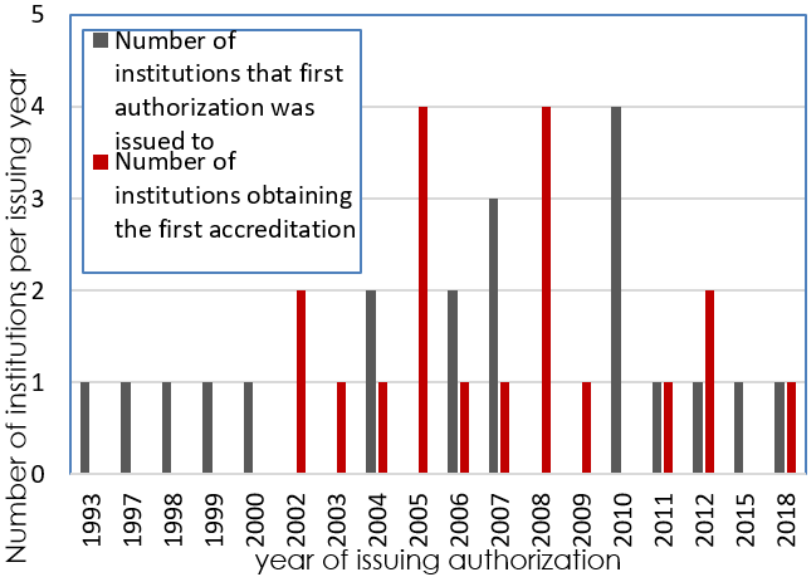

Figure 7.6. Issuing of the first authorization for environmental noise measurement by years.

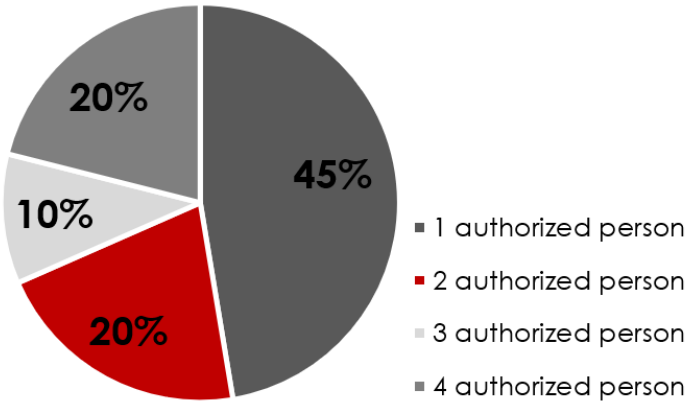

Figure 7.7. Employees in POs authorized for noise measurement.

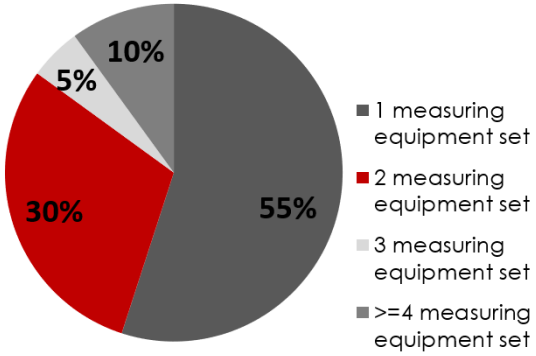

Figure 7.8. Classification of POs according to technical equipment.

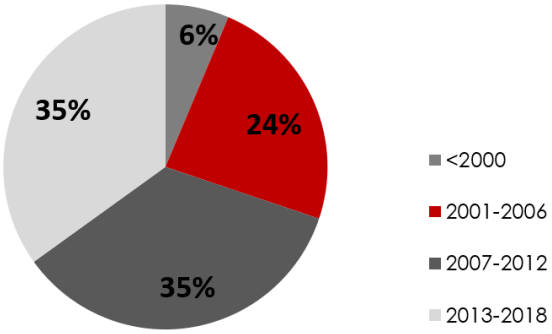

Figure 7.9. Age of equipment by the year of production-POs.

There is a need for continuous education in the application of national legislation in practice and EU regulations, providing practical instructions for designing No&Vib monitoring, as well as the method of preparing bases and data for the development of strategic noise maps;

Participation in the No&Vib Hub is expected to provide better access to various sources of funding, exchange of information, knowledge and practical experience in the field of No&Vib through strengthening partnership and cooperation among all stakeholders. Given that a small number of professional acoustic consultants are interested in the realization of students' practice and master these in vibro-acoustics, No&Vib Hub is expected to increase interest in transferring practical knowledge to younger generations through its activities (Figure 7.10).

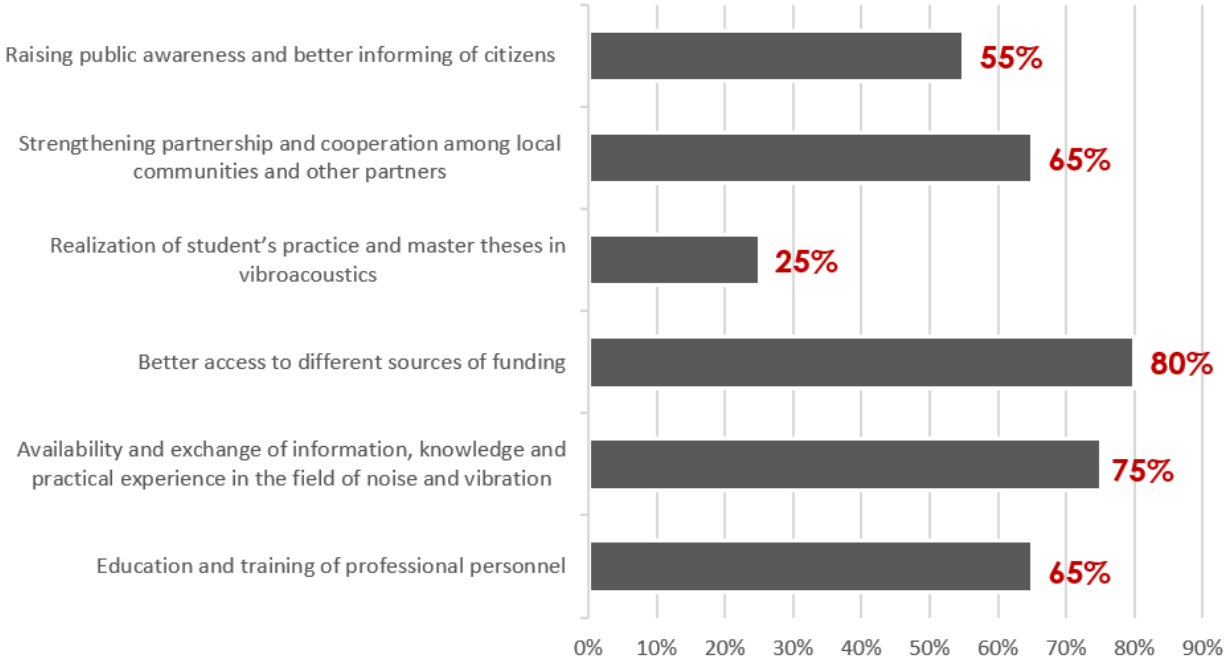

Figure 7.10. Forms of cooperation through No&Vib Hub-POs.

7.2.3 Industrial Plants (industrial sector)

Results and analysis indicate a great lack of interest of plants in completing the survey, with regard to the fact that 75% of plants to which the survey was being addressed, are in the process of issuing an integrated permit.

Given that one of the specific goals of the SENVIBE project is the development of No&Vib Hub - a central unit that will initiate and facilitate strategic cooperation among stakeholders in this field, the results of the questionnaire indicate that all plants are interested in participating in the partnership through SENVIBE platform for No&Vib / No&Vib Hub, mostly through the following forms of cooperation (Figure 7.11).

- Availability and exchange of information, knowledge and practical experience regarding the field of No&Vib;
- Better access to various sources of funding;

It is very important to provide the possibility of the realization of the practical work of students of engineering of different departments on solving problems in the field of No&Vib in plants (students' practice/internship and master theses in vibro-acoustics), which will be defined by a Non-Disclosure Agreement and by the definition of intellectual property rights during the realization of students' residence and/or work with plant-related data.

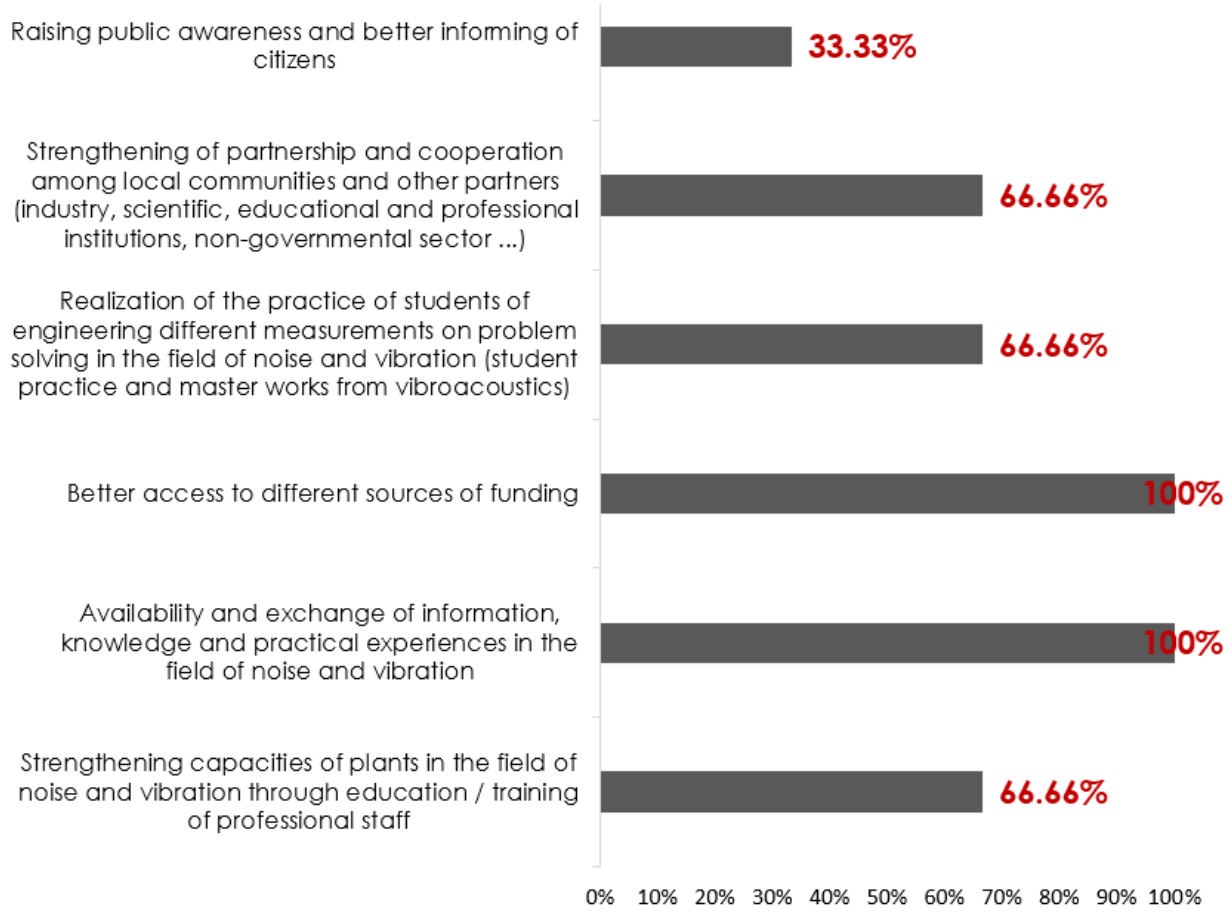

Figure 7.11. Participation in the partnership through SENVIBE platform for No&Vib/No&Vib Hub (%)-IS.

The previously presented results of the surveys related to ***Sections 7.2.1-7.2.3*** can be summarized as the following 'Gaps detected' and 'Recommendations':

Gaps detected:

- Local authorities: inadequate and unsatisfactory institutional capacities (financial, personnel, technical) and inefficient implementation of competences in the field of No&Vib;
- Personnel and technical capacities of professional organizations are low;
- Compared with knowledge of national regulations, there is far less knowledge of EU regulations in this field in all sectors covered by survey;
- Insufficient interest of the industry and business sector in this area and involvement in the HUB and SENVIBE project.

Recommendations:

- Need for education/trainings (key area: application of EU regulations and practices);
- Revision of laws and bylaws in the field of No&Vib, as well as, their harmonization with EU regulations are necessary;
- Better access to various sources of finance to improve assets and technical equipment;
- National No&Vib Marketing Campaign - providing the necessary information for all sectors covered by survey and the wider community;
- Dissemination of information to all sectors about the SENVIBE project and the benefits of the partnership through No&Vib Hub.

7.2.4. Business sector

Union of Employers of Vojvodina had the task of examining the needs and familiarity of business sector within this field.

From the obtained answers it was concluded that in most cases companies are not familiar neither with their responsibilities regarding the field of No&Vib, nor with the harmfulness to the health and productivity of employees. The competences of the companies in the field are limited, as well as their knowledge about regulations related to No&Vib (Figure 7.12).

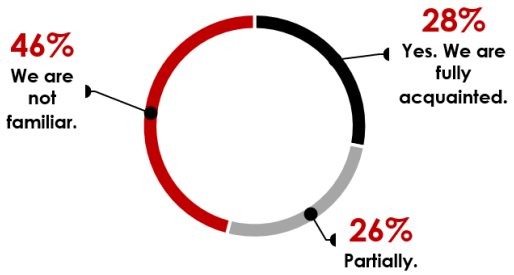

Figure 7.12. Are you familiar with relevant national legislation in the field of No&Vib?

Some companies that are familiar with regulations in the field consider them not applicable (Figure 7.13).

Bearing in mind that in most cases companies are not familiar with national No&Vib legislation, EU regulations are completely unknown to them and absolutely out of focus.

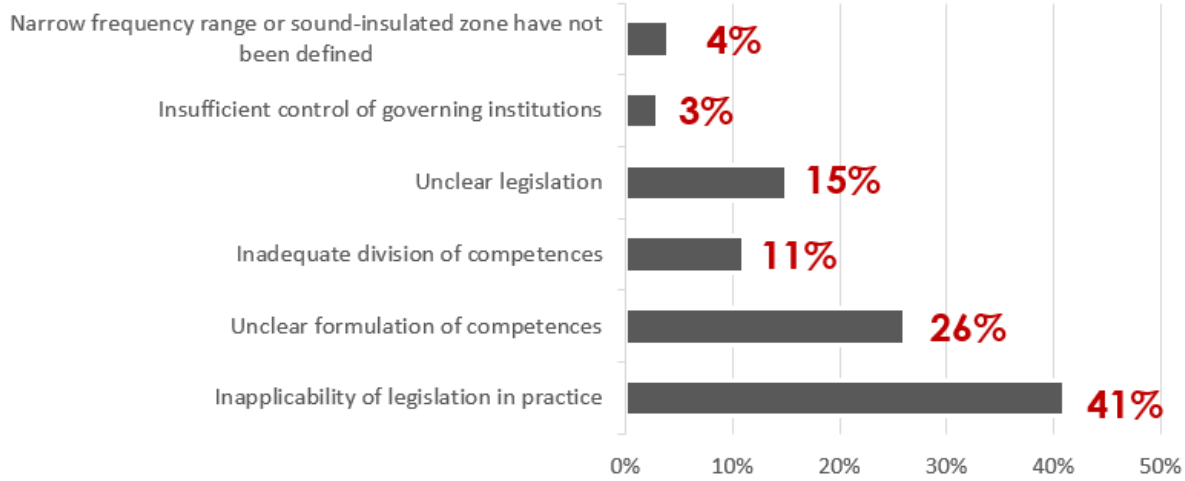

Figure 7.13. What are the shortcomings of the existing legislation?

However, businesspeople are aware that they have certain responsibilities in the field of No&Vib. Half of the respondents performed noise measurements in their business facilities and stated an estimated noise level in the Risk Assessment Act.

The need for education and more information was evident in half of surveyed companies. Most respondents have the opinion that the most effective training method would be in-house training, although a significant number of respondents believe that the manual regarding this field would be appropriate. Few respondents gave priority to seminars, thus in most cases we can conclude that there is no interest in this training method.

The total of 84% of respondents believe that information on No&Vib is not sufficiently represented in the public. On the possibility of participating in the SENVIBE project, the majority of the respondents gave negative answers - 60%. Other respondents gave the greatest importance to the availability and exchange of information, knowledge and practical experience in the field of No&Vib through the SENVIBE platform for No&Vib/No&Vib Hub. In addition, better access to different sources of funding, raising public awareness and informing citizens more on the field of No&Vib through a No&Vib Hub were highly evaluated (Figure 7.14).

The total of 60% of respondents answered affirmatively regarding the possibility of opening the doors of their companies for practical student placements and master theses projects for students, as part of which 42% of companies requested the signing of a Non-Disclosure Agreement and the definition of intellectual property rights for students working at the company or with data related to the company.

Obviously, the business sector is burdened by volatile business conditions and heavy bureaucratic burdens, which is one of the reasons why companies are unable to focus more on this topic. The business sector has expressed the need for better information, not only within its sector, but also in order to raise public awareness of the harmful effects of No&Vib. There is also a need for in-house training of employers and their employees, as well as for mentoring of companies - advisory function of competent inspections, free education. Better access to various sources of finance to

improve assets and equipment would contribute to improving the No&Vib situation, according to the business sector.

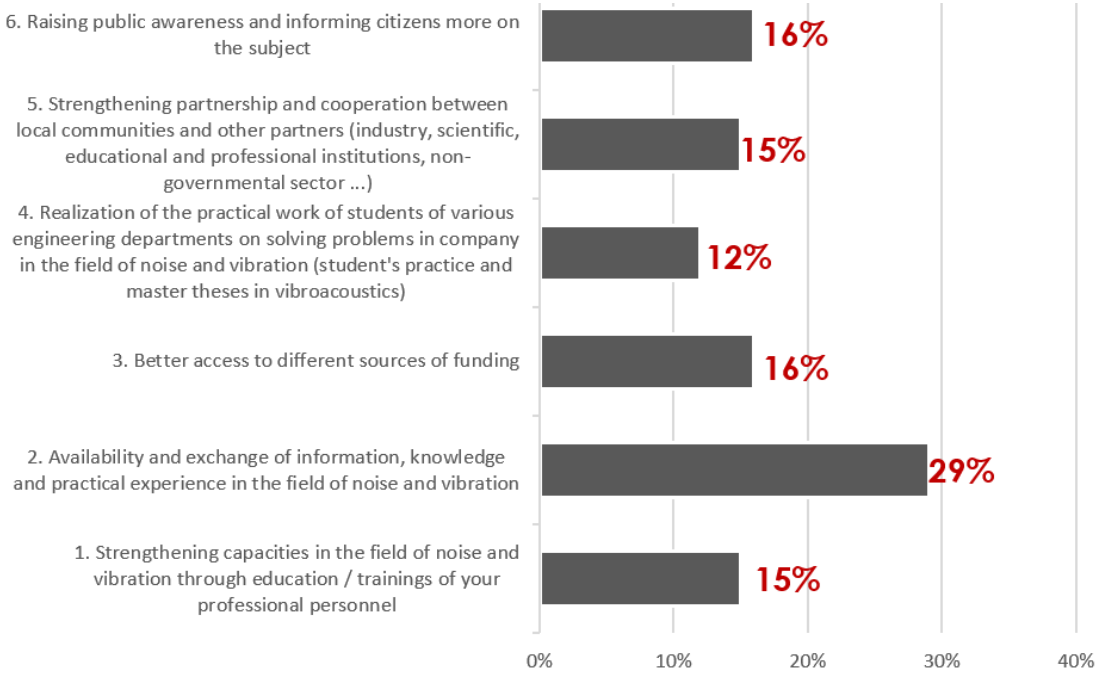

Figure 7.14. What does partnership bring?

It takes a lot of activity in the business sector to improve this area, as well as synergies of all partners to improve the economic situation in the field of No&Vib.

The previously presented results of the surveys related to ***Section 7.2.4*** can be summarized as the following 'Gaps detected' and 'Recommendations':

Gaps detected:

- The business sector is insufficiently aware of legislation and obligations in the field of No&Vib;
- The business sector has absolutely no knowledge of EU regulations in this area;
- Industry and the public are generally not sufficiently aware of the harmful effects of No&Vib;
- Insufficient interest of the business sector in this area and in involvement in the HUB and SENVIBE project.

Recommendations:

- Development of a manual - an informant that will contain all legal regulations and obligations of the business sector to reduce the harmful impact of No&Vib on the business process and productivity of workers;
- Better access to various sources of finance to improve assets and equipment
- Development of LLL courses and involvement of industry in them;
- National No&Vib Marketing Campaign - providing the necessary information for both industry and the wider community;
- Dissemination of information to the industry about the SENVIBE project and the benefits of the partnership through No&Vib HUB.

8 Afterword

As clearly stated in the Introduction, the project SENVIBE 'Strengthening Educational Capacities by Building Competences and Cooperation in the Field of Noise and Vibration Engineering' is aimed at improving and building national educational capacities, cooperation and competences in dealing with environmental and occupational Noise and Vibration engineering issues in accordance with the ongoing EU integration strategies and the needs identified in Serbia. In this respect, overviews have been made related to the higher education in the EU in these fields, the existence of LLL course and different ways of the formalized cooperation between academic and non-academic stakeholders. The analogous surveys have been done for Serbia, which were then compared with the findings for the EU. This enabled the partners engaged on these activities to draw some conclusions in the form of gaps detected as well as to point out some recommendations for short-term or long-term impacts and improvements.

We do hope that this Report will be well received by the readership within Serbia. The Report was written with the best of intention, but there might be criticism or some level of disagreement with the case being made by parties outside of the present SENVIBE project. However, all our conclusions have been made on the analyses and previously written Reports listed under footnotes 4-10, which all in all lasted for more than one year.

We do sincerely hope that some of the recommendations will be successfully implemented during the SENVIBE project. However, some findings and recommendations for addressing identified gaps need the support and action plans from higher national and regional authorities, and this Report will be distributed to those who are relevant for the issues in question.

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Stockholm, 02/10/2019

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"This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein"