# IO1.A1
# Research report – partner country


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# RESEARCH

**1POINT** (1Point: VET training using the one-point lessons approach 2020-1-SI01-KA202-076060) has been funded with support from the European Commission.

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# 1. Introduction

This document is the result of a careful analysis carried out within the 1POINT: VET training using the one-point lessons approach project (project number: 2020-1-SI01-KA202-076060) funded by the European Commission through the Erasmus+ programme - KA2, Strategic Partnership for Innovation and Exchange of good practices.

1POINT project aims to transform a standard quality assurance method and information security process used in the industry into a creative and innovative training methodology for the VET sector. Our focus is the training of future maintenance professionals in order to improve IT skills, foster employability and develop innovative thinking. The training course will be designed in accordance with high quality VET standards in order to meet the labour market needs.

The next generation of industry workers should be tech savvy, but VET programs and teaching methodologies have not caught up yet. 1Point will promote a work-based learning approach and the acquisition of concrete knowledge and skills. Therefore, training with the 1Point methodology will support participants to carry out and reflect on tasks that are directly connected to their future workplace (vocational context). The methodology will include the use of modern ICT technologies, accessible from different mobile devices (e.g., tablets, laptops) and will include gamification aspects (badges, missions). In this way, the 1Point lesson model creates benefits for VET providers, trainers, learners and the industry.

The project is carried out by a consortium of partners composed by:

- RAZVOJNI CENTER ORODJARSTVA SLOVENIJE (TECOS) (Slovenia),
- ATLANTIS ENGINEERING AE (ATL) (Greece),
- ASOCIACION EMPRESARIAL DE INVESTIGACION CENTRO TECNOLOGICO DEL MUEBLE Y LA MADERA DE LA REGION DE MURCIA (CETEM) (Spain),
- European Digital Learning Network (DLEARN) (Italy),
- CENTER REPUBLIKE SLOVENIJE ZA POKLICNO IZOBRAŽEVANJE (CPI) (Slovenia),
- HEARTHANDS SOLUTIONS LIMITED (HESO) (Cyprus).

This research report presents the valuable collected results of a conducted comparative analysis on maintenance trainings offered in each partner country and inside the EU with the help of ESCO database. Partners checked inside their countries existing curricula with special maintenance emphasis on four sectors of interest. The aim was to have an overarching view of existing courses and a list of national qualifications that may be relevant for the ECVET profile.

In the last part of this document, there is a general conclusion about the research carried out.

Prior to project start an initial phase of research was conducted in partnership countries in order to assure the adequate European relevance of the ECVET profile and to guarantee perfect correspondence to the training needs of the target group. In initial phase we relied at the beginning on information that was identified in the pre-grant analysis and then started with real in-depth research in the first project months in which we focused on the actual current learning needs and the digital skills-gap of maintenance professionals, trainees and VET students along with an overview look also on national level inside the partnership countries as already stated. In parallel, the entire consortium conducted also a comparative analysis on maintenance trainings offered in each partner country and checked for existing curricula in given sectors such as 3D printing, augmented reality (AR), virtual reality (VR) and lean manufacturing (LM).

The main goal of this research report is to have an overarching view of existing courses and a list of national qualifications that may be relevant for the ECVET profile. For this reason, coordinating partner TECOS provided a common methodological framework that served for all partners in this phase as a guideline to easily collect the information in each partner countries. The results per each partner country are presented in the next chapter.

# 2. Slovenia

## 2.1 Collected results in Slovenia - collection of existing courses, training materials and contents relevant to maintenance

TECOS and CPI, project partners from Slovenia, conducted the research with different activities that were orchestrated from several sources, taking into account the interesting 4 sectors 3D printing, augmented reality (AR), virtual reality (VR) and lean manufacturing (LM), for example such as existing courses, list of national qualifications, study/high school programs, available curriculums, webinars or similar maintenance training offers, interviews with production/maintenance companies, maintenance society …

### Slovenia: Current learning needs and the digital skills-gap of maintenance professionals, trainees and VET students

In order to find out what are the exact or current learning needs and digital skills-gap in Slovenian maintenance world we first interviewed some of the more important persons and companies inside Slovenia in the sectors of 3D printing, augmented reality (AR), virtual reality (VR) and lean manufacturing (LM).

***Interviews***

Interview with President of the Slovenian Maintenance Society Mr. Darko Cafuta, where we identified crucial needs and drawbacks of professional maintenance workers in Slovenia. During the discussion we came to the conclusion that in some cases the elder maintenance professionals can potentially deny or even block the progress and usage of new modern ICT tools that are useful in the field of maintenance training. Currently there is a lack of digital tools that could be easily used for different maintenance topics. During the regular traditional Technical Conference of Slovenian Maintenance Workers which was held online due to COVID-19 impact all agreed that the usage of digital tools in maintenance sector is a big must-have tool not only for educational purposes to boost digital skills of new unexperienced maintenance employees but also for real working purposes. Currently in Slovenia many maintenance companies still rely on traditional learning concepts without digital tools. With Mr. Cafuta we agreed to openly share the developed 1Point platform for the Slovenian maintenance world as soon as it will be put into working operation, and in return the 1Point consortium will have the chance to actively hold different dissemination activities in collaboration with Slovenian Maintenance Society on different events such as fairs, technical conferences …

Interview with director and two 3D-printing engineers working at company MARSI (Mario Šinko, Simon Erban and Matic Vogrin). This company deals with 3D printing process technology for several years and tried in the past to employ new workers in this field. The identified problems here are smaller level of 3D printing maintenance knowledge that the current students and future workers gain at their faculties. They learn the basic working procedure for 3D printing but on the maintenance field the knowledge is often very weak.

The interview related to the current needs in Lean manufacturing we hold with company Lean Rešitve d.o.o., who's representative Mr. Matic Golavšek already held in the past at TECOS facilities successful seminars dedicated to the Lean manufacturing and is regarded as one of the practically experienced experts in Slovenia for LEAN manufacturing field. In general, we

could conclude that companies need the basic and extra knowledge on Lean manufacturing and especially in terms of maintenance since it's not sometimes fully clear who is responsible for which action in a typical industrial production company. Besides that, there is a digital skill gap identified at elder maintenance people who know how to browse on the web but are unsure of using digital tools (tablets, smart glasses …) at all in their daily work.

In terms of AR and VR fields we were in contact with adequate companies and can state that both fields are still emerging and are both very popular currently in Slovenia. In both fields we have lots of interesting high tech engineering companies (Kolektor, Špica, …) that already offer AR and VR solutions that can be used for maintenance professionals, trainees and VET students. These companies experience currently partial interest from manufacturing companies due to COVID-19 outbreak but the trend of usage of AR and VR solutions for industrial maintenance actions is still growing. For this reason, we expect that in the forthcoming years the manufacturing companies will see greater benefit and implement it as part of learning process for their employees in majority, and specially for maintenance student newcomers and professionals. In Slovenia there are also some start-up companies dealing with AR and VR solutions that develop solutions for virtual reality and augmented reality with deep knowledge about the VR & AR industry and decades of experience in technical development and computer graphics.
Overall, the COVID-19 pandemic situation showed that the usage of digital tools and new emerging technologies is a must needed solution tool for maintenance stuff and other workers in order to gain more knowledge in their respective working fields.

***VR center in Slovenia***

Virtualist is the first VR center in Slovenia. Visitors, regardless of age and experience, are offered the opportunity to discover an unforgettable world of virtual realities on three VR stations.

At Virtualist, they want to bring together in one place all those who deal with virtual reality in Slovenia and beyond, both amateur and professional. They have the latest VR technology and friendly staff to guide visitors through the first VR experiences.
One can also rent several VR stations at the same time, or making all the space, for multiplayer, business meetings, education, team building… Their goal is to present and bring virtual reality technology closer to the general public, and they are also planning VR education http://virtualist.si/ .

***Demo smart factory in Slovenia***

At the Faculty of Mechanical Engineering of the University of Ljubljana, a demonstration center "Smart Factory" was opened, which is the first of such kind in Slovenia. It was created in line with the GOSTOP program, the largest program of the Smart Specialization S4 in the field of smart factories in Slovenia in which TECOS was the leader of Toolmaking pillar. The idea of the demonstration center is in line with the basic idea of the Slovenian smart specialization strategy S4, which is to demonstrate the innovative application and deployment of Industry 4.0 technologies and the concept of a smart factory in a real industrial environment. This demo center also includes a smart manual workplace where it is possible to demonstrate the various smart factory technologies, such as virtual and augmented reality (AR & VR), digitization and transparency of installation or assembly instructions, the flexibility of assembly points and magazines, ergonomics of the workplace, etc.

## Existing National Vocational Qualifications and Education Programs (Curricula) that may be relevant for the ECVET profile – Slovenia case

Below we are listing the most 1Point project relevant list of existing qualifications in the field of mechanical engineering:

| | |
|---|---|
| NAME OF QUALIFICATION: | Operater/operaterka sistema za 3D tisk in dodajalno tehnologijo |
| TRANSLATED TITLE (NO LEGAL STATUS): | **Operator of the 3D printing system and additive technology** |
| SOURCE: | https://www.nok.si/en/register/operater-operaterka-sistema-za-3d-tisk-dodajalno-tehnologijo |
| TYPE OF QUALIFICATION: | National vocational qualification, SQF level 5 |
| ISCED FIELD: | Engineering, manufacturing and construction |
| QUALIFICATION LEVEL: | **SQF 5 / EQF 4** |

LEARNING OUTCOMES:

The candidate is able to:

- plan and organize their work and the work of the group
- rational use of energy, material and time
- ensure the quality and performance of work in the work environment in accordance with standards
- perform work in a way that does not endanger oneself, others, property and the environment
- in their work to take into account the principles of rational use of energy, materials and time
- behave responsibly, enterprisingly and ethically
- communicate with various stakeholders and use modern information and communication technology required in the field of 3D technology
- carry out the work in accordance with technical and technological instructions

- download, review and prepare a 3D file to create a 3d model / product
- to make a product in 3D printing technique and additive technology
- manage 3D printing system and additive technology
- perform finishing operations on the fabricated 3d-model / product

| | |
|---|---|
| NAME OF QUALIFICATION: | Operater/operaterka na CNC stroju |
| TRANSLATED TITLE (NO LEGAL STATUS): | **CNC machine operator** |
| SOURCE: | https://www.nok.si/en/register/operater-operaterka-na-cnc-stroju-0 |
| TYPE OF QUALIFICATION: | National vocational qualification, SQF level 5 |
| CATEGORY OF QUALIFICATION: | Vocational Qualification |
| ISCED FIELD: | Engineering, manufacturing and construction |
| QUALIFICATION LEVEL: | **SQF 5 / EQF 4** |

LERANING OUTCOMES:

The candidate is able to:

- Plan, prepare, carry out and control their own work,
- use a rational approach to the use of energy, materials and time,
- ensure occupational safety and take into consideration the principles of environmental protection,
- use computer equipment and software tools,
- communicate at professional level with co-workers and business partners,
- develop entrepreneurial characteristics, skills and behaviour,
- design and draw simple contours and programme CNC machines,
- attach tools and workpieces and set machine parameters,
- use CAD data and NC programme readers,
- fill out accompanying work documentation and documents related to the processing process.

| | |
|---|---|
| NAME OF QUALIFICATION: | Skrbnik/skrbnica procesnih naprav-mehatronik/mehatroničarka |
| TRANSLATED TITLE (NO LEGAL STATUS): | **Process equipment administrator – mechatronics technician** |
| SOURCE: | https://www.nok.si/en/register/skrbnik-skrbnica-procesnih-naprav-mehatronik-mehatronicarka |
| TYPE OF QUALIFICATION: | National vocational qualification, SQF level 5 |
| CATEGORY OF QUALIFICATION: | Vocational Qualification |
| ISCED FIELD: | Engineering, manufacturing and construction |
| QUALIFICATION LEVEL: | **SQF 5 / EQF 4** |

LEARNING OUTCOMES:

Candidate is able to:

- Plan, prepare and ensure the quality of their own work and services,
- make rational use of energy, material and time,
- protect health and the environment,
- communicate with co-workers, outside contractors and customers and take part in project teams,
- use relevant programming tools,
- develop enterprise characteristics, skills and behaviour,
- plan a process system,
- manage the functioning of process systems and ensure the quality of the process,
- diagnose and eliminate faults in a process system,
- maintain and monitor the correct operation of devices in an automated system,
- carry out assembly and complex repairs of breakdowns of an automated process,
- maintain software and hardware and file documentation relating to the maintenance of an automated system,
- implement controls of the process and equipment.

| | |
|---|---|
| NAME OF QUALIFICATION: | Strojni tehnik/strojna tehnica |
| TRANSLATED TITLE (NO LEGAL STATUS): | **Mechanical engineering technician** |
| SOURCE: | https://www.nok.si/en/register/strojni-tehnik-strojna-tehnica |
| TYPE OF QUALIFICATION: | Upper secondary technical education |
| CATEGORY OF QUALIFICATION: | Educational Qualification |
| TYPE OF EDUCATION: | Upper secondary technical education |
| DURATION: | 4 years |
| CREDITS: | 240 credits |
| ISCED FIELD: | Engineering, manufacturing and construction |
| QUALIFICATION LEVEL: | **SQF 5 / EQF 4** |

LEARNING OUTCOMES:

The holder of the certificate is qualified to:

- use expertise, IT and software tools in the resolution of real practical problems in the discipline;
- size and shape machine parts, select standard machine elements and construct assemblies;
- mathematically solve technical problems in the field and elaborate analytical and graphic charts;
- employ technical terminology, process data in order to obtain information and keep technical and technology documentation;
- examine and make use of technical and technology documentation, technical regulations and standards as well as technical plans and manufacturer's instructions;
- perform measurement and control procedures, use measurement and control machines, appliances, tools and aids;
- plan the steps from idea to the production of goods or supply of services;
- cooperate in projection and construction of new products and proposals leading to the improvements of the already existing products;

- select the technology procedure for processing, transformation or blending of products in the light of the materials and the purpose of use;
- select and use materials, tools and working instruments for processing and procedures in various fields of mechanical engineering;
- assess the rational use of energy, use of energy sources and waste management;
- assess development potential and the use of non-conventional energy sources and rational use of energy;
- evaluate eco-eligibility for the use of individual machines, appliances and systems;
- carry out and guarantee measures pertaining to health and safety at work, environment protection, fire safety and accident prevention;
- seek rational and professional solutions when conducting activities in the working environment;
- think entrepreneurially, judge critically and act responsibly and socially in the working environment.

Optional:

Spatial modelling and documentation preparation

- perform parameter and spatial modelling of products, assemble units and elaborate technical documentation;

Computer based technologies

- select working processes, programme NC machines by setting and correcting processing parameters;

Mass production tools and appliances

- construct tools and aids, assemble, dismantle, test and maintain tools;

Planning production processes in mechanical engineering

- plan technology processes and draw up basic technology documentation for production by taking into consideration its ergonomic impact;

Automation and robotics

- analyse the operation of control functions, determine automation type in production and assess the impact of robotics;

Energy systems

- identify and select energy appliances and machines as well as maintain and optimize energy systems;

Housing installations planning

- plan construction installation elements of heating, cooling and ventilation;

Energy generation and distribution

- monitor and control technology processes of heat generation and distribution.

In addition, the holder of the certificate also upgraded his/her key professional skills and competences with key general knowledge and skills in line with national standards.

| | |
|---|---|
| NAME OF QUALIFICATION: | Inženir strojništva/inženirka strojništva |
| TRANSLATED TITLE (NO LEGAL STATUS): | **Mechanical engineer** |
| SOURCE: | https://www.nok.si/en/register/inzenir-strojnistva-inzenirka-strojnistva |
| TYPE OF QUALIFICATION: | Short cycle higher vocational diploma |
| CATEGORY OF QUALIFICATION: | Educational Qualification |
| TYPE OF EDUCATION: | Short cycle higher vocational education |
| DURATION: | 2 years |
| CREDITS: | 120 credits |
| ISCED FIELD: | Engineering, manufacturing and construction |
| QUALIFICATION LEVEL: | **SQF 6 / EQF 5 Short cycle** |

LEARNING OUTCOMES:

Students will be able to:

(general competences)

- take into account safety regulations and environmental protection regulations at work;

- develop communication skills in the working environment and beyond;
- use written sources and information technologies;
- adopt a systematic approach to the detection and resolution of problems;
- develop responsibility for professional development;

(specific vocational competences)

- apply the theoretical knowledge they have acquired to act effectively in the working environment;
- use a foreign language for communication and the study of specialist literature;
- use basic knowledge of economics, marketing and project management to run a business;
- apply knowledge of mechanics in determining the dimensions of structural elements;
- analyse the functioning of electrical circuits and eliminate simple faults, taking the appropriate protective measures;
- draw up a technological manufacturing process;
- select, determine and evaluate time and manufacturing costs and select tools;
- select appropriate materials, appropriate heat treatment and corrosion protection on the basis of requirements and demonstrate familiarity with the impact of materials on the environment;
- plan products taking into account relevant technical legislation;
- draw up technical documentation in all phases of the creation of a product;
- use a computer to prepare and monitor manufacturing cost plans and schedules;
- apply quality management and quality assurance methods in the production process;
- plan simple energy systems and demonstrate familiarity with the functioning of more complex energy systems;
- ensure the economical and environmentally acceptable consumption of energy;
- recognise opportunities to introduce automation and conduct projects in the field of the automation of manufacturing processes;
- autonomously plan the automation of simple manufacturing processes and participate in the planning and introduction of automation of complex manufacturing processes;

- plan, organise and lead preventive maintenance work on machines, devices and energy systems in the manufacturing process;
- analyse the impact of maintenance on a company's costs;
- plan and organise work and lead production;
- plan costs and investment in manufacturing processes;
- train for the construction process of designing tools on the basis of a client's requirements, including selection and definition of the standard parts of a tool;
- demonstrate knowledge of the economic and technological characteristics of a tool.

| | |
|---|---|
| NAME OF QUALIFICATION: | Tehnik mehatronike/tehnica mehatronike |
| TRANSLATED TITLE (NO LEGAL STATUS): | **Mechatronic Technician** |
| SOURCE: | https://www.nok.si/en/register/tehnik-mehatronike-tehnica-mehatronike |
| TYPE OF QUALIFICATION: | Upper secondary technical education |
| CATEGORY OF QUALIFICATION: | Educational Qualification |
| TYPE OF EDUCATION: | Upper secondary technical education |
| DURATION: | 4 years |
| CREDITS: | 240 credits |
| ISCED FIELD: | Engineering, manufacturing and construction |
| QUALIFICATION LEVEL: | **SQF 5 / EQF 4** |

LEARNING OUTCOMES:

Certificate holders will be able to:

- use and demonstrate understanding of technical plans;
- use information systems in technological processes;
- automate technological processes and maintain technological systems;
- determine loads and load-bearing capacities of structural elements;
- use hydraulic and mechanical elements or systems and electrical machinery or devices;
- build mechatronic systems and plan the assembly and disassembly of mechatronic systems;

- diagnose faults and carry out simple repairs to mechatronic systems;
- program relatively simple applications in different programming languages;
- integrate the information system with the manufacturing process;
- maintain equipment and applications at the level of integration of the information system with manufacturing processes;
- design control and regulation mechanisms and plan pneumatic and hydraulic control systems;
- use and plan digital circuits, microcontrollers, programmable logic controllers (PLCs) and elements of sensor technology.

Elective:

Assembly and testing of mechatronic systems

- assembly and disassembly of simple mechatronic systems;

Maintenance and repair of mechatronic systems

- maintain and repair mechatronic systems.

Certificate holders have built on their key vocational knowledge and abilities with key general knowledge in line with national standards.

| | |
|---|---|
| NAME OF QUALIFICATION: | Inženir mehatronike/inženirka mehatronike |
| TRANSLATED TITLE (NO LEGAL STATUS): | **Mechatronics engineer** |
| SOURCE: | https://www.nok.si/en/register/inzenir-mehatronike-inzenirka-mehatronike |
| TYPE OF QUALIFICATION: | Short cycle higher vocational diploma |
| CATEGORY OF QUALIFICATION: | Educational Qualification |
| TYPE OF EDUCATION: | Short cycle higher vocational education |
| DURATION: | 2 years |
| CREDITS: | 120 credits |
| ISCED FIELD: | Engineering, manufacturing and construction |
| QUALIFICATION LEVEL: | **SQF 6 / EQF 5 Short cycle** |

LEARNING OUTCOMES:

Students will be able to:

(general competences)

- demonstrate familiarity with technical/theoretical knowledge in a field, sector or activity,
- manage basic and, in particular, methodologically relevant procedures to resolve technical problems for the development of innovations in work processes, procedures and media and for effective operations,
- use acquired knowledge for successful professional communication in both the domestic and international environments,
- demonstrate understanding of the relationship between the development of production, social development and the development of the environment; develop global awareness of the opportunities, limits and dangers of technological development,
- resolve more complex technical problems in the work process,
- link knowledge from various areas when using and developing new applications,
- carry out tasks in the preparation and control of working processes and, in particular, in the organisation and management of working processes,
- demonstrate mastery of the fundamental categories of enterprise, economics and finance, above all with regard to markets, manufacturing and related resources, and
- develop awareness of the importance of good-quality interpersonal relations and teamwork.

(specific vocational competences)

- acquire the specialised theoretical and practical knowledge for autonomous professional work that is needed in order to prepare and implement tasks in the field of mechatronics at a high level of quality,
- disseminate, enhance and reinforce knowledge from the field of mechatronics and build on the theoretical and practical vocational competences acquired in prior education,

- demonstrate familiarity with basic legislation, standardisation, technical regulations, certification and quality assurance systems in the mechatronics field and other fields tied to the basic activity,
- acquire and disseminate knowledge of mechatronics in connection with economics, management and business communication,
- develop confidence and decisiveness for business decisions and address specific technical issues,
- develop the capacity to autonomously keep abreast of the development of the profession and take the initiative for the introduction of new features in practice,
- develop the capacity to autonomously keep abreast of the development of the field and take the initiative for the incorporation of new developments,
- perfect their knowledge of foreign languages and technical terminology and use them for international cooperation and for keeping abreast of new developments in other countries.

**VIRTUAL REALITY (MODUL A)**
**General VR subject at Faculty of Electrical Engineering, University of Ljubljana**
*Education > 1st Cycle Academic Study Programme > Electrical Engineering > Subjects+*
SOURCE: Subjects - Electrical Engineering - 1st Cycle Academic Study Programme - Education - English - FE (uni-lj.si)

| | |
|---|---|
| NAME OF QUALIFICATION | Diplomirani inženir elektrotehnike |
| (un)/diplomirana inženirka elektrotehnike | |
| TRANSLATED TITLE (NO LEGAL STATUS) | **Academic bachelor's degree in electrical engineering** |
| TYPE OF QUALIFICATION | Academic bachelor's degree |
| CATEGORY OF QUALIFICATION | Educational Qualification |
| TYPE OF EDUCATION | Academic bachelor's education |
| DURATION | 3 years |
| CREDITS | 180 credits |
| ISCED SUBFIELD | electricity and energy |
| QUALIFICATION LEVEL | **SQF 7 / EQF 6 First level** |

**SUBJECT DESCRIPTION**
*Prerequisites: Enrolment in the third year*
**Content (Syllabus outline):**

Introduction (virtual environment, presence, sensory feedback, interactivity, multimodal virtual environments), human factors (visual, acoustic, haptic and vestibular perceptions, motor system), creation of virtual environment, visual modality (graphical modelling, animation, visual rendering , 3D displays), auditory modality (acoustics, surround sound, audio rendering), haptic modality (kinesthetic and tactile haptic interfaces, haptic rendering), dynamics of virtual environment (motion, deformation, collision detection, virtual environment modelling), motion tracking (user's pose and motion tracking, measurement of interaction forces, environment sensing), interaction (manipulation of objects, virtual navigation, interaction with other users), cooperation and interaction in multi-user virtual environments, presence (mental and physical immersion and presence, creating conditions for presence, measuring presence), augmented reality, virtual reality systems ("cave" environment, platforms, man/machine interfaces), virtual prototypes, use of virtual reality in industrial and medical applications and design.

**Objectives and competences:**
The course addresses the interaction between a human and a computer-generated virtual environment. It analyses physical background, technological challenges as well as opportunities and constraints related to the construction of multimodal virtual environments. The emphasis is on concepts necessary for understanding virtual environments and user's responses to synthetic visual, auditory and haptic stimuli. Students acquire practical knowledge in the laboratory while completing interdisciplinary research projects.

**Intended learning outcomes:**
Understanding of human visual, acoustic, tactile and kinesthetic perceptions; measurement and analysis of human movement; knowledge necessary for synthesis of visual, auditory and haptic artificial stimuli, as well as integration of these stimuli into a multimodal virtual environment that allows the user to feel physically and mentally present within the environment.

**Learning and teaching methods:**
Students have access to a book with the course content. In the lectures, the emphasis is on theoretical basics of multimodal virtual environments. Due to the specificity of the course, lectures are mostly conducted with the help of multimedia presentations. Latest developments in the field of virtual environments are presented in the form of "video lectures". Practical exercises are conducted in the laboratory, which is equipped with a number of different haptic robots, surround sound systems and 3D stereoscopic graphical displays. Students work in interdisciplinary project teams, where each student engages in a particular modality of virtual environment.

**Slovenia overview:**

In Slovenia, an individual can obtain a qualification, in fields that are relevant and addressed in the 1Point project, at levels NQF 4-7/EQF 3-6. In researching the gap between the skills required in the workplace and those acquired through education and training, we found that there exist quite a few gaps. In particular, these gaps are linked to practical knowledge about the use of modern IC technology, which includes also AR/VR technologies. Existing training and education offer do not cover all the needs in manufacturing. There is a skill gap in labour force - workers need to be equipped with more suitable ICT tools.

Key players in the field of maintenance in industry in Slovenia are very interested in new innovative training and training opportunities in the field of maintenance (e.g. on-line training in a motivational digital environment). This type of education/training could also be of interest for the VET educational programs.

# 3. Greece

## 3.1 Collected results in Greece - collection of existing courses, training materials and contents relevant to maintenance

ATLANTIS was in charge to collect the results for Greece on the status and evolution of the maintenance interesting groups.

During the first stage of the research in the 1Point project, the effort was put on understanding the existing courses that are taking place in Greece and that may be relevant for the maintenance workers competence profile. Furthermore, deep search of the training materials used during those courses were obtained, as it supported the understanding of the extend of knowledge shared on the topic of the interest.

Overall, there are few resources available in finding information on Greek courses that are offered to maintenance workers. The classification of European Skills, Competences, Qualifications and Occupations, ESCO (https://ec.europa.eu/esco/portal) is one of the fruitful sources deeply consulted during this research, as it presents relevant skills for the EU labour market, education and training. As a result, several occupations e.g., Factory technicians, Repair mechanics, Factory safety technicians, Electrical Engineers, etc. are gaining the essential and basic knowledge of the maintenance, maintenance procedures, programming knowledge, AR & VR Knowledge, etc. The following table 1 just below is a summary of these findings containing details of the occupations that are offered in the labour market as well as essential and optional skills and knowledge obtained. Relevant information is in English supported with the ESCO link.

# 1POINT: Table 1. Skills, Competences, Qualifications and Occupations in Greece

| NO. | Occupation and description | Alternative Label | Essential Skills | Essential Knowledge | Optional Skills | Optional Knowledge | LINK ESCO DATABASE |
|---|---|---|---|---|---|---|---|
| 1 | Factory technicians | Specialised workers in industrial environments | Use of factory machinery and tools, such as presses, punchers and maintenance tools (screwdrivers, raster) to repair machine malfunctions | Knowledge of the machinery on the factory, basic knowledge of the maintenance, knowledge of the use of repair tools | Use of factory vehicles and small maintenance on them | Knowledge of the vehicles used in the factory, knowledge of the maintenance procedure for the vehicles (ex. Change a tyre) and knowledge of the basic tools for the vehicles | http://data.europa.eu/esco/isco/C7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | Repair mechanics | Maintenance technicians | Use of maintenance machinery, specialty in the maintenance of factory machinery, specialty in the maintenance process | Knowledge of the factory machinery, their functions and maintenance procedure in order to provide timely maintenance Knowledge of the mechanics in the factory and the repair tools | Use of lean manufacturing maintenance procedures | Knowledge of the 5S process in industry and maintenance | http://data.europa.eu/esco/isco/C72 |
| 3 | Heavy and standing machinery operators | Factory machinery operators | Use of the standing machinery on the factory during production and the production order of products | Knowledge and training of the heavy factory machinery, Knowledge of the production process steps and the production techniques as well as the product characteristic | Use of specialised production machinery and tools | Knowledge of the production interesting steps and the product behaviour during the special conditions of the production | http://data.europa.eu/esco/isco/C723 |
| 4 | Factory safety technicians | Safety specialist | Use of the safety procedures for personnel, tools and machinery | Knowledge of the safety procedures of personnel, machinery and tools on the factory | Use of safety procedures about the products | Knowledge of the safety procedures of the products | http://data.europa.eu/esco/isco/C8 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | Electrical engineers | Electrical assets engineers/electricians | Use of electrical circuits, design and installation of electrical applications on the factory, safety of the electrical installations | Knowledge of electrical circuits, design and implementation Knowledge of the electrical safety of installations and machinery on the factory | Use of specialised electrical tools | Knowledge of the electrical procedures and standards | http://data.europa.eu/esco/isco/C215 |
| 6 | Automation electricians | Automation installers | Use automation programming, PLCs and automation sensors | Knowledge of PLC programming and programming of other automation applications | Use of the high-level program language | Knowledge of programming and installation of development applications | http://data.europa.eu/esco/isco/C2152 |
| 7 | Developers | Software engineers | Use of software and programming languages for development of applications Coding tests for applications | Knowledge of high-level programming languages, algorithms and understanding of the concepts of artificial intelligence | Use of artificial intelligence tools and creation of a appealing artificial environment | Knowledge of the interactions between artificial and real environment and understanding the user needs for artificial intelligence | http://data.europa.eu/esco/isco/C251 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | System analysers | Testers and data scientists in AR, VR & IT | Use of analysis tools and data for AR & VR, creation test AR applications | AR & VR Knowledge of algorithms of data analysis and knowledge for written AR & VR test applications | Use of graphical development tools and simulators | Knowledge of application development of the graphical tools and creation of technical requirements | http://data.europa.eu/esco/isco/C2511 |
| 9 | Industrial workers | Factory workers | Move objects, load and unload vehicles etc | knowledge of loading and unloading schedules knowledge of tasks schedule | Use of moving tools and machines (clarks, lifts etc) | Knowledge of use the moving tools and machinery Basic understanding of their failures | http://data.europa.eu/esco/isco/C932 |

## Analysis of categories related to the maintenance sector (3D printing, AR, VR, Lean manufacturing)

## Partner country: Greece

**Source:** https://ec.europa.eu/esco/portal/home

Furthermore, the following table 2 presents the maintenance training that are offered at National Level taking into consideration current learning needs of Maintenance professionals, Trainees and VET students while summarising the digital skill gaps of these focus groups.

# 1POINT – partner country Table 2: Greece

| NO. | Maintenance training | Current learning needs | | | Digital skill gaps | NQF/EQF Level |
|---|---|---|---|---|---|---|
| | . | **Maintenance professionals** | **Trainees** | **VET students** | | |
| 1 | Mechanical assets maintenance studies | **Repair mechanics** | **Industrial workers, factory technicians, repair mechanics** | **Students of mechanical assets maintenance, students of repair mechanics** | Familiarise and train on the mechanical assets of factories<br>Specialise in maintenance through new techniques and implementation of technical requirements and standards<br>Creation of maintenance standards based on the production cycle and needs<br>Guarantee of maintenance results performed by certified and specialised personnel | **NQF/EQF 4** |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | Automation technology studies | **Automation electricians** | **Factory workers, automation technicians, electricians** | **Students of automation technology** | Automated systems in the production lines, in the monitor systems and the product development<br>Certified technicians with state-of-the-art knowledge of the automation systems and tools | **NQF/EQF 5** |
| 3 | Safety specialists' studies | **Factory safety technicians** | **Factory workers, repair mechanics** | **Safety specialist students** | Safety rules in the industrial environment, safety for personnel, costumers and executives<br>Analysis of the work of the safety technicians<br>Specialisation on the dangers and the mitigations measures in an industrial environment | **Not specified** |
| 4 | Developer and analyst studies | **Software developers, data analysts** | **System analysts, developers** | **Developers and analysts (students)** | Learning of the popular programming languages, coding techniques and application development<br>Application compatibility between information systems, data bases<br>Application implementation and integration, application testing and software debugging | **NQF/EQF 5** |
| 5 | Electrician studies | **System electricians, Electrical engineers** | **Factory technicians, automation technicians, repair mechanics** | **Electricians/ Electronics students** | .<br>Differentiate between signals in an electrical circuit and knowledge of counters and systems<br>Definition of combinational systems characteristics and | **NQF/EQF 5** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | knowledge of creating by discrete elements<br>Knowledge of the functionality of the typical commercial combinational devices<br>Knowledge of the difference of a sequential and non – sequential circuits and also their description and devices that are most used | |
| 6 | Industrial asset and machinery technician studies | **Factory technicians, repair mechanics and factory workers** | **Factory workers, heavy and standing machinery operators** | **Industrial asset and machinery students** | Suitable industrial maintenance to prolong the useful life time of products, assets, machinery for better factory performance. Studies of industrial maintenance in critical areas of: electricity, power, programmable controllers and robots, mechanics etc leading to a qualified industrial machinery technician. | **Not specified** |

# 3.2 EXISTING CURRICULA AT NATIONAL LEVEL IN GREECE

During the same stage of our research, the curricula at national level has been looked into. Concerning the sector of non-formal education, Greece has included information on vocational training institutes and existing curricula (just below) is respectfully presented for:

1. Technician of Automation – handles the installations of automated systems, workbenches, tools, measuring and control instruments in the maintenance departments.

2. Technician of Security – handles the safety rules that must exist in the professional premises, among all employees, customers and executives of the company,
3. Software Technician - handles the most popular programming languages, which help him to write code for the implementation of the proposed analysis, to check the compatibility between the proposed solution and information systems design, to manage databases in the development of new applications, but also in the optimization of existing applications, detecting and resolving errors in the software.

## Existing curricula:

1. **School of Automation Technology – NQF/EQF 5**
   https://www.iekdelta360.gr/spoydes-technologias-aytomatismon

   Courses
   a. Automated installations
   b. Industrial electronics
   c. Automated control systems
   d. Industrial informatics
   e. Mechanics
   f. Computer programming
   g. Electronics
   h. Digital electronics
   i. Electrical design
   j. Automation practice
   k. Sensors and measurements

2. **Business Security Technician – NQF/EQF Not Specified**
   https://anko.edu.gr/el/academy/subject/texnikos-asfaleias/

   Courses
   a) Introduction to work safety
   b) National standards and law applications on safety
   c) Organisation of safety on the industrial environment
   d) Safety requirements and risk mitigation techniques

e) Risks on the industrial environment
f) Written essays for risks on the industrial environment

**3. Computer Programming / Computer Software Technician – NQF/EQF 5**
https://iek-akmi.edu.gr/sxoli-programmatismou/

Courses
a) Introduction to Informatics
b) Algorithms and Databases
c) Pascal
d) Computer Architecture
e) Operation System
f) Data communications
g) Web Development
h) Databases
i) C, C++, C#
j) Digital Image Processing
k) Visual Basic
l) Object Oriented Programming
m) System Security
n) Client Server Applications

**Greece overview:**

The main operational focus of this O1/A1 was to undertake deep research and understand the current needs of maintenance professionals, trainees and VET students on a national level taking in consideration the current and existing materials, content, lessons and training courses that are offered in Greece. Even though, factory workers and professionals in Greece are given some opportunities for the development of their skills through novel knowledge delivery mechanisms, it must be noted that still workers need to be equipped with more suitable ICT tools while it is important to train maintenance professionals to properly and safely program, operate and maintain manufacturing systems. Recognising this output, 1Point project will produce training content specialised for the target group needs supporting the continuous improvement of maintenance departments' performance by developing a VET course relevant for maintenance professionals.

# 4.Spain

## 4.1 Collected results in Spain – collection of existing courses, training materials and contents relevant to maintenance

CETEM was in charge to collect the results for Spain on the status and evolution of the maintenance interesting groups.

**SITUATION IN SPAIN – INDUSTRIAL MAINTENANCE IN VOCATIONAL TRAINING: DIGITAL SKILLS**

| 1 | |
|---|---|
| **Name of course** | **Electromechanical Maintenance Technician** |
| **ICSED/EQF** | **ISCED3 / EQF not specified** |
| **Possible occupations** | – Maintenance mechanic.<br>– Industrial fitter.<br>– Electrical equipment fitter.<br>– Electronic equipment fitter.<br>– Automated line maintainer.<br>– Equipment goods assembler.<br>– Pneumatic and hydraulic automatism fitter.<br>– Industrial electrician installer.<br>– Maintenance and repair electrician for control, measurement and precision equipment. |
| **Essential skills** | • Perform the operations associated with the assembly and maintenance of installations.<br>• Gather the resources and means necessary to undertake the execution of the assembly or maintenance of installations.<br>• Propose modifications to installations in accordance with the technical documentation to ensure the feasibility of the assembly, solving problems within his/her competence and reporting other contingencies.<br>• Assemble mechanical, hydraulic, pneumatic and other auxiliary systems associated with electromechanical installations. |

| | |
|---|---|
| | • Assemble electrical and regulation and control systems associated with electromechanical installations, under quality and safety conditions.<br>• Manufacture and/or join mechanical components for the maintenance and assembly of electromechanical installations.<br>• Carry out tests and verifications, both functional and regulatory, of installations to check and adjust their operation.<br>• Diagnose malfunctions of equipment and elements of installations, using appropriate means and applying established procedures with the required safety.<br>• Repairing, maintaining and replacing equipment and elements in the installations to ensure or re-establish operating conditions.<br>• Starting up the installation, carrying out safety and operation tests of machines, automatisms and safety devices, after the assembly or maintenance of an installation. |
| **Course content** | 1. Manufacturing techniques<br>2. Joining and assembly techniques.<br>3. Electricity and electrical automatism.<br>4. Pneumatic and hydraulic automatism.<br>5. Mechanical assembly and maintenance.<br>6. Electrical-electronic assembly and maintenance<br>7. Assembly and maintenance of automated lines.<br>8. Training and job orientation.<br>9. Business and entrepreneurship<br>10. Training in the workplace. |
| **Digital skills** | CAD Software (computer aided design)<br>Basic PLC (Programmable Logic Controller) programming<br>Simple manipulator and/or robot control technologies |
| **Gaps on digital skills** | Lack of introduction to new innovative technologies applied to the industrial maintenance sector such as augmented reality, virtual reality, 3D printing or Lean Manufacturing. |
| **Link to the course** | https://www.todofp.es/que-como-y-donde-estudiar/que-estudiar/familia/loe/instalacion-mantenimiento/mantenimiento-electromecanico.html |
| 2 | |
| **Name of course** | **Higher Technician in Industrial Mechatronics** |
| **ISCED/EQF** | **5** |
| **Possible occupations** | – Technician in planning and programming of maintenance processes for industrial machinery and equipment installations.<br>– Team leader of assemblers of industrial machinery and equipment installations.<br>– Team leader of industrial machinery and equipment installations maintainers. |

| | |
|---|---|
| **Essential skills** | • Configuring industrial mechatronic systems: machinery, industrial equipment, automated production lines, etc.<br>• Plan the assembly and maintenance of industrial mechatronic systems: machinery, industrial equipment, automated production lines, etc., Defining resources, necessary times and control systems.<br>• Supervise and/or execute assembly and maintenance processes of industrial mechatronic systems, controlling times and quality of the results.<br>• Supervise the operating parameters of industrial mechatronics systems, using measurement and control instruments and specific purpose computer applications.<br>• Diagnose and locate breakdowns and malfunctions occurring in industrial mechatronic systems, applying specific operating techniques and procedures, in order to organise their repair.<br>• Establish minimum spare parts levels for the maintenance of machinery, industrial equipment and automated production lines.<br>• Set up the equipment after the repair or assembly of the installation, carrying out the necessary safety and operation tests, modifications and adjustments, on the basis of the technical documentation, ensuring the reliability and energy efficiency of the system.<br>• Programming automatic systems, checking the operating parameters and the safety of the installation, following the procedures established in each case.<br>• Supervising or executing the start-up of the installation's, adjusting the parameters and carrying out the necessary functional and regulatory tests and checks.<br>• Drawing up the technical and administrative documentation to comply with the regulations in force, with the assembly processes and with the maintenance of the installations. |
| **Course content** | 1. Mechanical systems.<br>2. Hydraulic and pneumatic systems.<br>3. Electrical and electronic systems.<br>4. Machine elements.<br>5. Manufacturing processes.<br>6. Graphical representation of mechatronic systems,<br>7. Configuration of mechatronic systems.<br>8. Maintenance and quality processes and management.<br>9. Systems integration.<br>10. Simulation of mechatronic systems,<br>11. Industrial mechatronics project.<br>12. Training and job orientation.<br>13. Business and entrepreneurship.<br>14. Workplace training. |
| **Digital skills** | 3D Surface design |

| | |
|---|---|
| | Computer aided drawing techniques both in 2D and 3D.<br>PLC control programs of an automatic system<br>Automation programming: literal language, contact language, GRAFCET and others.<br>Simulation of the operation of robotic cells.<br>Artificial vision |
| **Gaps on digital skills** | Lack of introduction to new innovative technologies applied to the industrial maintenance sector such as augmented reality, virtual reality, 3D printing or Lean Manufacturing. |
| **Link to the course** | https://www.todofp.es/que-como-y-donde-estudiar/que-estudiar/familia/loe/instalacion-mantenimiento/mecatronica-industrial.html |
| | 3 |
| **Name of course** | **Curso de Especialización en Digitalización del Mantenimiento Industrial** |
| **ISCED/EQF** | **5/5** |
| **Possible occupations** | – Expert in digitisation of industrial maintenance.<br>– Expert in industrial automation and digitisation.<br>– Industrial digitalisation manager. |
| **Essential skills** | • Characterise the types, activities and main indicators if industrial maintenance in order to propose strategies according to the needs of the organisation.<br>• Adapt maintenance activities and procedures to minimise risks associated with the human factor and the type of industry.<br>• Adapt processes and/or machines by incorporating selected digital technologies, taking into account safety, efficiency and sustainability criteria.<br>• Evaluate the improvement in the digitalised maintenance processes by monitoring the evolution of the identified indicators.<br>• Reprogramming and adjusting operating parameters and readapting the system to new operating and monitoring requirements in the maintenance process environment.<br>• Apply industrial communications solutions, performing data collection and integrating data storage systems,<br>• Analyse the information collected as a result of digitisation of maintenance to optimise the processes involved.<br>• Organise and manage the maintenance of installations using digital techniques and applications<br>• Optimise maintenance operations by introducing advanced technologies specific to the sector. |
| **Course content** | 1. Metrology and intelligent instrumentation.<br>2. Industrial maintenance strategies.<br>3. Safety in industrial maintenance.<br>4. Monitoring of machinery, systems and equipment.<br>5. Advanced maintenance support systems. |

| | |
|---|---|
| **Digital skills** | FMEA Methodology (Failure Mode and Effects Analysis)<br>Lean Methodology for continuous improvement<br>5s Methodology applied to maintenance activities.<br>Augmented Reality<br>Virtual Reality<br>Smart Data (collection and analysis of large volumes of data)<br>Computer-aided Design<br>Artificial Vision<br>Sensor programming |
| **Gaps in digital skills** | The specialisation course has a digitisation-oriented content and therefore contains training on Augmented Reality, Virtual Reality and Lean Manufacturing, among others. This course does not include training related to 3D printing, a technology that has become a good ally for the maintenance of industrial equipment and machinery. |
| **Link to course** | https://www.todofp.es/que-como-y-donde-estudiar/que-estudiar/familia/loe/instalacion-mantenimiento/espe-digita-mante-industrial.html |

| **Training on Industrial Maintenance** | **Needs on Current Training** | **Gaps on Digital Skills** |
|---|---|---|
| In July 2020, the Strategic Plan for the Modernisation of Vocational Training was presented with the aim of covering the needs of the labour market in all sectors, including the field of industrial maintenance.<br><br>Currently in Spain there are 10 courses oriented to installation and maintenance, however, only 3 of them are oriented to industrial maintenance, as the rest are based on home maintenance, thermal or refrigeration equipment or smart manufacturing.<br>The Vocational Training (VET) courses aimed at industrial maintenance within the | Training is an essential aspect in any profession, and industrial maintenance is one of the areas of knowledge in which training needs are detected. Specifically,<br>3 out of 4 companies perceive training needs in production, assembly and industrial maintenance and 40% of companies detect a lack of new technologies.<br>On the one hand, there are training needs for professionals, as the technologies used by these professionals are often obsolete and it is necessary to update and obtain training in new technologies in order to be able to apply them at work.<br>The innovations that occur are motivated by the incorporation of new tools, machinery and work | Digitalisation and the incorporation of new technologies was already necessary for any organisation, however, after the current health crisis resulting from Covid-19 it has become a key aspect.<br><br>Within the identified medium and higher vocational training courses related to industrial maintenance, there is a lack of training in digital skills such as 3D printing or additive manufacturing, augmented reality, virtual reality or Lean Manufacturing methodology.<br>However, following the presentation of the Strategic Plan for the Modernisation of Vocational Training, which included |

| | | |
|---|---|---|
| branch analysed are divided into three different levels, on the one hand, the "Electromechanical Maintenance" course is an intermediate level, on the other hand, the "Industrial Mechatronics" course is a higher level, and finally the "Digitalisation of Industrial Maintenance" course is a specialisation course that requires a higher-level qualification in related fields. | equipment or the use of new materials, as well as by the entry into force of new technical regulations.<br>On the other hand, the training needs of Vocational Training students are aligned with the needs of workers in the sector, so that more training is required in new technologies, new tools and work equipment, new materials and technical regulations related to industrial maintenance.<br>Due to these training needs, a Teacher Improvement Plan has been established, which includes various courses related to new technologies aimed at VET teachers. | specialisation courses that allow training to be completed by specialising in aspects demanded by the labour market, the Industrial Maintenance Digitalisation Course was launched, which incorporates a variety of new technologies applied to the sector, such as augmented reality, virtual reality, Lean Manufacturing or Smart Data, among others. |

**AR, VR, 3D & Lean Manufacturing on Vocational Education Training**

As we have observed, AR, VR, 3D and Lean Manufacturing technologies in industrial maintenance vocational training courses can only be found in the specialisation course, however, there are vocational training degrees in other families that incorporate these technologies, for example:

- Higher Technician in 3D Animations, Games and Interactive Environments.

Family: Image and sound
Level: Higher level
Technologies: Virtual reality. Integration of virtual worlds and reality. Augmented reality projects.

- Specialisation Course in Cybersecurity in Information Technology Environments

Family: Computing and Communications
Level: Specialisation course

Technologies: Cloud computing, big data, 3D printing, collaborative robotics, augmented reality, cyber-physical systems and the Internet of Things will be essential to boost Industry 4.0, implement the necessary cybersecurity measures and effectively promote the Circular Economy.

In addition, there are several drafts of future courses that will be available throughout 2021, which include these technologies:

- Specialisation Course of Videogames and Virtual Reality (Virtual Reality and Augmented Reality)
- Specialisation Course on Additive Manufacturing (3D Printing)
- Specialisation Course on BIM (Building Information Modelling) (Virtual and Augmented Reality)
- Specialisation Course on 5G Implementation (Virtual Reality)

**Spain overview:**

The final purpose of Industrial Maintenance could be summarised as follows:

- To avoid, reduce and, if necessary, repair failures on assets.
- Reduce the severity of failures that cannot be avoided.
- Avoid unnecessary stoppages or machines stoppages.
- Avoid accidents.
- Avoid incidents and increase safety for people.
- Maintain productive assets in safe and pre-established operating conditions.
- To reduce costs.
- Reach or extend the useful life of assets.

Because of these reasons, maintenance is considered as a fundamental part of Spanish companies. These tasks are distributed in a balanced way between corrective maintenance and preventive maintenance, with little impact on predictive maintenance. Despite of this fact, in the Spanish context, training has decreased in recent years while computerisation of the aspects related to maintenance is increasing which shows a gap between the current state of technology and the quality of the training (even the skills and knowledge from the workers)- Even though, both employees and those responsible for maintenance receive a high workload which also shows us a gap on the Spanish content, where is most appreciated the quality, costs and availability of the maintenance tasks and workers. In this sense, asset management are beginning to be implemented, being the most widespread Total Productive Maintenance (TPM) or Lean Maintenance.

# 5. Italy

## 5.1 Collected results in Italy - collection of existing courses, training materials and contents relevant to maintenance

DLEARN was in charge to collect the results for Italy on the status and evolution of the maintenance interesting groups.

**Introduction**

Maintenance has been traditionally conceived and regarded as a simple repair of the asset: historically, maintenance was perceived as a "science of conservation". The subject has then evolved over time, gaining an evolutionary character and essence.

Initially perceived as a mere cost for a business, company or entity, maintenance shifted to be seen as a strategic asset, an opportunity for growth and improvement. This way, it acquired the meaning of an investment and added value for the future of any industrial or artisan company. The focus moved therefore along times from conservative and repairing maintenance to a scheduled, preventive and predictive activity, likely to contribute to saving, that's to say to profit.

During the last decades, severe conditionings came from cyclical economic crisis, the last one (apart from Covid-19 pandemic) a few years ago, when all over the world there was a slowdown in consumption and therefore in industrial production. The consequences of this slowdown in production cycle have also invested to a certain extent the maintenance one, but have not stopped the incessant technological development, that involved maintenance too. Indeed, the difficulties that have invested the companies have furtherly emphasized, if possible, the importance to maximize the efficiency of the maintenance of the systems, in

order to avoid waste of money and time. Such dimension of maintenance implies that maintenance techniques are no longer aimed at simply and only maintaining the "status quo", but on the contrary the innovative aspect makes them following and encourage an evolution of the same system, a system which must adapt itself to new needs and requests in order to improve and boost the productivity at a constant rhythm.

**Origins and evolution of the modern concept of Maintenance**

The tradition of maintenance works is old and well-grounded in Italian history and culture along the centuries: in particular, it is during the Middle Age and even more the Renaissance period that the laboratory, at that time called *'bottega'* became central for the subject. In the laboratory, artists, craftsmen and proto-technicians repaired and created objects and tools, and taught each other's skills, competences and techniques. These laboratories can be considered the ancestors of those that today are well known as "FabLab".

FabLabs are places dedicated to learning, testing and innovation, where citizens can create, play, mentor and invent through advanced digital technology (https://www.fablabs.io/). FabLabs are aligned with the new digital era and its fast step forward, such as 3d Printing, Internet of Things, Artificial Intelligence, Lean Manufacturing and Augmented Reality.

In this new context, linked and determined by digital transformation, the role of the Maintenance Technician has evolved and changed too: nowadays, in the industrial panorama, this figure is a necessarily stable and reliable reference point in Asset Integrity, ensuring the efficiency and availability of assets and systems.

Nowadays, the skills required to maintenance technicians are first and foremost technical, but they extend their range to operational and coordination of people and activities, as well as to knowledge of policies and suitable maintenance strategies. In Italy and everywhere in EU, the level of technicians working in Lean Manufacturing and similar contexts can be measured in excellence scale and certified according to the guidelines indicated by the UNI EN 15628 standard.

We are assisting since some time now, to the development of IoT technologies and also to the rising of other digitalization processes, such as augmented reality and artificial intelligence. Even for these technologies, the research and development phase have been underway for years, and the products using those technology have been in the market for some time.
In Italy, despite being one of the most advanced and industrialized countries, the spreading of these digitalization technologies and products has been only sectoral, peculiar to some productive realities and even jeopardized in some cases and areas/fields of industry.

**Industry 4.0 – the digital revolution**

To tackle all of those issues and to assure the inclusion of revolutionary devices, tools and innovation brought by the digital revolution in its industrial structure, since 2016 Italy has been provided by Government an ambitious National Business Plan called “Industry 4.0”. This plan had the objective of mobilizing in the following year (2017) additional private investments for a value of 10 billion, and allocated 11.3 billion of public spending on research, development and innovation with a focus on Industry 4.0 technologies, where 2.6 billion euros were offered for private investments.
The ultimate aim of this economic measure was to encourage businesses and industries to fully adapt and adhere to the fourth industrial revolution. This meant pushing through a mix of incentives, tax reductions, venture capital and training towards four development guidelines:

- use of data and connectivity (big data, open data, Internet of Things, machine- to-machine and cloud computing)
- information analytics.
- interaction between man and machine
- robotics, additive manufacturing, 3D printing, machine-to-machine interactions, communications and new ‘smart’ technologies.

The following years have witnessed an enduring development of the national plan, whose budgets have been gradually allocated to trainings and education of workers and technicians, shifting partially the focus from being able to use correctly machineries and tools of smart manufacturing to the more general issues linked to training and skills gap mismatching.

In 2019 an updated version of the industrial development plan anticipated the quite big changes contained in “Impresa 4.0 Plus”, the last version available and approved some months ago in the outbreak of COVID-19 pandemic.

Each new version of the National Plan strengthened more and more the role of training and competences and the need of educating adequately the human capital. The intervention in terms of incentives and economic investments in (and for) more equipped workers is a necessary must in the Italian landscape, and in the next paragraph we will discover how and why.

The short and long-term availability of digital and interdisciplinary skills is one of the decisive elements for taking the path of modernisation, digitalisation and therefore success of ambitious plan like Industry 4.0 and following versions, willing to contribute to economic development of the country.

Economists and observers of industrial growth agree that employment will increase where there has been an investment in digital skills, and consequently will decline in those that have not acquired them adequately: the challenge of Italian manufacture industry is exactly this one, related to a national context where the main weakness is within the lack of proper training and development of abilities of working people.

**The figures of a digital gap to be bridged**

Skills boosting and competences acquisition is exactly the key knot to detangle: Italy in fact, is one of the European countries where the issues linked to a lack of general ICT skills and lack of innovation within the general education system are more evident: 34% of Italian pupils aged 6 to 17 possesses low digital skills according to ISTAT (national Statistics Institute), qualifying Italy as one of the worst countries in the European Union.

Adding up to this scenario, it is important to take into consideration that also the availability of devices and technical equipment are generally insufficient, and not equally distributed among different territories. In one word: in Italy there is still a big problem of digital divide, that so far policy makers and big investors were not able to solve.

Available data show that between 2018 and 2019, 33.8% of households did not have a computer or a tablet, and only 22.2% had one computer per family member. Moreover, there is still almost a 30% of Italian households who have not access to internet at all, especially in the islands and Southern regions of the Country. Such discrepancy is also reflected in the school environment, with sensitive differences among areas, regions, towns and cities for what concerns scholastic buildings, infrastructures and related services. In such circumstances, how can we imagine to have or to train in a short time a new generation of technical figures working on advanced maintenance with all the necessary skills?

**ITS - High Technical Institutes, a new and modern way to an efficient training**

The future workers, 'to-be' technical, are primarily educated in the so defined High Technical Institutes, shortened in ITS.

The ITS is a high school of excellence with high technological specialization that allows students to obtain the diploma of higher technical. They were established to represent an opportunity of absolute importance in the Italian training panorama. The strategy underneath those technical high schools is based on the connection between education and training

policies on one hand, and industrial policies on the other one: the ITS schools have the mission of forming and educating future workers who can support interventions aimed at the productive sectors, with particular reference to innovation and technology transfer needs of small and medium-sized enterprises. Because of this, at least half of the teachers in each ITS school are company managers and technician themselves, covering roles in real businesses outside the school and- for the same motivation- at least 30% of the duration of the courses is carried out in an actual running company through practical internships.

Who can access ITS? First of all, let's say ITS are not secondary schools, because they represent a post-diploma training opportunity. The formal requisite to attend an ITS is therefore to have at least a secondary school diploma, which means that potentially even graduate people may decide to attend an ITS to acquire specific skills with highly technical and operational content in a certain field.

The students acquire competences which refer to the V level of the European Qualifications Framework for lifelong learning (EQF) if they follow four semesters, while they can reach the VI level EQF staying into ITS education for six semesters. Moreover, the title is accompanied by the EUROPASS diploma supplement. The diplomas are issued by the foundation that gave life to the ITS, on the basis of a national model approved by the Ministry for Education.

Through the ITS system, the Italian approach to technical education is therefore a blended one, combining practical and 'hands on' abilities with a theoretical background. This learning by doing for youngsters willing to become competent maintenance professionals is run in cooperation with companies and business in the attempt of bridging the gap between school system and real, outside world. Theoretically, this approach should grant the expected results, implementing a win-win strategy able to satisfy both the needs of skilled workers by the industrial companies and the job search by youngsters facing a difficult occupational context. Unfortunately, the starting of ITS is not yet sufficiently widespread to meet the needs of the market, as at territorial level not always you reach the conditions of economic agreement to finance their birth and operation.

**A statistic frame of the current situation**

When it is called to close the gap deriving by the shortage of high-qualified people for the industrial sector, the Italian education system still suffers from structural weaknesses and uneven conditions depending on single schools, provinces, territories and entities. A general lack of funds and economic provisions from local administrations also contribute to the worsening of the situation. Such pitfalls resulted more and more evident in 2020 with the outburst of COVID-19 pandemic. Italian Government imposed 'distance learning' since March 2020, speeding up the sudden digitalisation of education. The obligation for schools to go 'digital' and for lessons to be held online was economically sustained by an allocation of 85 million euros, of which 70 million euros designated to the purchase of devices such as computers and tablets for those students who had not. Ultimately, the confused situation given by the sanitary emergency stressed the uneven conditions and differences among regions, provinces, schools and teachers.

The social and economic contexts that were already fragile before the crisis suffered more the sudden shift to online education, with almost 20% of students not able to follow the lessons remotely. The compulsory and abrupt digitalisation of education entered in collision with the generally low level of digital skills of Italian students, belonging to the lower range in Eu-27 as highlighted by various OECD reports. This low preparation and the wide lack of devices and proper infrastructure is also worsened by the conditions of Italian Higher Education teachers. Another research carried out by OECD highlights how the average old age of school staff – 60% of share over the age of 50 years old - is the highest in Europe, factor which is explaining why teachers themselves often show lack of a good level of digital skills.

Technical secondary schools, where maintenance professionals can start their educational journey at the age of 14, are suffering of all those conditions explained above. This is the main reason why the National Business plan Industry 4.0 recalled the need to strengthen the High Technical Institutes (ITS) and to reduce the skills gap of those who works in industry, including maintenance figures and roles, specifically in the fields of Robot collaborators, Additive manufacturing, Augmented reality, Simulation Digital integration and Big Data. Improving the

quality of educational and training offer is crucial for the future of Italian industries, that need to turn the tide of another ranking in which the country is placed in the last positions among the most advanced European economies: workers with appropriate digital skills and participating in permanent training programs are only 8,3%, compared to a European average of almost 11%.

To modernise the curricula and boost the employability of youngsters is hence a priority, even more since the Government has been giving in the last years incentives for the transformation of the manufacturing sector. A tax credit of 40% is granted to companies willing to invest in this area incrementally over the years, together with a future investment of 400 million in ITS to reach the goal of 100,000 students enrolled in the next few years, needed to supply the workforce to the factories of tomorrow.

Funds and economic availability provide a central node in the Italian response and suitable solution to the problem of lack of appropriate skills and trained workers. This issue is, as explained above, rooted in the nature of educational system, where ITS only account a number of students not comparable to the target and to other European economic powers which have way higher numbers (800.000 in Germany, for instance): the cultural bias is still strong in Italy, where technical and practical education and skills are still somehow regarded as 'inferior', or anyway less important comparing to humanistic and theoretical ones. All this despite the fact that it is well known employment will register a positive growth in countries that have invested in digital skills and will consequently suffer a severe decline in those that have not acquired them adequately: a mentality change is also necessary, together with the economic measures and financial support provided by the Government.

Skills are hence at the basis of a decisive production factor: work, on which efforts must now be directed if the productive system of Italy wants to stay at pace with the new machines and disruptive technologies dominating the current digital era. The National Plan needs to come out of the theoretical dimension and become tangible reality: this is certainly a problematic issue, and skills are at the core of its possible solution. But undoubtedly in terms of skills, Italy is in a position of weakness: not only students' skills, as illustrated in the previous paragraph, but also professionals, trainees, VET learners and workers' ones.

Digital skills are ‘The Skills’: they are in fact a fundamental requirement for 70% of the professional figures sought in 2018, becoming a basic "indispensable" requirement for entry into the world of work, as emerges from the “Digital skills report” of the Excelsior information system, coordinated by Unioncamere (Association of Chambers of Commerce) and Anpal (National Agency for Active Labour Market Policies). Digital skills are not only necessary for those companies dealing with digital and information technology, but they are crucially important across all sectors facing Digital transformation and modernisation. Besides, they are a standard requirement even for those professional figures considered as more traditional.

**The reasons of a difficult growth for a technologically advanced maintenance sector**

Maintainers fall exactly in a hybrid category, since their know-how combines digital skills with traditional training (the same is for installers, IT equipment repairers, chemical engineers and many others). Digital skills are therefore the detangling factor that can help soothing the situation and allowing the Government efforts to be put into place and have a tangible and real effect on the Italian industrial productive system, manufacture and maintenance included: if part of the problem is identifiable at school level – technical secondary schools and then ITS - another issue is the low level of professional skills, a challenge that lies in training, not only in school. As stated above, Italy is at the last positions of European ratings for percentage of workers engaged in permanent training programs, and this is the result of a cultural approach where training is somehow still considered by entrepreneurs an extra expenditure and not, as it should be, an investment in the future of the country. The lack of long-life learning for maintainers and technical workers is aligned hence with (and partially the result of) the reality of Italy in terms of productivity and industrial system, whose structure is mainly composed by companies belonging to medium and small enterprises, often family-run.

In Italy, family-run businesses represent far more than 85% of the total, and account for about 70% of the country's total employment. But among family business, people covering

managerial roles often lack the skills to adopt and manage new and complex technologies which require new digital skills and innovative, different competences. Furthermore, another element discourages workers and especially the technical ones from following educational paths all along their careers: the level of wages in Italy is often related to the age and experience of the worker rather than to individual performance, a characteristic that discourages employees from an intensive use of skills in the workplace and the attainment of further specializations and high-level trainings. This mix of factors places Italy at the top of the ratings among OECD countries for skills mismatch, positioning and trapping the country in a situation defined of low-skill equilibrium. In fact, the status quo is characterised by a generalized low-skill level: a situation in which low-skill supply in production and maintenance sectors is accompanied by a weak demand from the wide basis of micro and small companies. And this occurs exactly because of the structure of the productive system, ruled by micro, small and medium realities. While many relatively large companies compete successfully on the global market, there are many others which represent the majority that operate with low-skilled management and lower-productivity workers. This is combined also with low investments in technologies and with poor adoption of work practices that would improve productivity: as reported by Marco Taisch, Professor of School of Management at Polytechnic University in Milan and collaborator to the implementation of Industry 4.0, the most relevant competence for companies is *"…the ability to define a plan for the adoption of technologies for the improvement of production processes".* In particular, Professor Taisch evidences the critical areas for the digital transformation of small and medium enterprises, saying that

"*…More practical actions such as the use of digital devices (for which 50% are not ready) or crucial issues for 4.0 such as predictive maintenance leave 60% of companies behind. 65% of companies are not well versed in the management of man-machine interaction. There are percentages close to 70% of companies "unprepared" for functions such as the simulation of production scenarios or the programming and management of robots; not to mention virtual and / or augmented reality which is not yet in the ropes of 80% of SMEs*".

The words of a Professor who is touching with hand the reality of low-skill equilibrium form, which Italy is suffering nowadays, put the emphasis on the need of filling the gap between

education, general culture and perception of workers and employers and the needs of competences and skills adequate to the new technologies. Under this light, the role of education and long life learning is key: an evolution of curricula targeting future maintenance professionals is very much necessary in the Italian context in order to avoid the current vicious cycle where already low-qualified workers are not pushed (if not openly discouraged) from gaining higher level of skills and competences in their technical field, and where many industries do not invest in modernization because of a cultural bias and an insufficient skills level of their managers and decision making figures.

Numbers show well this stagnant position: for instance, only three years ago (end of 2017) there were still at least 60,000 vacant positions in industrial sector due to a lack of qualified personnel. In Italy, the high-skilled maintenance professional is therefore one of those almost unobtainable figures yet essential for the success of corrective measures implemented and sponsored by Government.

Today, given the rapidity of changes, the school is unfortunately not yet able to manage the new paths desirable to cope with the sudden innovations. If schools still cannot align totally with this new need, it therefore becomes unavoidable to give students and future workers those new elements that will allow them to enter the world of work more easily and that will partially bridge the gap with labour market requirements. Training offer – both at school and adult education level- should evolve and ensure that the indispensable basic knowledge on the principles of maintenance activities is accompanied by ICT knowledge and competences and technical and managerial character: in such respect, the so called 'soft skills' or transversal skills are gaining a major importance, in particular problem-solving ones.

**ITS, FabLabs and further opportunities to improve maintenance skills for the industry of the future**

As already highlighted in the previous paragraphs, some experts have identified the FabLabs and ateliers as ideal arenas for the promotion and boosting of the new skills for the maintenance workers, whose acquisition is also the result of a change in the mentality of the

maintainer who, from being a passive actor of the system, must increasingly become an active and proactive actor. The FabLab and moreover the 'neighbourhood-laboratory' are the favourite places where to feed this change and where to start matching education and employer needs. In this sense, the collective knowledge and the exchange of competences can be a valid input towards alignment of resources and requirements.

Competence centres, instituted with the national plan in February 2019, work exactly in this direction. Those centres are examples of excellence for Industry 4.0 and scattered mainly in Northern Italy but somewhere also in Southern regions - Turin, Milan, Bologna, Genoa, Padua, Pisa, Rome and Naples. The centres involve about 400 companies and over 50 universities in close partnerships: their task is to provide orientation and training on advanced technologies in Industry 4.0. The Centres support and favour the implementation of projects fostering innovation, industrial research and experimental development through creation of new techniques, products, processes and services. Centres are born with the main objective of letting Industry and education system cross in a 'laboratory-like' space which can represent the starting point for the uptake of all the changes which the figures of maintenance worker need to necessarily meet, and the new challenges brought by digital revolution whom fulfilment is key to the perseverance of technical professional.

The picture of the current situation is the existence in Italy, at least on paper, of a wide range of opportunities for young people who independently decide to train for the maintenance of industrial plants with high technological content and for companies that want to advance the level of their maintainers. In addition to ITS and competence centres, it is worth to remind that universities and private training centres too, sometimes through synergies between different actors, offer specialization courses for maintenance technicians at companies that produce with lean manufacturing criteria, using 3d printing, Internet of Things, augmented reality etc.

It is not possible to define an exhaustive list of all the training paths available in Italy for enhance-skilled maintainers, but limiting our gaze to the most industrialized regions of the North (Lombardy, Veneto, Piedmont and Emilia Romagna), we can summarize the most important training opportunities in the following table:

| Title of the Training path | Organizers | Brief description and link | NQF/EQF LEVEL |
|---|---|---|---|
| University Master MEGMI - Management of Industrial Assets and Maintenance (16th edition) | Polytechnic University of Milan and School of Management of the University of Bergamo | The master course lasts 18 months and aims to meet the need from the world of production companies and services to have high-profile managerial figures in the area of maintenance. https://sdm.unibg.it/corso/megmi-i-livello/ | Generally speaking, the level for this course is **NQF7**, just because it's a course being managed by universities as a master diploma. BUT: for the admission, a degree in engineering or scientific disciplines is preferable but not mandatory. In fact, it may be considered, after evaluation of the adequacy of the individual professional background, the admission of candidates in possession of the qualification of secondary school. At the end of the course, these candidates will be awarded the Diploma Executive in Industrial Asset Management and Maintenance, that is not a degree or a |

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| | | | master after degree. In this case, the level we can consider would be **NQF5.** |
| Master in Asset Maintenance and Management | Festo Academy (Assago, Milan) | The master (184 hours of lessons) provides for the transfer of know-how for a new culture of maintenance that knows not only to intervene effectively on the failure, but also predict and plan, to exceed the traditional cost requirement and become an important saving item. https://www.festocte.it/academy/manutenzione_gestione/master_manutenzione_e_gestione_degli_asset/?mid=80E1952E5D084F7AA3665BFB31CEED13&gclid=EAIaIQobChMIi4aQzpDj7gIVhrrVCh1W4gsLEAAYASAAEgJjMfD_BwE | This course is a Master, although not managed at university level. Nevertheless, it is recognized at European level by the European Federation of National Maintenance Societies (CEN/TC319/WG9 Qualification of Maintenance Personnel). The EQF/NQF of this course is not specified, but it is valid as **NQF5.** |
| ITS paths that use Industry 4.0 enabling technologies in | Network of High Technical | Two-year post-diploma courses for the progressive application | **EQF5** |

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|---|---|---|---|
| educational activities, as tools to learn and create smart products for each area. | Institutes (ITS) managing courses oriented to the Plan Industry 4.0 | of digital methodologies and tools in all phases of production and management of products and services. https://sistemaits.it/?p=industria-4 | |
| Maintenance of industrial assets as a competitive advantage for the company | TUV Italy and Unipro s.r.l. (Bologna) | Brief course. The integration of the tools related to the Industry Plan 4.0 is shifting the task of the employees operating in the area of maintenance from planners and performers of the interventions themselves to analysts and decision makers of the interventions to be carried out. https://www.tuvsud.com/it-it/store/italia/catalogo-formativo/asset-maintenance-management-it/MANT4_IT | EQF level is not specified, but we can compare it to EQF5. It is a short course, to update maintenance managers' available knowledge.<br>The course provides for the issue of credits for the mandatory updating of professional figures for prevention and protection. |
| The Management of the Plant Maintenance | CIS – Scuola per la | This brief course aims to train managers and | EQF level is not specified, but we can |

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|---|---|---|---|
| System with a view To Industry 4.0 | Gestione d'Impresa – Reggio Emilia | managers involved in improving their organization beyond the concepts of preventive, extraordinary and predictive maintenance. https://www.cis-formazione.it/it/corso/479/LA+GESTIONE+DEL+SISTEMA+MANUTENZIONE+DEGLI+IMPIANTI+IN+OTTICA+DI+INDUSTRIA+4.0 | compare it to EQF5. The course is dedicated to maintenance management of the equipment and the plant; maintenance managers, manufacturing and operational managers, consultants and professionals. |

With the exception of ITS and university masters, the training courses currently available in Italy are short-lived and have no content directly related to the high-tech sectors 1Point intends to investigate. It is therefore confirmed the need to propose a specific training course as the one that the project aims to structure and make later available to the world of industry and training.

**Italy overview:**

The extraordinary technological development that is at the basis of the concept of Industry 4.0 has determined in the industrial sector a further awareness of the strategic value of the dynamics related to the maintenance of plants and equipment.

In Italy as elsewhere, however, there is a glaring asymmetry between the needs of industries and the availability of manpower with the necessary requirements. When talking about maintenance, it has become common practice to refer to highly qualified technical personnel who are entrusted with the management of production processes based on Total Productive Maintenance and on the use of advanced technologies such as 3D printing, augmented and virtual reality, etc.

For this reason, the Italian vocational training sector has begun in recent years to take note of this new industrial reality and is organizing itself to propose - in a still fragmentary and disorganized way - specific training courses, all oriented to a medium-high professional standard, often in the form of Master's degrees for managerial profiles already inserted in the business dynamics. Thanks to far-sighted policies which, in the last six-seven years, have grasped the importance of public investment in a concept of industry oriented towards the future and advanced technology, an attempt to overcome the gap separating Italy from the average of other European countries in terms of the widespread diffusion of digital tools and knowledge is making headway. This is a process that also involves the training of maintenance technicians, both young and already experienced, whose effectiveness and efficiency can find an answer in the innovative model proposed by 1Point.

**References:**


https://italicsmag.com/2020/06/03/digitalization-of-the-school-system-due-to-the-coronavirus/)

https://www.istat.it/it/files//2020/04/infograficapcTablet.pdf

https://www.fablabs.io/

https://www.manutenzione-online.com/fileadmin/user_upload/MANUTENZIONE-MAGGIO-2020.pdf

https://www.industriaitaliana.it/lavoro-4-0-la-digital-transformation-ne-ha-bisogno-ora/

https://scuola24.ilsole24ore.com/art/scuola/2019-12-02/competenze-digitali-indispensabili-7-lavoratori-10-175906.php?uuid=ACY2uo2&refresh_ce=1

https://www.rivistacmi.it/articolo/approfondire-le-competenze-verso-la-digital-transformation-la-manutenzione-e-sul-pezzo/

https://www.jobbydoo.it/descrizione-lavoro/manutentore-meccanico#:~:text=La%20formazione%20necessaria%20per%20diventare,idraulica%2C%20impiantistica%20e%20automazione%20industriale.

https://www.assoeman.it/wp-content/uploads/2016/07/manutentore-4.0.pdf

https://www.economyup.it/innovazione/cos-e-l-industria-40-e-perche-e-importante-saperla-affrontare/

https://sistemaits.it

https://www.miur.gov.it/tematica-its#:~:text=Gli%20ITS%20sono%20scuole%20di,lavoro%20con%20le%20politiche%20industriali.

# 6. Cyprus

## 6.1 Collected results in Cyprus - collection of existing courses, training materials and contents relevant to maintenance

HESO was in charge to collect the results for Cyprus on the status and evolution of the maintenance interesting groups.

### Industry 4.0 And Job Market in Cyprus

Currently, manufacturing processes are becoming increasingly digital, and along with the information technology, data and analytics, lead the way to another industrial revolution that urges businesses to move towards a new era, capitalising on smart machines, factories, products and services, utilizing new interaction models and going beyond the automation of production.[1] This new era is known as the "Industry 4.0", commonly referred to as the Fourth Industrial Revolution.

The Fourth Industrial Revolution, otherwise referred to as Industry 4.0, incorporates technologies from digital, physical and biological spheres. In general, Industry 4.0 relates to the concept of smart factories, where machines are connected through the web to a system, which is able to conceptualize the whole production line and engage into decision-making processes on its own.

Making full use of its strategic position at the crossroads of Europe, Asia and Africa, Cyprus, has always relied on trade for the development of its economy, facilitating the access of the island's main industrial products (such as pharmaceuticals, food and beverages, clothes,

[1] https://www2.deloitte.com/content/dam/Deloitte/cy/Documents/innovation-and-entrepreneurship-%20centre/Industry%204.0%20readiness%20report%202019.pdf

minerals, machinery and equipment) to international markets. In Cyprus, there are 5.300 manufacturers, the majority of which are small and medium sized, mostly family owned. Most manufacturing companies have less than ten employees and only seven are large, i.e., employ more than 249 people.[2]

Cyprus has also a small, predominantly service-based economy, with tourism, financial services and shipping being the important sectors. However, the manufacturing sector is fast growing, reaching a 2% increase every year since 2016. High-tech job covers a 7.3% of employment share in 2018 while forecasts say that the manufacturing sector in Cyprus will grow 23.4% over the next 10 years.

The main growth areas in manufacturing in Cyprus, have been in the ICT sector, manufacturing parts, instruments and electronics, as well as consumer products such as cosmetics. Some of the most established export industries are those of the production of pharmaceuticals, cement and fabricated metal items. Findings from the latest published Industrial Statistics of Cyprus reveal that, while the manufacturing of food products is the activity with the highest contribution of added value of the industrial sector, the biggest export segment within manufacturing is pharmaceutical products (34,6%). This is followed by food products (32,2%) and non-metallic mineral products (9%). [3]

Manufacturing is the most important sector of industrial activity in Cyprus and it accounts for 72% of total industrial production[4]. According to the Statistical Service of the Republic of Cyprus, industrial production seems to be recovering from its 2013 all-time low performance.

[2] Statistical Service (2017) Business Registry, 2016. Available at: http://www.mof.gov.cy/mof/cystat/statistics.nsf/All/8A220DD4941EDCA9C225803500304320/$file/ENTERPRISES_NACE2_SIZE-2016-16117.pdf?OpenElement

[3] Statistical Service (2018) Industrial Statistics, 2016. Available at: http://www.mof.gov.cy/mof/cystat/statistics.nsf/All/762D9FE76879C461C22577D2003627BC/$file/INDUSTRIAL_STATISTICS-2016-260618.pdf?OpenElement
(The Statistical Service of Cyprus publishes Industrial Statistics annually. The latest publication was Industrial Statistics, 2016, released on the 26th of June, 2018)

[4] Industrial production measures the output of businesses integrated in the industrial sector of the economy..

## Related jobs

Even though manufacturing is the largest part of the industrial sector, in 2016 it employed just over 30.000 individuals (9% of the total labour force of the country)[5]. The growth of industrial activity in recent years has not led to a similar increase in this number, whereas expenditure in fixed assets increased, suggesting that enhanced automation processes most probably lead the productivity increase. In regards with occupations in the manufacturing sector, the highest concentration is found in manufacturing workers, machine and plant operators and construction workers, with 3340, 3224 and 2479 working professionals respectively. Although the numbers are big for a small manufacturing sector, only a fragment of these professions are related to Industry 4.0 and the technologies involved. After conducting a thorough research through the web for job openings in Industry 4.0 related fields, the results do not look promising. The research contained the following websites:

- linkedin.com
- indeed.com
- monster.com
- kariera.gr
- cypruswork.com
- cyprusjobs.com;
- grsrecruitment.com
- carrerfinders.com.cy

The most related job to Industry 4.0 and its various technologies are as follows:

- BI Specialist (Data Science and Consulting)
- Automation Engineer
- Software Engineer for Robotic Systems

[5] Statistical Service (2017) Business Register, 2016. Available at: http://www.mof.gov.cy/mof/cystat/statistics.nsf/labour_33main_en/labour_33main_en?OpenForm&sub=3&sel=4 (The Statistical Service of Cyprus publish the Business Register annually. The latest publication was Business Register, 2016, released on the 26th of November, 2017)

- Cloud Architect and Software Developer (Java/Cloud/Android)

Our research revealed that there is a higher demand on IT related jobs compared to manufacturing and other industries related to Industry 4.0, which led us to the conclusion that IT growth overcomes any other relevant industry in Cyprus.

## Skills & Competences

As digital transformation and the Fourth Industrial Revolution continue to redefine manufacturing jobs of the future, a mismatch between available workers and the skills necessary for open jobs is created. The industry is expected to blend advanced technology and digital skills with unique human skills to yield the highest level of productivity. Consequently, a company's success in implementing Industry 4.0 processes heavily depends on having a workforce with the right digital skills, technical knowledge and soft skills (i.e. strength in agility, continuous learning, interpersonal communication, and proactive problem-solving skills).
The most popular skills, for Industry 4.0, that our research revealed are:

- Programming (various languages)
- Data analytics and visualization
- Artificial intelligence
- Automation engineering
- Systems engineering
- Robotics

Education relevant competences are:

- Business Intelligence
- Data Science
- Computer Engineering
- Computer Science
- Mechanical Engineering
- Software Engineering

Required experience:

- For IT relevant jobs, minimum 2 years of working experience in similar positions.
- For Engineering relevant jobs, minimum 5 years of working experience in similar positions.
- Some IT positions did not require any prior experience.

In terms of soft skills, employers are mostly looking for the following:

- Analytical skills
- Critical thinking
- Flexibility
- Ability to working effectively in teams
- Reliability, integrity and positive attitude

| Title of the Training path | Organizers | Brief description and link | NQF/EQF LEVEL in Cyprus |
|---|---|---|---|
| BSc in Mechanical Engineering | University of Nicosia | This is a Bachelor of Science in Mechanical Engineering can either be completed part-time or full-time and its duration (when full-time) is 4 years. It aims at preparing graduates to became successful professional engineers that are familiar with state-of-the-art technological tools and can cope with technological challenges in the field https://www.unic.ac.cy/mechanical-engineering-bsc-4-years/ | **NFQ Level 6**: UNIVERSITY DEGREE (PTYCHION/BACHELOR'S DEGREE) |
| CO2 Cooling Systems, (RV 44) New Technologies | Cyprus Productivity Center (KEPA), Larnaca | This 60-hour long seminar plans to familiarize various specializations in the VET sectors (technicians, engineers, consultants, | **NFQ Level 5**: Post Secondary Certificates and Diplomas |

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| | | maintainers) with alternative, environmentally friendly technologies and urge them to use them at their work. https://www.myseminars.com.cy/en/seminar-detail/15465/psiktika-systimata-co2-rv44-Nees-technologies | |
| Geoinformatics and Geospatial Technologies | Cyprus University of Technology, Limassol | This master's program is addressed to graduates of recognized institutions of higher education (Universities and Polytechnics) in cognitive subjects related to Geoinformatics and its applications and to enable graduates to deepen and expand their knowledge in the scientific field of Geoinformatics and state-of-the-art Geospatial Technologies, as well as in their practical applications. https://www.cut.ac.cy/faculties/fet/ceg/programmes- | **NFQ Level 7**: MASTER'S DEGREE |

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|---|---|---|---|
| | | of-study/postgraduate/msc-geoinformatics/?languageId=100 | |
| Management, Technology and Quality | Open University of Cyprus, Nicosia | This master's program's aim is to provide specialised knowledge and practices in the fields of Management, Technology and Quality. In addition, to give graduates the opportunity to apply this knowledge and skills in their working environment. https://www.ouc.ac.cy/index.php/en/studies/programs/master/studies-degrees-master-dtp | **NFQ Level 7**: MASTER'S DEGREE |

## National Policy

According to an Industry 4.0 readiness report for Cyprus by Deloitte, developing an Industry 4.0 strategy in Cyprus, companies will need to consider the below:

- Customer – providing an experience where customers view the organization as their digital partner.
- Strategy – focuses on how the business transforms or operated to increase its competitive advantage through digital initiatives.
- Technology – underpins the success of digital strategy by helping to create process, store, secure and exchange data to meet customer needs.

- Operations – executing and evolving processes and tasks by utilizing digital technologies.
- Culture, People, Organization – defining and developing an organizational culture with governance and talent processes to support progress along the digital maturity curve.

Concerning skills and jobs, the industry is expected to blend advanced technology and digital skills with unique human skills to yield the highest level of productivity. Consequently, a company's success in implementing Industry 4.0 processes heavily depends on having a workforce with the right digital skills, technical knowledge and soft skills, namely strength in agility, continuous learning, interpersonal communication and proactive problem-solving skills.

Therefore, the Cypriot government has introduced a new holistic and integrated national industrial strategy (2017-2030), which mission is the development of innovative products and high value-added services that contribute to sustainability, competitiveness and extroversion of the Cypriot industry. Its main objective is to increase the industry's productivity, innovation, and exports and its contribution to the country's Gross Domestic Product.

This Strategy has 5 strategic pillars:

- Digitization of Industry
- Developing new skills and enhancing / upgrading existing skills
- Improvement of the industrial / business environment
- Enhancing access to finance
- Enhancing access to markets.

**Cyprus overview:**

Summarizing the above, we can come to two conclusions:

1. Cypriot companies are not ready yet to shift to Industry 4.0 and related technologies. Job openings and skills required are focused more on IT, computer engineering and related sciences rather than robotics, AR/VR technology, additive manufacturing and/or digitalization of the industry.
2. Cypriot companies might neglect the fact that the new era of interconnectivity and digitalization has already arrived, and might not be aware of the various benefits that come with Industry 4.0 technologies, such as improved productivity and quality of product and services, better asset efficiency, rapid prototyping, customization and big data analysis.

Manufacturers will need to start shifting to Industry 4.0 if they are not to be left behind by the developments and their competitors both in-land and abroad.

# 7.ESCO web search on maintenance training field: LEAN manufacturing, AR, VR and 3D printing

Below we are listing the results most related to maintenance training field according to 1Point project ESCO web search.

| Occupations | Code | Description | Alternative label |
|---|---|---|---|
| **3D printing technician** | 3118.1 | 3D Printing technicians assist in the designing and programming of products, ranging from prosthetic products to 3D miniatures. They may also provide 3D printing maintenance, check 3D renders for customers and run 3D printing tests. 3D printing technicians can also repair, maintain and clean 3D printers. | 3D printing field service technician<br>3D printer operator<br>prototyping technician<br>printer repairer<br>3D printing technician<br>3D printer repairman<br>printer technician<br>printing field service technician<br>3D printing operator<br>3D printing repairman<br>3D print service technician<br>3D printer repairer<br>3D printing prototyping technician<br>3D printing repairer<br>printing machine technician<br>print service technician<br>printer repairman |
| **digital media designer** | 2166.8 | Digital media designers create and edit graphics, animations, sound, text and video to assist in the creation of integrated multimedia products. They may perform activities related to the web, social networks, augmented reality and virtual reality but exclude the production of music using physical instruments and complex software sound synthesis tools. Digital media designers may program and build websites, mobile applications and other multimedia products. | digital media developer<br>interactive media designer<br>new media designer<br>multimedia developer<br>digital media designers<br>digital multimedia designer<br>digital media engineer |
| **3D animator** | 2166.3.1 | 3D animators are in charge of animating 3D models of objects, virtual environments, layouts, characters and 3D virtual animated agents. | 3D animators<br>computer-generated imagery animator<br>3D designer<br>CGI animator<br>CGI designer |

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|---|---|---|---|
| **3D modeller** | 2166.1 | 3D modellers design 3D models of objects, virtual environments, layouts, characters, and 3D virtual animated agents. | 3D modellers<br>3D texturing artist<br>3D specialist<br>3D developer<br>3D artist<br>computer-generated imagery modeller<br>CGI modeller |
| **lean manager** | 2421 | Lean managers plan and manage lean programs in different business units of an organisation. They drive and coordinate continuous improvements projects aimed at achieving manufacturing efficiency, optimise workforce productivity, generate business innovation and realise transformational changes impacting on operations and business processes, and report on results and progresses to the company management. They contribute to the creation of a continuous improvement culture within the company and they are responsible for developing and training a team of lean experts. | lean expert<br><br>process excellence manager<br><br>manufacturing excellence manager<br><br>continuous improvement manager<br><br>operational excellence manager<br><br>lean engineer<br>lean facilitator<br>lean coach<br>lean project manager<br>lean director<br>kaizen manager |
| **industrial maintenance supervisor** | 3115.1.6 | Industrial maintenance supervisors organise and supervise the activities and maintenance operations of machines, systems and equipment. They ensure inspections are done according to health, safety and environmental standards, and productivity and quality requirements. | maintenance machine adjuster supervisor<br><br>maintenance machine shop supervisor<br><br>maintenance work supervisor<br><br>maintenance machining and assembly supervisor<br><br>leading maintenance machinist<br><br>lead maintenance operative<br><br>maintenance machining department supervisor<br><br>maintenance machining and assembly manager<br><br>machine setter supervisor<br><br>maintenance machine charge hand |

| | | | |
|---|---|---|---|
| | | | maintenance machine shop manager<br><br>maintenance machine team leader<br><br>maintenance machining supervisor<br><br>maintenance and assembly team leader<br><br>maintenance machine and assembly maintenance team leader |
| **predictive maintenance expert** | 2152.1/ | Predictive maintenance experts analyse data collected from sensors located in factories, machineries, cars, railroads and others to monitor their conditions in order to keep users informed and eventually notify the need to perform maintenance. | predictive maintenance engineer<br><br>predictive maintenance expert |
| **maintenance and repair engineer** | 2141.7 | Maintenance and repair engineers focus on the optimization of equipment, procedures, machineries and infrastructure. They ensure their maximum availability at minimum costs. | machine engineer<br>mechanical engineer<br>production engineer<br>plant repair engineer<br>site superintendent<br>manufacturing engineer<br>repair engineer<br>maintenance engineer<br>manufacturing systems engineer<br>maintenance and repair superintendent<br>maintenance and repair manager<br>equipment engineer<br>plant maintenance engineer<br>engineering manager<br>plant engineer |
| **industrial machinery mechanic** | 7233.7 | Industrial machinery mechanics work on new machinery and equipment in operation. They set up for the specific application and build accessories, if necessary, perform maintenance and repair, and run diagnostics to find faults in systems or parts that need replacing. | mechanical fitter<br>industrial machinery repairer<br>electronic fitter<br>industrial machine inspector<br>engineering fitter<br>mechanical engineering fitter<br>industrial machinery inspector<br>industrial machine repairer<br><br>industrial machine maintenance engineer<br><br>electrical engineering fitter<br>industrial machinery fitter<br>industrial machine mechanic |

| | | | |
|---|---|---|---|
| | | | industrial machinery maintenance engineer<br><br>industrial machine fitter |
| | | | |

**ESCO V1.1: Consultation on the pre-release 15.12.2020**
**Excell document → Lean manufacturing (only Knowledge type and not Skill type):**

https://www.esco-projects.eu/esco/portal/skill?uri=http://data.europa.eu/esco/skill/82fea746-853f-4f1b-8ab7-55de8619cccd

# Conclusion

In order to assure European relevance of the ECVET profile and guarantee perfect correspondence to the training needs of the target group, an initial phase of research was conducted. We analysed in more depth the current learning needs and the digital skills-gap of maintenance professionals, trainees and VET students and also on national level. The consortium conducted a comparative analysis on maintenance trainings offered in each partner country and checked the existing curricula. We got an overarching view of existing courses and a list of national qualifications that may be relevant for the ECVET profile.

In general, we can state that in Maintenance sector there are lacks in digital skills especially between younger and elder interesting group, and of course in knowledge level in the fields of AR, VR, 3D printing, Lean manufacturing and maintenance. The first two are new emerging technologies and are important tools of Industry 4.0, which can be used to faster boost the knowledge level in Maintenance sector and they are still more and more arising in several EU countries, industrial companies, school facilities and training centres.