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WirelessUP!

UPraising VET skills for innovation in European electrotechnical sector

Project number: 2017-1-HR01-KA202-035434

WirelessUP! Training Module

Intellectual Output 2

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Acknowledgments

Lead partner of Intellectual Output 2:

Obrtničko učilište – ustanova za obrazovanje odraslih

Partner contributions:

Country	Partner Institution
Croatia	Elektrotehnička škola Zagreb
Czech Republic	Smíchovská střední průmyslová škola
Germany	Berufsschule B1 Nürnberg
Slovenia	Šolski center Krško-Sevnica
Turkey	Afyon Kocatepe Üniversity, Bolvadin Vocational School

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Introduction

In the emerging era of Digital Economy and Industry 4.0 the vocational education and training are lacking behind with delivering relevant offers and skills for new VET professionals. The WirelessUP! project aims at delivering new and innovative learning contents in the sector of electrotechnics. The sector is chosen because it is the sector which has cross-cutting influence and covers the field of building, industry and automatization.

Internet and wireless technology are changing the economy of tomorrow, called digital economy. It will revolutionize every commercial sector, disrupt the workings of virtually every industry, bring with it unprecedented new economic opportunities, put millions of people back to work, and create a more sustainable low-carbon society to mitigate climate change. Hand in hand with the process of digitalization emerges Industry 4.0 which refers to the fourth industrial revolution that creates gaps in productivity and changed people's behaviour throughout the world. Industry 4.0 is the transformation of the whole industrial production through the application of digital technology to the traditional industry. One of the key communication aspects in Industry 4.0 and Digital Economy are sensors. Sensors are embedded into every device and appliance, allowing them to communicate with each other and Internet users, providing up to the moment data on the managing, powering, and moving of economic activity in a smart Digital Europe. Already, 14 billion sensors are attached to resource flows, warehouses, road systems, factory production lines, the electricity transmission grid, offices, homes, stores, and vehicles, continually monitoring their status and performance. By 2030, it is estimated there will be more than 100 trillion sensors connecting the human and natural environment in a globally distributed intelligent network.

WirelessUP! – The Project

The WirelessUP! project recognises the shift in the digital economy and Industry 4.0. It thus seeks to develop a new vocational module which will contribute to the further strengthening of key competencies in VET curricula in the electrotechnical sector according to the needs of Industry 4.0 and Digital Economy. Alongside the module, a new toolkit for VET students and learners will be developed to facilitate the gaining of new skills. The skills benchmarking model in form of local and transnational competitions will be developed to assess and compare the skills of VET students and learners from different countries learning the same module. Through all the involvement of VET students and learner accent will be put on gaining practical skills, as key skills that are directly applicable and usable in the VET expert labour market.

The WirelessUP! project aims at contributing to :

1. smart growth by closing the gap between the set of traditional competences used to predict performance within VET organizations and the new challenges set by the digital economy. Specifically the project will focus on implementation of wireless communication between sensorial technologies within existing VET curricula for smart and sustainable houses and industry.

2. sustainable growth by focusing and developing competencies for energy efficiency solutions in order to turn the digital economy into a knowledge-driven sustainable business, with higher productivity and higher skilled employees. The project aims at upskilling digital competencies and spreading the digital culture.

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3. inclusive growth by providing through VET training “a more skilled workforce, capable of contributing and adjusting to technological change with new patterns of work organisation” (Agenda for New Skills and Jobs).

The project has identified some specific needs that refer to its target groups, namely:

1. VET students and learners – New Wireless-UP! training module for wireless technologies among sensors will be implemented to support professional growth, job opportunities and company competitiveness with a double effect: to generate new jobs and change the existing jobs.

2. VET teachers/trainers – New skills opportunities mean, however, demand for new skilled VET providers, not only among new recruited but also among the present staff.

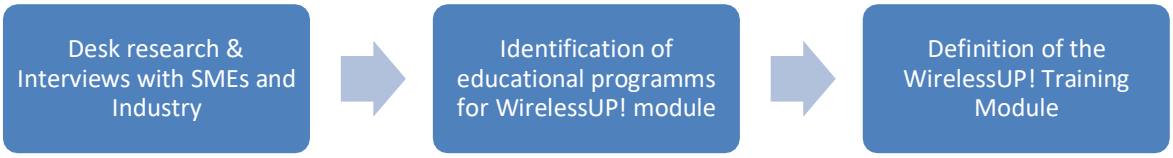
3. SMEs and Industry - Employers and training providers will have to agree changes to restructure and modernize existing curricula and training pathways as well as to retrain trainers, including professional skills in new technologies as pillars of training courses.

Intellectual Output 2: WirelessUP! Training Module

Methodology

The base for the development of the Intellectual Output 2 WirelessUP! Training Module is the product of Intellectual Output 1 “Recommendations for local implementation of smart systems in VET for industry 4.0”. The aim of the Recommendations is to provide a baseline for implementing an educational framework of the Wireless-UP! training module. The Recommendations provide a first step in the development and implementation of the WirelessUP! educational module. The methodology helps understanding current and future labour market demand, and how it will shape both the need to reskill the current workforce and vocational training for young people and helps to formulate skills development in the electrotechnical sector.

The methodology of the output is set as following:



At the desk research partners have used a variety of secondary data from internal sources, the internet, libraries, associations, government agencies, published reports as well as national and EU strategies. The desk research included the socio-economic base of each partner country, an overview of the national VET system of partner countries and a definition of a best practice example in VET electrotechnical sector in each partners’ institution. The research has shown the similarities and differences of the VET system and current status in partner countries as well as in the electrotechnical sector. Furthermore, good practice examples showed how factors of supporting innovation or fostering and enhancing competences can improve the VET electrotechnical sector.

Besides defining the socio-economic context and investigating good practice examples, the partners have conducted interviews with relevant SMEs and Industry in the electrotechnical sector. The 14

interviews collected in partner countries provide data for understanding the needs of employers, their status and goals toward Industry 4.0 principles as well as recommendations for changes in the VET electrotechnical sector.

The third step in the development of the Intellectual Output 1 was the identification of the present vocational education and training programs the new WirelessUP! Training Module could be implemented. Following the set methodology, the partners have identified altogether 28 occupations and 39 courses/subjects within the occupations in 5 partner countries which are suitable for implementing the new WirelessUP! Training Module. The Recommendations offer a detailed description of the level, duration and key competences of identified qualifications and for each qualification the level and learning outcomes of the identified subjects.

When developing the WirelessUP! Training Module, the partners have used the CEDEFOP definition of curricula, namely: "inventory of activities implemented to design, organize and plan an education or training activities, including the definition of learning objectives, content, methods (including assessment) and material, as well as an arrangement for training teachers and trainers".

The WirelessUP! Training Module is designed to be implemented in every European VET educational system due to the involvement of EU instruments of transparency. EQF, ECVET and ESCO tools remove geographical, institutional and sectorial barriers. The Training module is:

- modular as it allows learners to choose from 3 different modules which suite their needs and preferences;
- adoptable in workload to learners' needs according if the provision is made by a VET school or adult VET institution;
- designed to foster mobility between different training institutions and learning contexts due to the involvement of European instruments of transparency.

Purpose

The purpose of the WirelessUP! training module is to be the foundational document for the complete WirelessUP! training programme as part of the partners' goal of modernising the VET electrotechnical sector in accordance with modern technological requests.

As studies have shown we are in the midst of a significant transformation regarding the way we produce products thanks to the digitization of manufacturing. McKinsey defines Industry 4.0. "as the next phase in the digitization of the manufacturing sector, driven by four disruptions: the astonishing rise in data volumes, computational power, and connectivity, especially new low-power wide-area networks; the emergence of analytics and business-intelligence capabilities; new forms of human-machine interaction such as touch interfaces and augmented-reality systems; and improvements in transferring digital instructions to the physical world, such as advanced robotics and 3-D printing".[1] This digitalisation encompasses a wide range of communication between human- human, human-robots, robots-robots etc. as well as gaining an immense load of data. Both activities are at a more detailed level based on sensors and their activity. Sensors are and will be embedded into every device and appliance, allowing them to communicate with each other and the users, providing up to the moment data on the managing, powering, and moving of economic activity.

1 https://www.mckinsey.com/business-functions/operations/our-insights/manufacturings-next-act

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At the beginning of 2015 McKinsey has surveyed 300 manufacturing leaders. The results have shown that only 48 percent of the manufacturers consider themselves ready for Industry 4.0 and 78% of the suppliers say they are prepared. The survey the partners have conducted in partner countries in 2018 within the Intellectual Output 1 "Recommendations for local implementation of smart systems in VET for industry 4.0" show similarities. The conclusions of the questionnaire analysis are that the companies and employees are still not fully implementing or are not prepared to fully implement the Industry 4.0 principles.

The focus of the survey conducted by the partners was on the VET education and its connectivity to Industry 4.0. The survey has shown that companies are lacking qualified workforce with up-to-date skills and competences. More specific and especially practical education in technical and vocational schools needs to bridge the gap between real sector needs and VET students as future workers. Up-to-date VET education in the electrotechnical sector can enable the employers to directly engage workers in the process without the expensive and time wasting need for prior in-house training. At the same time VET students can significantly increase employment opportunities. The CEDEFOP analysis states that "growing labour market imbalances have seeped into higher structural unemployment rates, with the consequence of exacerbated concern that skill mismatch is worsening in the EU. Shifts in skill demand and supply have been reflected in the stated inability of employers to fill their vacancies with people who have the right skills."[2]

The WirelessUP! Training Module is the first step in closing the gap between the present VET electrotechnical offer and the needs of Industry 4.0. It offers VET students the possibility to acquire relevant competences in wireless technologies, sensors and actuators.

The project follows the conclusion of the CEDEFOP study stating that "Remaining competitive in the global market requires consistent investment in higher-order ICT skills and their integration within education curricula as a key competence, since they are likely to become the norm in a wide(r) set of future jobs."[3]

Goal

Analysts predict that new Internet of Things (IoT) products and services will grow exponentially in the next years. Also, EU countries will continue to support research and implementation in IoT in the forthcoming years.

In order to enable a fast uptake of the IoT, key issues like identification, privacy and security and semantic interoperability have to be tackled. The interplay with cloud technologies, big data and future networks like 5G have also to be taken into account.

Open and integrated IoT environments will boost the competitiveness of European SMEs and make people's daily life easier. For instance, it will be easier for patients to receive continuous care and for companies to efficiently source components for their products. This will lead to better services, huge savings and a smarter use of resources.

[2] Insights into skill shortages and skill mismatch, CEDFOP, 2018, p. 3.
[3] Insights into skill shortages and skill mismatch, CEDFOP, 2018, p.62.

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To achieve these promising results, I think it is vital to enhance knowledge of the Internet of Things. The data protection legislation and the cybersecurity strategy proposed by the European Commission clearly go in this direction. The Wireless UP module thus has a goal to implement simple mesh networks as a part of IoT and to expose to stakeholders and further people of specific interest to the progress towards the bright future of the Internet of Things.

Competencies:

- Understand operation and function of IOT sensors and actuators, RF and SPI communication modules
- Understand IoT value chain structure (device, data cloud), application areas and technologies involved
- Explore and learn about the Internet of Things with the help of preparing projects designed for wireless technology
- Install, program, test and adjust various wireless modules and devices into the functional smart system
- Connect functional smart system with smart devices via cloud services

Description

LEVEL OF LEARNING OUTCOMES	EQF 4
TOTAL DURATION	45 Hours
NUMBER OF CREDITS	3 ECVET

Module	**Duration**
Internet of Things: Sensing and Actuator Devices	15 hours
Connecting Devices to IoT via Wireless Mesh Networks	15 hours
Implementing Wireless Technologies in Automation Systems	15 hours

ESCO

The involvement of ESCO helps to bridge the gap between the world of education and training and the labour market. By introducing a standard terminology for occupations, skills, competences and qualifications, ESCO can help education and training systems and the labour market to better identify and manage the availability of required skills, competences and qualifications. Its multilingual character facilitates increased international transparency and cooperation in the area of skills and qualifications.

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Classifications (ISCO-08 code):

2 Professionals

25 Information and communications technology professionals

252 Database and network professionals

2521 Database Designers and Administrators

2522 Systems Administrators

2523 Computer Network Professionals

2529 Database and Network Professionals Not Elsewhere Classified

3 - Technicians and associate professionals

31 - Science and engineering associate professionals

311 Physical and Engineering Science Technicians,

3113 Electrical Engineering Technicians

3114 Electronics Engineering Technicians

3115 Mechanical Engineering Technicians

312 Mining, Manufacturing and Construction Supervisors

3122 Manufacturing supervisors

313 Process Control Technicians

3139 Process control technicians not elsewhere classified

35 - Information and communications technicians

351 Information and communications technology operations and user support technicians

3511 Information and Communications Technology Operations Technicians

3512 Information and Communications Technology User Support Technicians

3513 Computer Network and Systems Technicians

3514 Web Technicians

352 Telecommunications and broadcasting technicians

3521 Broadcasting and audio-visual technicians

3522 Telecommunications engineering technicians

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7 - Craft and related trades workers

74 - Electrical and Electronics Trades Workers

741 Electrical Equipment Installers and Repairers

7411 Building and Related Electricians

7412 Electrical Mechanics and Fitters

7413 Electrical Line Installers and Repairers

742 Electronics and Telecommunications Installers and Repairers

7421 Electronics Mechanics and Servicers

7422 Information and Communications Technology Installers and Servicers

8 Plant and machine operators and assemblers

82 Assemblers

821 Assemblers

8211 Mechanical Machinery Assemblers

8212 Electrical and Electronic Equipment Assemblers

Modules and Contents

MODULE 1	
NAME OF THE MODULE:	**Internet of Things: Sensing and Actuator Devices**
LEVEL OF LEARNING OUTCOMES:	4 (according to EQF)
TOTAL DURATION:	15 Hours
NUMBER OF CREDITS:	1 ECVET
OBJECTIVE / PURPOSE OF MODULE	The purpose of this module is to gain knowledge on the Internet of Things (IoT), which relates to the study of sensors, actuators, and controllers, among other things, IoT applications and examples overview (building automation, transportation, healthcare, industry, etc.) with a focus on wearable electronics.
LEARNING OUTCOMES:	1. Understand operation and function of sensors and actuators

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	2. Understand IoT value chain structure (device, data cloud), application areas and technologies involved 3. Understand IoT sensors and technological challenges faced by IoT devices, with a focus on wireless, energy, power, RF and sensing modules 4. Market forecast for IoT devices with a focus on sensors 5. Explore and learn about Internet of Things with the help of preparing projects designed for wireless technology
MATERIAL AND HUMAN RESOURCES:	**Material resources:** • Multimedia classroom (projector, printer) with access to the Internet and required demonstration equipment for electrical installations • Specialized cabinet with realistic conditions for installation of electrical installations for the purpose of realizing a simple project • Electrical installation tool, measuring equipment and devices **Human resources:** • Master in Electrical Engineering and Information Technology • Electrical Engineer • Professor of Electrical Engineering

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MODULE 2	
NAME OF THE MODULE:	**Connecting Devices to IoT via Wireless Mesh Networks**
LEVEL OF LEARNING OUTCOMES:	4 (according to EQF)
TOTAL DURATION:	15 Hours
NUMBER OF CREDITS:	1 ECVET
OBJECTIVE / PURPOSE OF MODULE	This module provides a comprehensive coverage of the challenges and research issues of design and management of wireless sensor networks. With using simple development tools to manage wireless modules and devices, this module has the aim of implementing wireless communication between sensorial technologies for smart and sustainable houses and industry.
LEARNING OUTCOMES:	1. Interpret and test new wireless technologies in IoT project for the purposes of economics, comfort and accessibility 2. Connect various wireless modules and devices into the functional smart system 3. Program and adjust the smart system elements in simple development environment 4. Install and test functional smart system for regulation consisting of different sensors and actuators (lightning, temperature etc.) 5. Connect functional smart system with smart devices via cloud services
MATERIAL AND HUMAN RESOURCES:	**Material resources:** • Multimedia classroom (projector, printer) with access to the Internet and required demonstration equipment for electrical installations • Specialized cabinet with realistic

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	conditions for installation of electrical installations for the purpose of realizing a simple project • Electrical installation tool, measuring equipment and devices • Electronic components and equipment for wireless technology **Human resources:** • Master in Electrical Engineering and Information Technology • Electrical Engineer • Professor of Electrical Engineering

MODULE 3	
NAME OF THE MODULE:	**Implementing Wireless Technologies in Automation Systems**
LEVEL OF LEARNING OUTCOMES:	4 (according to EQF)
TOTAL DURATION:	15 Hours
NUMBER OF CREDITS:	1 ECVET
OBJECTIVE / PURPOSE OF MODULE	This project based module introduces to programming techniques for various day to day devices. The aim of the module is to provide basic knowledge about modelling, design and application of wireless sensors. Get acquainted with current technologies and their concrete realization. Understand the principles of work, architecture, applications, and protocols. Familiarize with the advantages and disadvantages of wireless sensor networks.
LEARNING OUTCOMES:	1. Understand advanced and emerging technologies 2. Obtain skills to do advanced research

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	and programming 3. Learn how to use software programs to perform varying and complex tasks 4. Expand upon the knowledge learned and apply it to solve real world problems
MATERIAL AND HUMAN RESOURCES:	**Material resources:** • Multimedia classroom (projector, printer) with access to the Internet and required demonstration equipment for electrical installations • Specialized cabinet with realistic conditions for installation of electrical installations for the purpose of realizing a simple project • Electrical installation tool, measuring equipment and devices • Electronic components and equipment for wireless technology **Human resources:** • Master in Electrical Engineering and Information Technology • Electrical Engineer • Professor of Electrical Engineering

Syllabus

Module No.	Unit No.	Unit/Topic	Number of hours		Total
			T	P	
1.	1.1.	Sensing and Actuator Devices	4	1	**5**
	1.2.	Wireless technologies	3	2	**5**
	1.3.	Internet of Things	4	1	**5**
2.	2.1.	Wireless technologies in IoT projects	6	2	**8**
	2.2.	Smart systems	1	6	**7**
3.	3.1.	Programming of wireless sensor networks	2	13	**15**
		Total	**20**	**25**	**45**

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Module 1: Internet of Things: Sensing and Actuator Devices

TOPIC	CONTENT	LEARNING OUTCOMES	No. HOURS
Sensing and Actuator Devices	Electrical Measurement Units	Explain the fundamental Measurement Units in electrotechnics	
	A/D conversion and vice-versa	Describe the need and procedure of A/D and D/A conversion	
	Types of Sensors and Actuators	Describe types of sensors used for physical, chemical, and biochemical applications	**T4** **P1**
	Measurement methods in A/D devices	Interpret the acquired data and measured results	
		Explain the theory of measurement uncertainty	
Wireless technologies	Networks and Communication	Recognize the various network types and communication protocols	
	SONET, IP, Broadband, Ethernet, Routing, Switching	Explain the definition and usage of the terms: SONET, IP, Broadband, Ethernet, Routing, Switching	
	Reference model for a network architecture	Describe the reference model for a network arhitecture and be able to extend it	**T3**
	Wireless communication technologies	List available wireless communication technologies	**P2**
	Signals, modulation	Identify the various signal types and modulation procedures in Wireless communications	
	Data transfer rate	Calculate the transfer rate and identify the elements which influence on it	

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Internet of Things	The Internet of Things Today IoT Strategic Research and Innovation Directions IoT Infrastructure, Processes, Applications IoT - Governance, Privacy and Security Issues IoT Related Standardization Smart Objects, Smart Applications	Explain the definition and usage of the term 'the internet of things' in different contexts Recognize where the IoT concept fits within the broader ICT industry and possible future trends Explain various network protocols used in IoT Explain some possible governance, privacy and security issues when planning IoT network Recognize standardization elements related to IoT Describe the concept of application of IoT in Smart objects, Smart cities etc.	**T4** **P1**
Literature and other relevant sources for learners: - Internet of Things – Converging Technologies for Smart Environments and Integrated Ecosystems; O. Vermesan, P. Friess; River Publishers; 2013 -			
Literature and other relevant sources for trainers: - Internet of Things – Converging Technologies for Smart Environments and Integrated Ecosystems; O. Vermesan, P. Friess; River Publishers; 2013			

Module 2: Connecting Devices to IoT via Wireless Mesh Networks

TOPIC	CONTENT	LEARNING OUTCOMES	No. HOURS
Wireless technologies in IoT projects	Wireless Transceivers IOT Operating systems IOT Communication model	Recognize and describe implementation of specific wireless transceivers into different types of networks. Recognize various IOT operating systems and its possibilities Recognize various IOT communication models	**T6** **P2**

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	and protocols IOT MESH networks IOT Gateways RF and SPI Communication Security	and protocols Describe IOT MESH network and its function Explain the function of IOT Gateways Describe the operation of RF and SPI communication interfaces Identify adequate security measures	
Smart systems	Connectivity, Identification and Localization for IOT Creating the IQRF Networks IOT Cloud platform	Execute principles of connectivity, identification and localization processes in IOT Create simple IQRF network Connect simple IQRF network to cloud platform	**T1** **P6**
Literature and other relevant sources for learners: -			
Literature and other relevant sources for trainers:			

Module 3: Implementing Wireless Technologies in Automation Systems

TOPIC	CONTENT	LEARNING OUTCOMES	No. HOURS
Programming of wireless sensor networks	Project learning – Simple IoT system made up made up of sensors, wireless network connection, data analytics and display/actuators, and write the necessary control software using Arduino MKR 1000, Raspberry Pi	Design a simple IoT system made up of sensors, wireless network connection, data analytics and display/actuators, and write the necessary control software Build and test a complete working IoT system	**T2** **P13**
Literature and other relevant sources for learners:			
Literature and other relevant sources for trainers:			

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