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Erasmus+ - KA2 - Cooperation for Innovation and the Exchange of Good Practices
Strategic Partnerships | Adult education
Project reference: 2018-1-CZ01-KA202-048179

INDUSTRY 4.0 for VET

Report of the Expert Interviews

IO 2 – Task 1: Expert interviews

Table of contents

1. Introduction

The following report is based on the results of the interviews conducted as part of the "INDUSTRY 4.0 for VET" project, funded by Erasmus+ and started in October 2018. The project has been implemented by a consortium of 7 partners:

- bit cz training (Czech Republic),
- FyG (Spain),
- bit Schulungscenter (Austria)
- Centro de formación Profesional Xabec (Spain),
- LBS Murau (Austria),
- ERIFO – Ente Ricerca e Formazione (Italy),
- Istituto Tecnico Agrario Emilio Sereni (Italy).

The consortium was composed of VET schools and agencies specialized in VET, adult education, business internationalization and innovation, employment services and career counselling. The project aims at developing an online knowledge platform to fill the gap of knowledge on industry 4.0 tools and technologies and support technical and entrepreneurial education. The final objective of the project is to contribute to the alignment of VET to labour market needs. The interviews were conducted in order to assess the level of knowledge of Industry 4.0 among students and teachers in VET schools and learners and trainers in educational centres. The data collected through the interviews allowed to assess the situation on the ground and contributed to identify relevant topics and tools for the InVET Online Knowledge Platform, a tool that project partner aim at developing in order to support development of teachers' competences and knowledge and update of educational programmes.

The interviews were conducted between August and December 2019 in all partner countries.

The research sample consisted of 78 people:

- 20 trainers working at adult education centres
- 58 teachers working in VET schools.

The interviewees were chosen by each partner based on their network and on the purpose of the research. Partners tried to ensure heterogeneity of the sample in terms of backgrounds and fields of expertise in order to get a wider overview of the current needs and gaps.

2. Knowledge of Industry 4.0

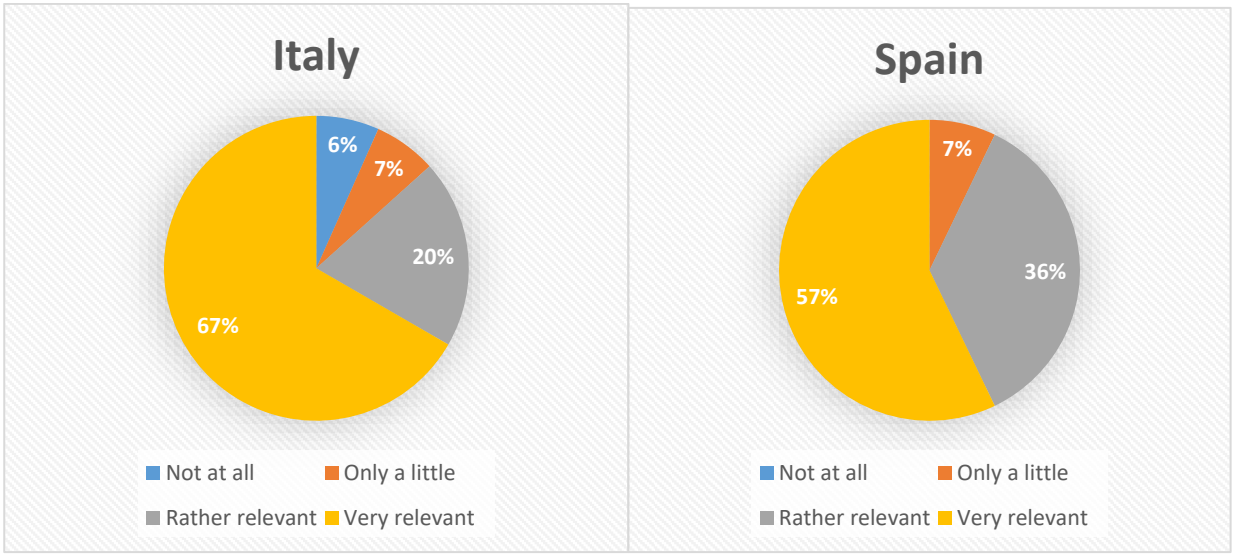
In general terms, the respondents showed an understanding of Industry 4.0 gained mainly through the the web. Their knowledge is limited to theory; they are aware of the main features and technologies of Industry 4.0, although their ability to use them in their daily life and work is limited. They provided some general definitions of Industry 4.0 focusing on two main concepts:

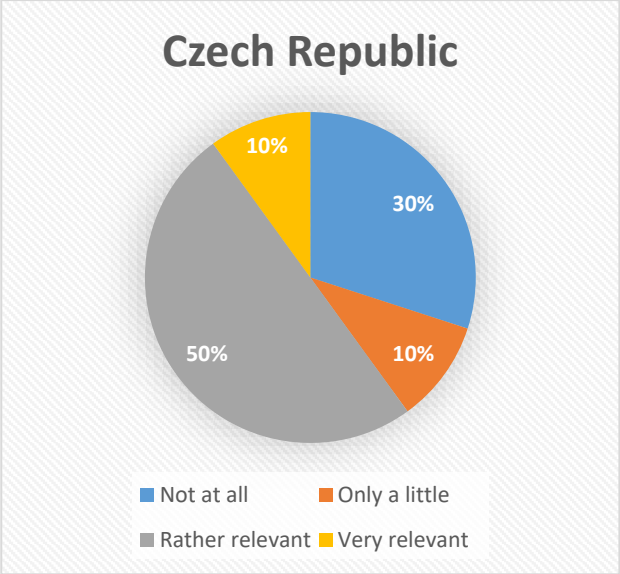
- digitalization of production processes and company's procedures
- integration of new technologies (Big Data, IoT, Internet, Artificial Intelligence) that speed up manufacturing and make it more efficient

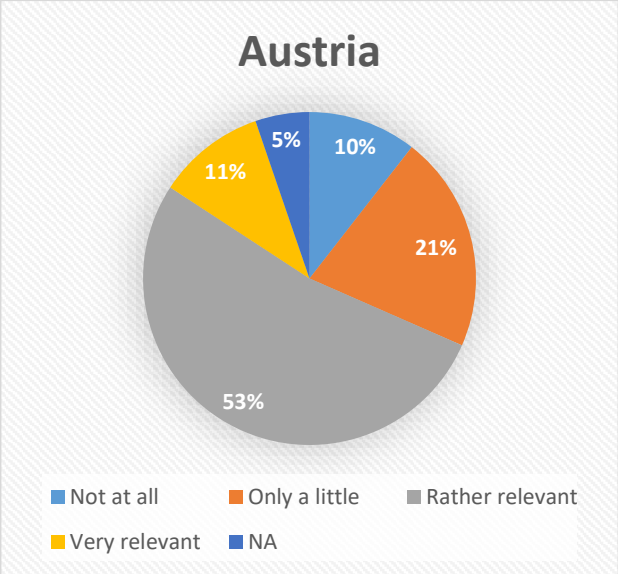
People showed in all countries their awareness of the 4.0 technologies such as 3D printing, Cloud, robotics, smart machines/cognitive computing and artificial intelligence. The answers they provided showed that general information on Industry 4.0 is all in all easily available, except in Czech Republic where the majority of the teachers interviewed (80%) reported a difficulty in accessing this kind of information.

The percentage of teachers who don't consider Industry 4.0 relevant for their field and future trends is particularly high among the teachers interviewed in Czech Republic. Nevertheless the majority of the respondents from all countries consider Industry 4.0 very/rather relevant for their field (Fig. 1.1)

Fig. 1.1 Relevance of Industry 4.0 for teachers' field of work and future trends







The percentage of respondents that consider Industry 4.0 relevant for their field and future trends is even higher among trainers from educational centres; all of them reported that it is very/rather relevant for their field and future trends.

Teachers and trainers agree on the fact that educational institutions will need to adapt to the new trends in order to equip students with the adequate tools and competences and thus facilitate their transition to the labour market, taking into account the companies' need of new competences and professional profiles. Therefore, new learning and teaching methods will be needed that foresee use of artificial intelligence, 3D printing, augmented reality and an update of the educational programmes. Teachers highlighted that Industry 4.0 will ensure faster and easier communication between people and companies, more efficient and easier management and control of business, high quality and low cost production. Spanish teachers provided specific examples of how Industry 4.0 will impact on companies and mentioned that it will change industrial maintenance at different levels and introduce new technologies and products; it will bring innovation in terms of data management and analysis and allow to test solutions before their application.

2.1 Integration of Industry 4.0 topics and tools in class

The level of integration of Industry 4.0 topics and tools in class appears quite low especially in Italy where teachers reported that industry 4.0 topics are treated in books and during lessons and mentioned a few courses available at their institution: use of ICT in science, technologies in agriculture, ICT for controlling data in wine production. Based on what Italian teachers reported, it was possible to understand that the level of integration of Industry 4.0 topics and tools into school curricula is limited

to theory; students do not have the opportunity to attend courses that allow to develop practical skills related to the use of Industry 4.0 technologies.

In Spain the integration of Industry 4.0 appears to be stronger. Based on what the teachers interviewed reported, courses on Industry 4.0 topics and tools are available both in Spain and in Czech Republic. Spanish teachers mentioned courses on 3D printing, cyberphysical systems (Televis go, KNX, Arduino, PLC), mechatronics, robotics, cobotics and domotics. Czech teachers mentioned courses on digital business transformation, digital transformation in marketing, smart factory, IT courses.

Nevertheless the use of digital and 4.0 tools by teachers is not widespread, especially in Italy, Austria and Czech Republic due to limited availability. The Italian, Austrian and Czech teachers can only access PC, smartboards, tablets and online educational platforms, which they regularly use in class.

Although the quality of the tools is said to be low, the variety and quality of digital tools for teachers is rather high in Spanish VET schools where most of the interviewees reported that there are digital tools available to support teachers (sensors, electronic and computer equipment, digital educational platforms, 3D printers, domotic devices, Building Information Modeling (BIM) tool).

The availability of digital tools is limited in educational centres, in particular in Czech Republic, where all respondents replied they have no access to digital tools at their institution.

The average time during which digital tools are used is particularly low for Italy where teachers use them for 3 hours per week on average while the average is higher for Spain, Austria and Czech Republic (6-7 hours/week). The average time is higher in educational centres (16h approximately).

Digital tools are used by teachers and trainers for didactic purposes (smartboard, PC, tablet, online platforms) and also for internal and external communication and management of administrative procedures (attendance recording…).

The main obstacles for the integration of Industry 4.0 topics and tools into VET school/educational centre courses/curricula are similar in all countries: lack of financial resources to access the tools and technologies that are particularly expensive, **l**ack of training and information. Moreover, in Spain teachers underlined the limited flexibility of school curricula that don't allow for changes and adaptations. In Czech Republic, as the topic is not obligatory, its integration into classes is dependent on teachers' willingness and is not foreseen formally; nevertheless as knowledge of Industry 4.0 is increasingly required by companies, students are very likely to be exposed to it in companies after the completion of their studies.

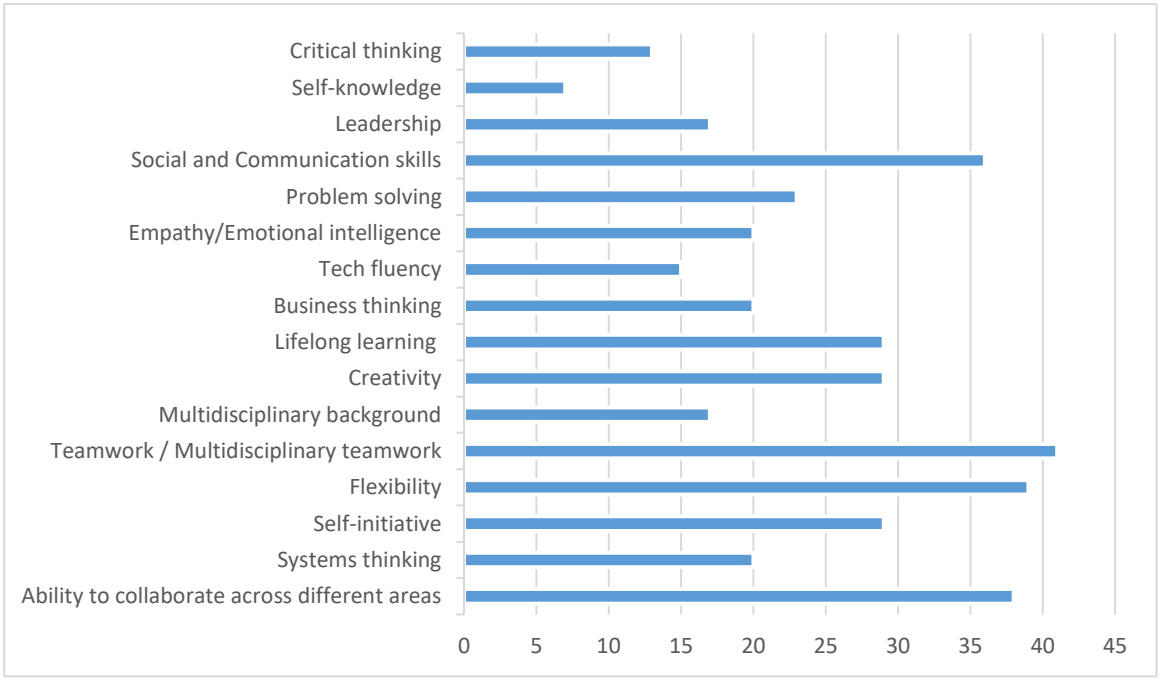
Most of the interviewees agreed with the idea to introduce industry 4.0 in schools to support students' development and their transition to the labour market through the development of skills and knowledge needed by companies; according to some respondents the integration of Industry 4.0 into school curricula will also allow training and professional development of teachers. Those who showed greater reluctance believe that the process would be very difficult due to the need of trained teachers, time and resources; moreover, a minor percentage of respondents believe that Industry 4.0 is not a relevant topic for their field, and therefore, there is no need to introduce it as a subject in schools.

The level of integration of Industry 4.0 topics and tools is limited also in educational centres. Only Spanish and Czech trainers mentioned some courses available at their institutions: automation, robotics, Industry 4.0, big data, artificial intelligence.

In all countries, efforts to support Industry 4.0 innovation in education are almost non-existent or limited and there is also a huge gap between theory and practice. Public authorities' efforts are mainly focused on the production sector rather than on education according to the teachers interviewed. Spain was the only country where teachers reported that their school has a policy to support industry 4.0 innovations in course teaching; school authorities are indeed committed to raise awareness among teachers on the importance of Industry 4.0 and support the integration of Industry 4.0 topics and tools into already existing subjects; this commitment is also showed by the establishment of the Prize for the Best Practice in Digitalization awarded every year to the best practice in the field of digitalization.

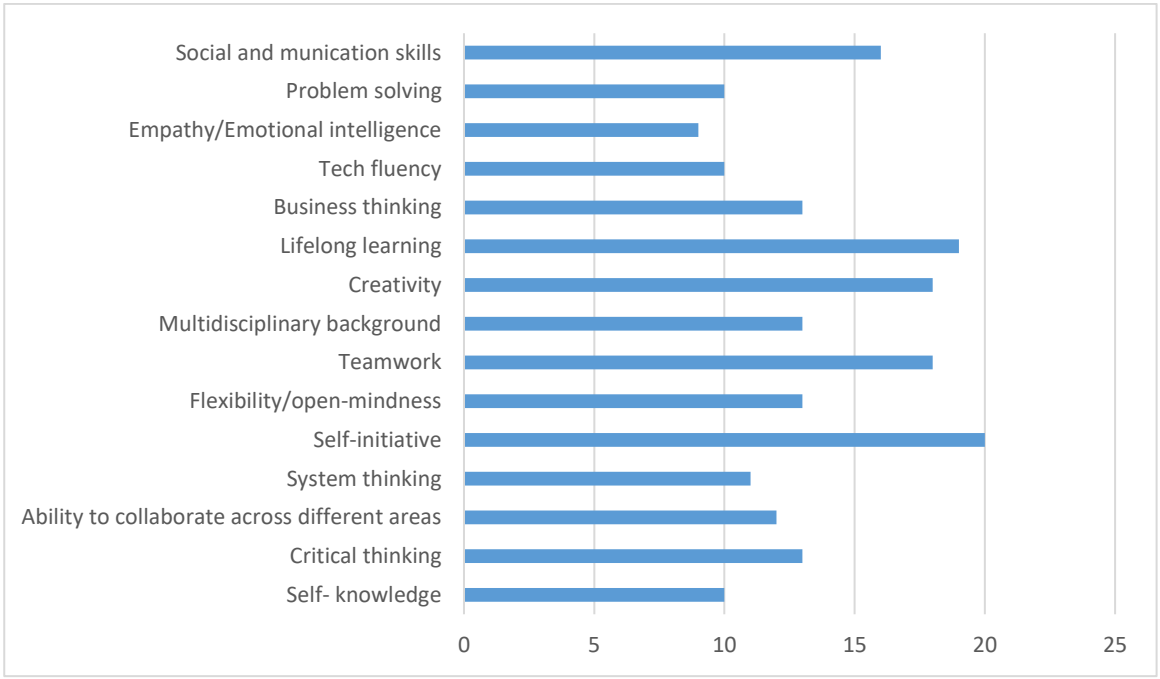
According to the teachers working in VET schools the top 5 skills requested by companies are:

- Teamwork
- Flexibility
- Ability to collaborate acros different areas or sectors
- Social and Communication skills
- Lifelong learning, creativity and self-initiative



According to the trainers from educational centres the top 5 skills requested by companies are:

- Self-initiative
- Lifelong learning
- Creativity and teamwork
- Social and Communication skills
- Critical thinking, Multidisciplinary background, Flexibility



Trainers interviewed in Czech Republic and Spain and teachers interviewed in Austria reported that their institution implements programmes that allow their students to develop these skills.

3. Main Gaps and Challenges

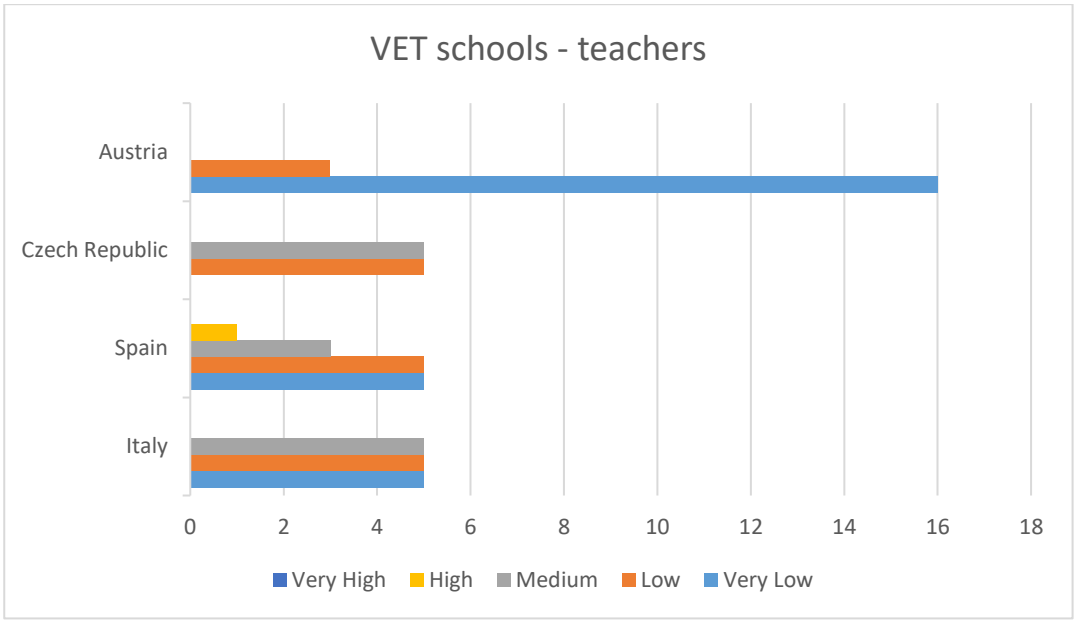
Teachers and trainers were asked to evaluate their overall knowledge of Industry 4.0 and also their knowledge of the different topics and technologies associated to it.

For the purpose of our research, 4 different levels of knowledge were identified:

- very low: general and limited understanding of some aspects of Industry 4.0 developed through the exposure to news and other means of information; at this level, a person can identify some of the main technologies and innovations of Industry 4.0 but has no clear understanding of its meaning and benefits;
- low: general understanding of the topic and its field of application usually acquired through reading scientific articles or participating in conferences/workshops; at this level, a person can provide a clearer but generic definition of Industry 4.0, recognize its main aspects and innovations and its fields of application although he/she is not using any 4.0 technologies in their daily work;
- medium: knowledge of current developments and overall benefits without specialized knowledge; limited ability to use 4.0 technologies in a specific field;
- high: knowledge of current developments and overall benefits related to a specific field of application and ability to use 4.0 technologies in a specific field;
- very high: highly specialized knowledge related to current developments and technical aspects in a specific field.

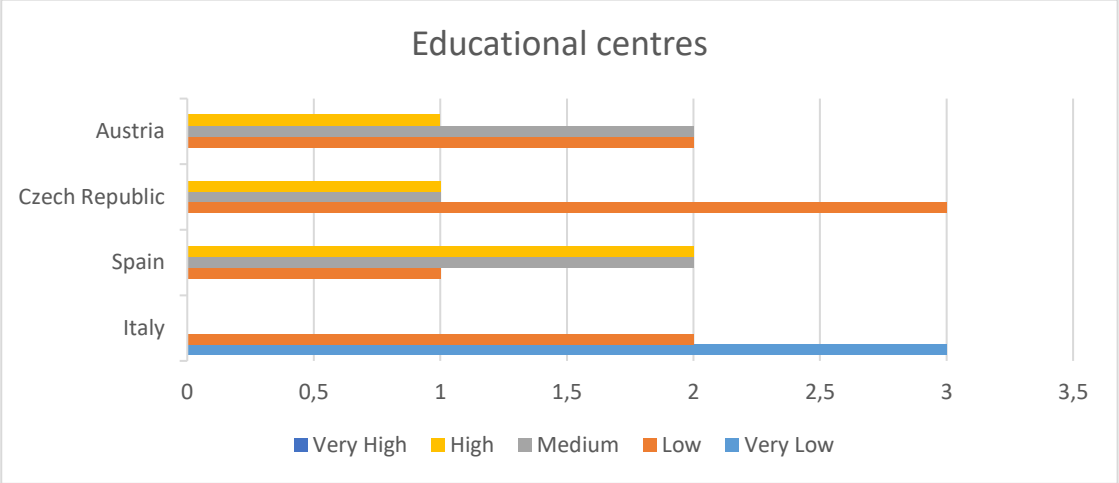
As showed by Fig. 3.1, in Italy, Spain and Austria the majority of respondents feel that their knowledge of Industry 4.0 is very low or low; in particular, in Austria, most respondents feel they have a very low knowledge of the topic and do not have a clear understanding of its meaning and benefits; in Czech Republic half respondents feel that they have a basic understanding of the topic and the other half reported that they know current developments and overall benefits but have limited ability to use the technology in a specific field.

Fig. 3.1 VET school teachers knowledge of Industry 4.0



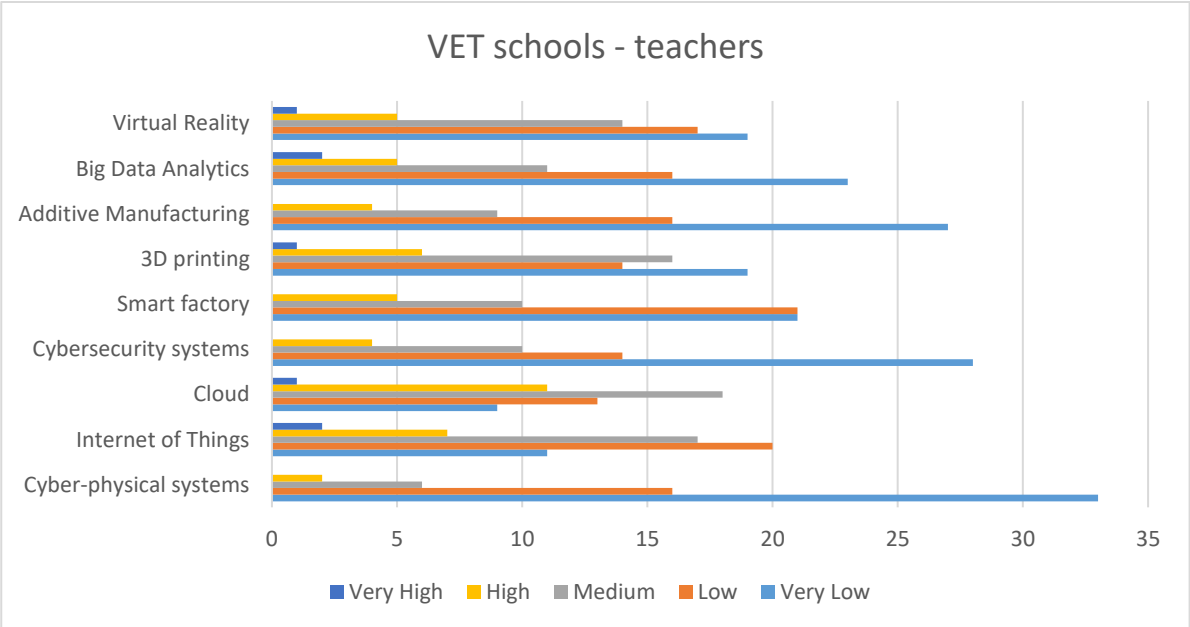
The situation is similar among trainers from educational centres in Italy and Czech Republic where the majority of teachers feel that their knowledge is limited to an overall understanding of the topic; in Spain, most respondents reported that they have a medium/high knowledge of the topic; half of them know developments and overall benefits with limited ability to use the technology in a specific field; half of them have a specialized knowledge related to the application of Industry 4.0 in a specific field. In Austria the majority of trainers reported that they have either a low or a medium knowledge of the topic; half of them only have a general understanding of the topic and its field of application and the other half feel that they know current developments and overall benefits but do not have a specialized knowledge.

Fig. 3.2 Educational centres trainers' knowledge of Industry 4.0



Based on the ratings provided on different topics, the majority of the teachers interviewed feel they have limited knowledge in almost all Industry 4.0 topics, ranging from very low to low level, Cloud is the only topic on which the majority of the people interviewed reported that they have an intermediate knowledge, which means that they are aware of current developments and overall benefits related to Cloud computing although their ability to use Cloud in a specific field is limited. A remarkable part of the sample (more than half) feels that they have a very low knowledge of different Industry 4.0 technologies; above all Cyber-physical systems and Cybersecurity systems.

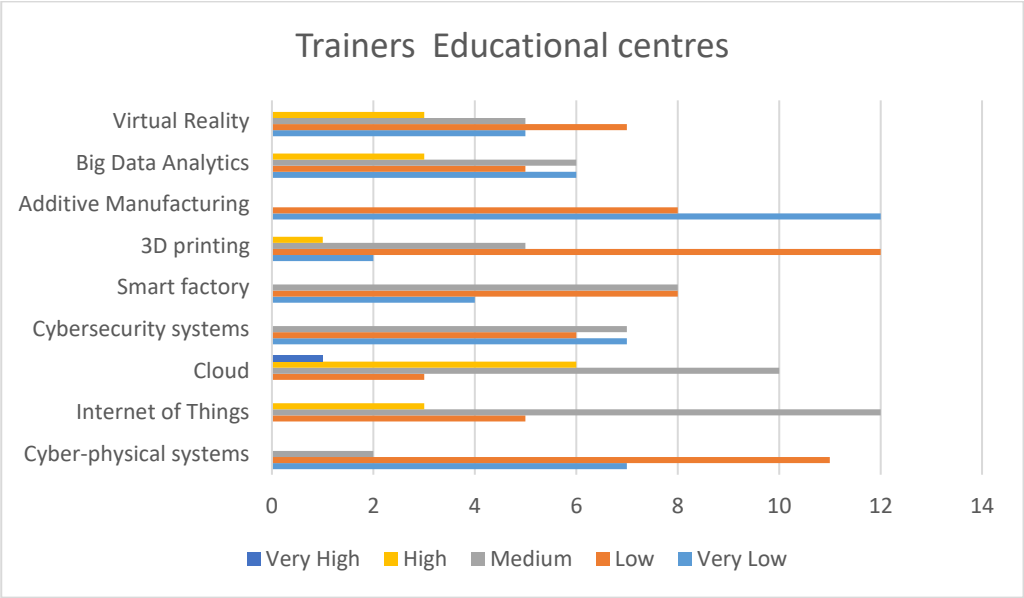
Fig. 3.3



Similarly, in educational centres, a majority of trainers reported that they feel they have a very low/low knowledge in almost all topics of Industry 4.0 except for Cloud and IoT. More than half of

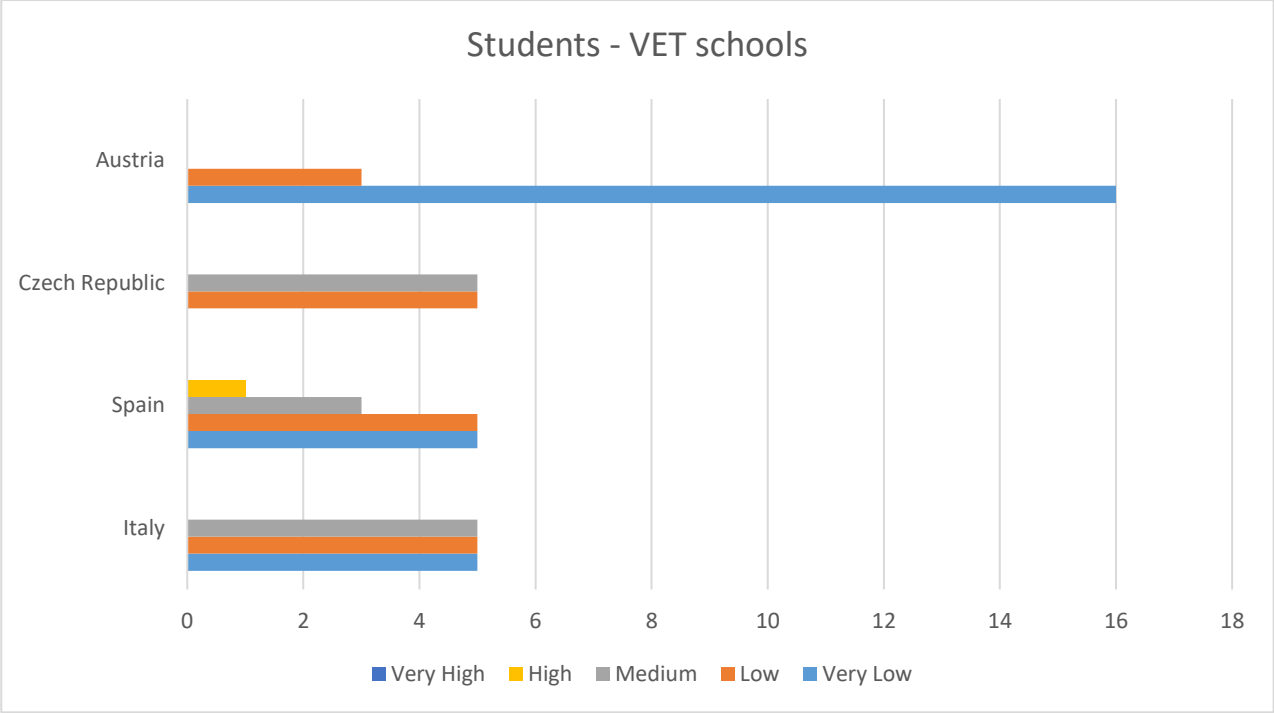
the respondents reported that they have a very low knowledge of Additive manufacturing and a low knowledge of 3D printing and cyber-physical systems.

Fig. 3.4

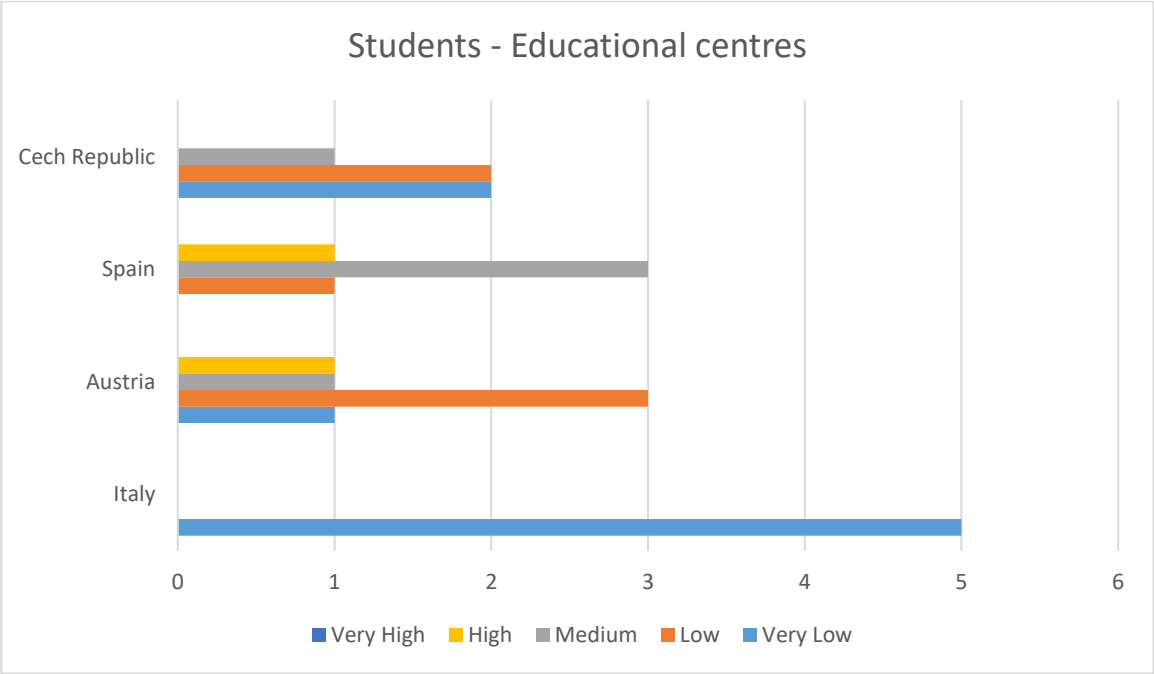


The main gaps identified by the teachers and trainers interviewed are: 3D printing, machine language and interfaces, virtual reality, cybersecurity systems, artificial intelligence, augmented reality and robotics. In order to improve the quality of their course and allow students' to develop useful skills, teacher feel they need first of all training at the basic level as most of them across all countries have a very low knowledge of Industry 4.0. They also listed some topics on which they would like to be trained: IoT and cloud computing, virtual reality, use of IoT for maintenance, Big Data, 3D printing, cybersecurity systems. Based on the answers provided by the trainers, they feel they need additional training on artificial intelligence, augmented reality, virtual reality and robotics.

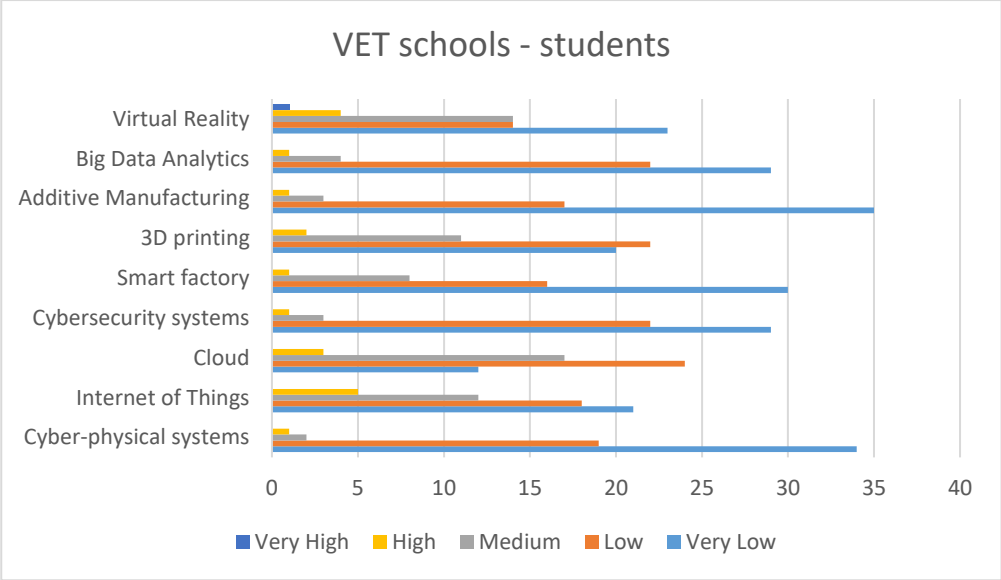
Teachers and trainers were also asked to provide an assessment of their students/learners' knowledge of Industry 4.0; the teachers and trainers answers vary among those interviewed in Italy and Czech Republic, ranging from very low to medium level, while in Spain and Austria the majority of teachers rated students' knowledge as very low or low. (Fig 3.5)



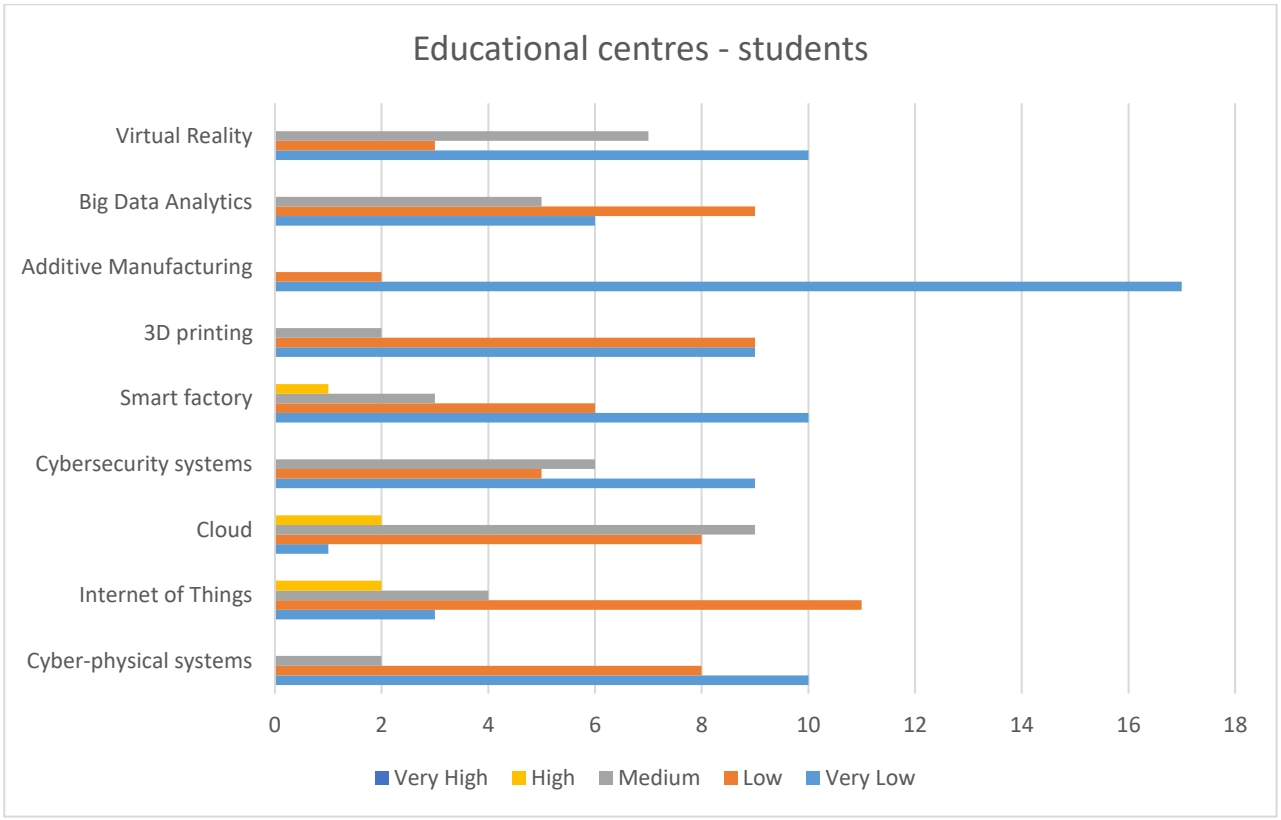
Trainers from educational centres rated their students' knowledge at very low level in Italy while in other countries perceptions among teachers differ; In Czech Republic and Austria most trainers perceive that their students' knowledge of Industry 4.0 is very low/low; in Spain trainers' perceptions are more positive as most of them believe that their students' knowledge level is medium.



Based on teachers' perspective, students have very low knowledge of almost all topics; the only topics that, according to a significant number of teachers, are more familiar to students are Cloud and Virtual reality.



The situation is similar in educational centres, where, according to the majority of trainers learners have a very low knowledge in almost all topics; almost all teachers agree that students have very low knowledge of additive manufacturing; half of the respondents perceive that students have a very low knowledge of virtual reality, mart factory and cyber-physical systems.



Considering the very low knowledge of Industry 4.0 among students, according to teachers, they should undergo a training starting from a very basic level. Among the topics listed by teachers as priority topics on which students need training there are cybersecurity systems, 3D printing, IoT, Cloud, Big Data.

4. Methodology

Most teachers identified blended learning as the most effective strategy to teach topics related to Industry 4.0 and highlighted the importance of "learning by doing". Based on their experience and understanding, the course should be focused on learning practical skills and include examples/case studies from the world of work. The content of the course has to be easy to understand and translated into national languages. Teachers also suggested the use of visual contents, videos and presentations; according to them, it would be also useful to include sessions with experts. The platform foreseen by the InVET project, according to the interviewees should include simple resources that can be used in class.

The course will allow to increase teachers and trainers' knowledge and skills so that they can support learners more effectively in developing the competences needed to enter the labour market.

5. Conclusions

The Report of Expert Interviews is based on the results of the interviews conducted with teachers and trainers working for different educational institutions (VET schools, adult education centres…). The interviews were conducted between August and December 2019 by the staff of the different partner institution involved in the "INDUSTRY 4.0 for VET" project.

The interviews were conducted in order to assess the level of knowledge of Industry 4.0 among students, teachers and trainers. The data collected through the interviews allowed to assess the situation on the ground and contributed to identify relevant topics and tools for the InVET Online Knowledge Platform, with which the partners involved in the project aim at promoting knowledge of Industry 4.0 and updating and aligning educational programmes with the labour market needs.

Based on the data collected through the Expert Interviews in all countries it was possible to understand that:

- the level of knowledge of Industry 4.0 among teachers and trainers is perceived as low

- among the trainers interviewed there was a considerable number of those that perceive their knowledge to be high;
- the level of knowledge of Industry 4.0 among students is perceived to be very low by the majority of the teachers and trainers interviewed;
- the majority of teachers and trainers interviewed reported that they have very low/low knowledge in almost all topics;
- teachers and trainers underlined the need for additional training on IoT and cloud computing, virtual reality, use of IoT for maintenance, Big Data, 3D visualization, artificial intelligence, augmented reality, robotics

According to the teachers and trainers a course on Industry 4.0 should:

- be implemented through blended learning
- be focused on learning practical skills and include examples/case studies from the work life
- be easy to understand and translated into national languages
- include visual contents, videos and presentations, sessions with experts.

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INDUSTRY 4.0 for VET

Questionnaires for Innovators report

IO 2 – Task 2: Specific research on the field of education in INDUSTRY 4.0 context

Contents

Table of Figures

1. Introduction

The following report is based on the results of an online survey conducted as part of the "INDUSTRY 4.0 for VET" project, funded by Erasmus+ and started in October 2018. The project has been implemented by a consortium of 7 partners:

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The consortium was composed of VET schools and agencies specialized in VET, adult education, business internationalization and innovation, employment services and career counselling. The project aims at developing an online knowledge platform to fill the gap of knowledge on industry 4.0 tools and technologies and support technical and entrepreneurial education. The final objective of the project is to contribute to the alignment of VET to labour market needs. The questionnaire was submitted to representatives of Industry 4.0 companies; the aim of the questionnaire was to assess the level of knowledge of Industry 4.0 among people working in manufacturing companies. The data collected through the questionnaire allowed to assess the situation on the ground and contributed to identify relevant topics and tools for the InVET Online Knowledge Platform, a tool that project partners aim at developing in order to support development of teachers/coaches/trainers' competences and knowledge and update of educational programmes.

The online interviews were conducted between August 2019 and May 2020 in all partner countries with 44 people working at different levels in companies that developed innovative solutions using 4.0 technologies to be used in the manufacturing sector. The companies are based in consortium partner countries: Czech Republic, Italy, Spain and Austria. The survey was conducted through Google forms. The online survey was conducted through Google forms.

The first part of the report contains a list of different companies identified in each partner country; these companies were selected as they use 4.0 technologies and have developed innovative solutions for manufacturing companies. The list is not exhaustive and includes some of the companies that were involved in the project survey; it was developed to provide an overview of the actual scenario in the different partner countries in terms of fields of specialization and good practices and can be a useful reference for further research. The VET schools involved in the project were fundamental for

the identification of the companies included in the list thanks to their wide network; desk research through online communities and fora was also crucial for the development of the overview.

2. Overview of companies involved in the Industry 4.0 – suppliers (innovators)

Name of the company	Town (Country)	Sector	Main products/Activities	4.0 Technologies used	Good practice example	Website
A1 Telekom Austria AG	Austria	Digital communication solutions, payment and entertainment services	Telecommunication	IoT	5G for IoT applications / smart mobility	www.a1.group/de/home
ABAX Informationstechnik GmbH	Austria	Information technology	IT Systems	CymbIoT, Lancom Systems, Acam, essecca, Phoenic contact, LineMetrics	Big Data analytics, Data Center automation, physical security, IoT	www.abax.at
AVL List GmbH	Austria	Development, simulation and testing technology of powertrains (hybrid, combustion engines, transmission, electric drive, batteries and software) for passenger cars, trucks and large engines	Powertrain Systems, Simulation, Engine Instrumentation and Test Systems	Artificial Intelligence, Big Data	Big Data for the Automotive Industry, Performance Racing Industry, Internal Combustion Engine 4.0, product development	www.avl.com/web/guest/home

IBM Österreich	Austria	Aerospace and defense, Automotive, Banking and financial markets, Chemicals, Construction, Education, Electronics, Energy and utilities, Healthcare, Insurance, Life sciences, Manufacturing, Metals and mining, Oil and gas, Retail and Consumer Products, Telecommunications, media and entertainment, Travel and transportation	AI; Big Data Analytics; High Performance Computing; DevOps; Cloud; Security; IBM Storage	Cloud; Artificial Intelligence; IoT; Big Data	IBM Cloud; IBM Watson (AI); Watson IoT Platform; IBM IGNITE Quality and Test; SAP; Sysco; Big Data Consulting Services; Blockchain Services	www.ibm.com/at-de
Infineon Technologies Austria AG	Austria	Microelectronics / Semiconductor and system solutions	Semiconductor; system solutions	Robotics	Industrial automation, robotics	www.infineon.com/cms/austria/de/
Kapsch BusinessCom AG	Austria	Digitalization	Connected Platforms & Applications; Converged Infrastructure; Digital Facility Solutions; Intelligent Network;	SAP; Tribefire; Azure	Digital Facility Solutions, Intelligent Network, Security, unified workplace	www.kapsch.net/kbc

			Security; Unified Workplace; professional planning, controlling and continuous monitoring of project progress			
Know-Center GmbH	Austria	Research center for data-driven business and big data analytics.	Industrial Data Analytics; Strategic Intelligence; Data-driven Process and Decision Support; Digital Life Science	Cognitive Computing System	Data Analytics, Data-Driven Markets, Strategic Intelligence, Data-driven Process, Learning 4.0, Digital Life Science	www.know-center.at
Magna Steyr Fahrzeugtechnik AG& Co KG	Austria	automotive industry	automotive: innovation and manufactoring	Robotics	Advanced robotics	www.magna.com/home
REXEL Austria GmbH	Austria	Electrical installation material and electrical appliances	Electrical installation material and electrical appliances	Automation technology	Competence Center Industry	www.rexel.at/
Rosenbauer International AG	Austria	Firemen outfitters	Fire fighting vehicles, aerial ladders, aerial rescue platforms, airport vehicles, industrial vehicles, special vehicles, extinguishing systems, fire fighting equipment, stationary extinguishing systems and in the field of telematics solutions for vehicle management	RFID; 3D Printing; ICT	Emerec Tablet- Information management for emergency forces	www.rosenbauer.com/en/at/rosenbauer-world

			and operational management.			
SBA Research	Austria	Research center for Information Security	Advanced Training; Data Protection Governance, Infrastructure Security; Security Governance; Software Engineering; Software Security	ICT; Network communication; Big data; Cloud computing	Cyber Security Guideline, InduSec -information security in IT/OT environments	www.sba-research.org/
Schneider Electric	Austria	Energy management and automation technology	Building automation; IT infrastructure; UPS; racks; Cooling and monitoring; Automation and control technology, low-voltage products and systems; Medium voltage products and energy automation; Installation and building system technology	Cloud computing; CAD;	EcoStruxure-Platform -IoT-enabled, open, and interoperable plug-and-play architecture and platform	www.schneider-electric.at
Siemens AG Österreich	Austria	Technology: electrification, automation and digitization.	Industrial automation; Building technology; Drive technology; Energy; health care; Mobility; financial solutions	automation technology; advanced robotics; cyber-physical systems; ICT	SIPLUS CMS-Condition Monitoring System	www.siemens.com/at/de/home.html

Tieto Austria GmbH	Austria	software and services	Digital experience and consulting; Industry solutions and software; Software R&D services, Cloud transformation; Data and AI; Managed services and integration	Digital experience and consulting; Industry solutions and software; Software R&D services, Cloud transformation; Data and AI; Managed services and integration	Mondi-introduction of smart technical solutions	https://campaigns.tieto.com/de/node/302
voestalpine AG	Austria	Technology and industrial goods company	Steel; High Performance Metals; Metal Engineering; Metal Forming	Digital automation	EPD 4.0-An external end position detector to monitor the position of the two switch blades, industrial tube components	www.voestalpine.com/group/en/group/
Zumtobel Group AG	Austria	Lighting	Manufacture of hardware and software for lighting systems (LED light sources and LED drivers, sensors and lighting management)	Indoor Navigation; People Tracking; Remote Monitoring; Sprace Management; Dynamic Lighting;		www.zumtobelgroup.com/en/

				Lighting Infrastructure		
FOXCONN CZ s.r.o.	Czech Republic	IT	A Comprehensive Portfolio of Services in the Field of Industrial Automation; industrial automation of spare parts sales and repairs	Smart projects for iot and industry 4.0, digital factory	This company has been awarded as one of the most importartant company in the Czech Republic according to CZECH TOP 100 in 2018.	foxconn.cz
Siemens	Czech Republic	IT	automation technology; advanced robotics; cyber-physical systems; ICT	Industrial automation; Building technology; Drive technology; health care; electrotechnology,	Siemens in the Czech Republic is a pioneering leader in the area of Industry 4.0 and Smart Cities.	new.siemens.com/cz
Bosch	Czech Republic	mobility, industry, trades	innovative solutions, multimodal transportation services, smart transport infrastructure	Smart Factory	Smart Factory Demonstrator, consisting of several modules that show the benefits and potential of Industry 4.0: for example unlimited data exchange between individual production modules and many others.	bosch.cz
Mobis Automotive Czech, s.r.o.	Czech Republic	Automotive industry	Innovation and new technologies in the automotive market	Smart factory	Intelligent auto, DAS	mobis-auto.cz

ANASOFT, s.r.o.	Czech Republic	Software solutions	Manufacturing Execution Systems and Logistics Optimization, Software Development, IT Security	Advanced HMI, Big data for smart industry, artificial intelligence, digital transformatio n	The company operates research laboratory in the area of Smart Industry	anasoft.com/cz
B&R Industrial Automation	Czech Republic	Automation technology	Robotics, software, mobile automation	IoT, modeling, simulation	B&R as a part of the group ABB (ABBN: SIX Swiss Ex) is a pioneering technology leader in power grids, electrification products, industrial automation and robotics and motion, serving customers in utilities, industry and transport & infrastructure globally.	br-automation.com
K2 atmitec s.r.o.	Czech Republic	ICT	IT, software, services	IT, Intelligence solutions, loT, Cloud	The company is the only one producer of information systems with its own data center in the Czech Republic.	k2.cz
Unicorn	Czech Republic	ICT	SW development, information systems and solutions in the area of information and communication technologies	Cloud, IoT	SW solutions - Integration and Enrichment of Data	unicorn.com
Robix	Czech Republic	Robotics	Industrial robots, auto-controlled trucks, collaborative robots, and other tools to help	Advanced robotics	Industrial robots	robix.cz

			your factory work efficiently			
ABB s.r.o.	Czech Republic	energy, industry, transport and infrastructure	A comprehensive portfolio of industrial technologies for customers in the energy, industrial, transport and infrastructure sectors	Robotics	The company develops standard robots as well as advanced robotic components.	abb.com
Piovan	Italy	Manufactoring	Plastics	Big Data, Internet of Things and services	Winfactory 4.0 (supervision software for the factory)	www.piovan.com
HPE Coxa	Italy	Manufactoring	Engineering services and precision manufacturing (automotive industry), automotive, motorsport and automation solutions	Big Data, Internet of Things and services	Industrial IoT Innovation Centre	www.hpe.eu
Paglieri	Italy	Chemical	Cosmetics	IoT, CBS	Interconnection of the cosmetics packaging plant	www.paglieri.it
Buffoli	Italy	Manufacturing	Precision transfer machine	Internet of Things, Cloud	Multi-spindle CNC transfer machines and turnkey production systems	www.buffoli.com
Ileana s.p.a.	Italy	Manufacturing	Clothing	Internet of Things, CBS	Vending machines and digital payments for stockings; these machines can collect, analyze and release information about the preferences of the purchasers who are connected online	www.calzeileana.it

Valni	Italy	Manufactoring	Clothing	3D printing	Glasses printed in 3D, customizable based on the size of the purchaser's face	www.valni.me
Italtel	Italy	Technology	Information & communication	Big Data, predictive maintenance, CPS, augmented reality	IndyMachine, an all-in-one solution to connect any kind of machine to the network and allow automation, collection and analysis of data to improve production processes	www.italtel.com
Olivetti	Italy	Technology	Information & communication	IoT, Big Data	loT Smart, a cloud-based solution to develop IoT solutions and ensure remote management of various smart objects (sensors…)	www.olivetti.com
Arken s.p.a.	Italy	Manufacturing	Modular furniture for shops	CPS, Big Data	Automated warehouse	www.arken.it
Italcementi	Italy	Construction and materials	Cement, concrete and aggregates	Big Data	Centralized room using the PROFINET communication technology to connect all detection tools and departments to collect and analyze data and trends	www.italcementi.it
Wolters Kluwer	Spain	Software development	Integral information, knowledge, training and software solutions aimed at our clients in the legal, fiscal, financial, accounting / commercial, human resources, education, public sector and health markets	Cloud computing	a3bill (in Spanish a3factura), a3ERP	www.wolterskluwer.es/

be Services	Spain	software	cloud computing providers	Cloud Computing	beCloud, beHelp	www.beservices.es/
pfstech	Spain	Process Automation	Robotic process automation	Big Data and Analytics, Cloud computing	RPA (robotic process automation) which allows the automation of repetitive administrative activities	https://pfstech.es/
3D Whole	Spain	3D printing	3D printing	3D printing	Prototypes, models and final products designed and manufactured	http://3dwhole.com/
ic telecom	Spain	Software development	digitalization of business, tools and customized solutions	3D printing	Prototypes, models and final products designed and manufactured	https://ictelecom.es/
doeet	Spain	Software development	Industry 4.0 platforms	Big Data	OEE and MES systems for production and productivity control	https://doeet.es/
SOTHIS	Spain	IT	Provide IT-related services and specialise in the agri-food, pharmaceutical, chemical, construction, distribution, and automotive sectors	Big Data, cyber security and Analytics (SAP,Nebula Suite,microsoft hyper-v EsEt…)	Thanks to the talent of their employees they have managed to develop an innovative approach where the information systems of a productive company are always linked and work with a unique data.	www.sothis.tech/en/enterprise/
CONTINUUM SECURITY	Spain	Security	Free and open source software, BDD-Security, recognized in the world of DevOps and SecDevOps.	Cyber security and big data	This company has been awarded with the Prize for the Best Cybersecurity Entrepreneurial Company in Spain, given by INCIBE in December 2015.	https://iriusrisk.com/
ACCIONA	Spain	Energy and Infrastructure	ACCIONA is a leading group in sustainable infrastructure solutions	Artificial intelligence, 3D	Awarded in Europe for its good practices in occupational risk prevention	www.acciona.com/

			and renewable energy projects worldwide.	printing,Robotics,automatization		
SICNOVA	Spain	3D printing	Active collaborators in open projects such as OWASP, and we dedicate part of our budget to R+D.	Additive manufacturing	Distribution, sales and oficial technical service in Europe and Latin America for Markforged,JCR3D, B9Creations,HP,Shining 3D and ultimaket	https://sicnova3d.com/
BESERVICE	Spain	IT	Cloud computing: Infrastructure in Corporate Cloud format and a Technical Assistance Platform	Cloud	The company considers it a competitive advantage to have a real action scenario where it can continue to investigate the specific needs of corporate consumers	www.beservices.es/
METRIPLICA	Spain	IT	Design of the web metrics plan to help and guide towards the achievement of the client's objectives by using dashboards.	Cloud,big data and analytics	They work with many innovative tools like Analytics Suite 360 Google Analytics 360 Google Universal Analytics (free) Google Tag Manager Google Optimize Google Data Studio Adobe Analytics	www.metriplica.com/
ALIENVAULT	Spain	IT	Developer of commercial and open source services to manage cyber attacks	Artificial intelligence, cloud and cyber security	AlienVault won the "BEST CLOUD COMPUTING SECURITY SOLUTION" for EMEA . In the same year, Forbes featured AlienVault in their Forbes Cloud 100 list	https://cybersecurity.att.com/

EMBEBLUE	Spain	IT	Electronic engineering specialized in electronic devices for the Internet of Things and Industry 4.0.	IoT and Sensor Technology	In 2018, the Ministry of Economy and Industry awarded the company with the Innovative Company of the Year Award.	www.embeblue.com/
ELEVENPATHS	Spain	IT	Support customers with digital transformation, creating disruptive innovation in cybersecurity in order to provide the necessary privacy and trust.	Cybersecurity	Company focused on cyber-resilience that can compromise the success of an organization's business and reputation	www.elevenpaths.com/
HEXA INGENIEROS	Spain	IT	It is an expert company in the Automation of processes and the development of information systems that improve the tasks of supervision and industrial control through the most advanced technology.	Automatization	They are different from the competitors because they embrace all services: advisory, consulting, design and implementation of systems and their maintenance.	www.hexaingenieros.com/

3. Online interviews

The questionnaire respondents work mainly in ICT and in the manufacturing sector (design and assembly of electrical appliances and devices, electronic manufacturing, steel production, automotive sector). Big data, IoT and cloud computing represent the most widely-used 4.0 technologies within the companies in which the respondents work.

Manufacturing companies use daily remote maintenance, diagnosis and control systems and smart sensors, robots and 3D printers, software for the integration of management processes and the entire production and distribution chain.

4. Good practices

The following section collects some of the good practices involving the application of the 4.0 paradigm identified through the online survey.

4.1 Spain

The Spanish respondents highlighted the following good practices:

- **remote real time control** used for fine machining;
- **smart sensors** for advanced statistical analysis of PLC sensor data along with quality input inspection to improve processes in the manufacturing field;
- **cloud** used by a company producing air conditioning systems to share information with project management architecture firms;
- **inter-connection** among wrapping machines used for packaging to speed up production and anticipate problems;
- **robots** to speed up the production cycle in a manufacturing company.

4.2 Austria

The Austrian respondents mainly work in automotive factories, electronic manufacturing, steel manufacturing; **augmented reality, advanced simulation models, artificial intelligence and optical drilling** are the 4.0 technologies mentioned by respondents and used in their companies.

In particular, augmented reality is used in assembly lines to guide workers to the right tools and how to use them; one of the interviewees works for **AVL RACING**[1], the world's largest independent company for the development, simulation and testing of all types of powertrain systems (hybrid,

[1] https://www.avl.com/web/guest/company

combustion engine, transmission, electric drive, batteries, fuel cell and control technology), their integration into the vehicle, assisted and autonomous driving as well as data intelligence. At AVL RACING they conduct tests with the power units using state of the art equipment. This could include component tilting, advanced simulation models, a driver simulator, artificial intelligence, as well as analytic functions for an enhanced usage of the testbed. A specially designed and developed drilling machine is used for optical drilling of PCB mounting systems. The machine, which is installed in a fully air-conditioned room, is designed for a 6σ process capability at 50µm. This is achieved through a complex interaction of high-resolution cameras, the most precise positioning devices, and perfectly coordinated software.

Other automotive companies are reportedly using **drones** for inventory to avoid the time-consuming inspection of warehouses.

The respondents working in the field of electronics manufacturing reported the use of **predictive maintenance** to detect anomaly for critical production equipment; one of the technologies used for predictive maintenance is the **digital Twin,** a virtual replica of physical, potential and actual resources (objects, processes, people, places, infrastructures, systems and devices).

Respondents working in the field of steel manufacturing mentioned the use of **a forging press** which is fully automated and high speed and a digital plate rolling mill.

4.3 Czech Republic

The Czech respondents mainly work in the ICT and transports field; respondents working in companies specialized in ICT mentioned the use of **simulation systems and software to** simulate business systems and manufacturing processes by analysing system input and output; one of the respondents mentioned that his company developed **a Platform to monitor working conditions and allow predictive maintenance;** the platform includes software and hardware technologies and is also accessible to the suppliers with which the company collaborates. Another IT company develops **financial software for small businesses** to innovate service delivery, radically changing processes and introducing new methods and practices

4.4 Italy

In Italy, it is worth highlighting the **automated warehouse** of Arken, equipped with automated machines able to transport semi-finished products to different sections of the warehouse where they undergo other processes; the warehouse is also equipped with an automatic air filtering and treatment systems that absorbs the dust produced by the working areas with which it is connected. This mechanism is fully automated and possesses a device that controls device to regulate the speed of the

suction fans and the opening / closing of the suction vents located near the areas where dust is produced.

Arken also uses **Smart sensors t**o monitor continuously working conditions and process parameters and **ERP** to allow the integration in real time among all management processes, including administrative, logistic and commercial ones and the entire production and distribution chain: order / order confirmation / 3d cad design / order launch / cam processing for in-line processing on CNC machines / production and quality control / shipping / eventual installation / post-assembly assistance / billing / payment certificates. It makes use of the recognition of the pieces via QRcode and uses interconnected software such as: - Solidworks (cad) - Alfacam (post processor-cam) - Wodwoop (post processor-cam) - Software for data network protection.

5. Knowledge of Industry 4.0

Respondents were asked to evaluate the overall knowledge of Industry 4.0 among people working in manufacturing industries and in general.

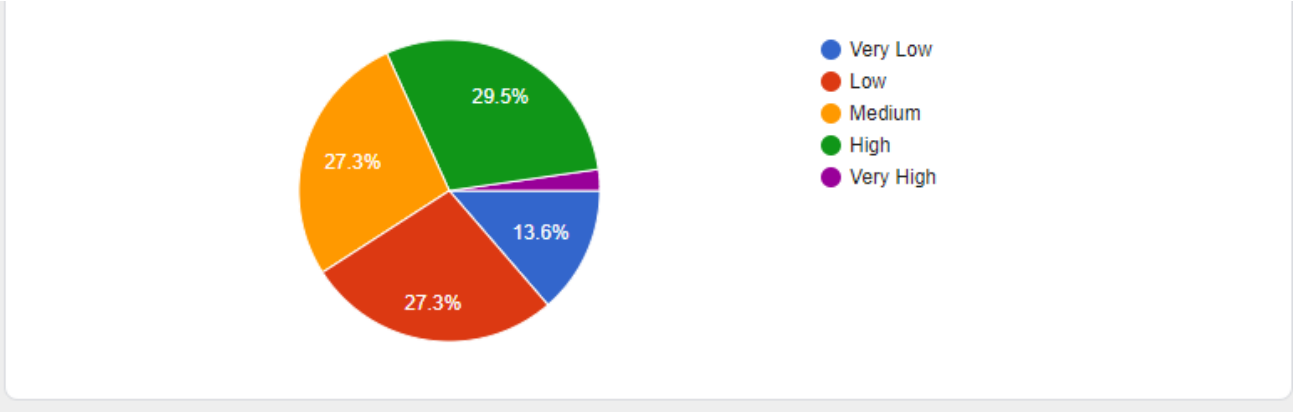
For the purpose of our research, 5 different levels of knowledge were identified:

- very low: general and limited understanding of some aspects of Industry 4.0 developed through the exposure to news and other means of information; at this level, a person can identify some of the main technologies and innovations of Industry 4.0 but has no clear understanding of its meaning and benefits;
- low: general understanding of the topic and its field of application usually acquired through reading scientific articles or participating in conferences/workshops; at this level, a person can provide a clearer but generic definition of Industry 4.0, recognize its main aspects and innovations and its fields of application although he/she is not using any 4.0 technologies in their daily work;
- medium: knowledge of current developments and overall benefits without specialized knowledge; limited ability to use 4.0 technologies in a specific field;
- high: knowledge of current developments and overall benefits related to a specific field of application and ability to use 4.0 technologies in a specific field;
- very high: highly specialized knowledge related to current developments and technical aspects in a specific field.

As showed by Fig. 1, the majority of respondents feel that knowledge of Industry 4.0 among manufacturing companies is high while according to 27.3% it is at a medium level. Only a minority

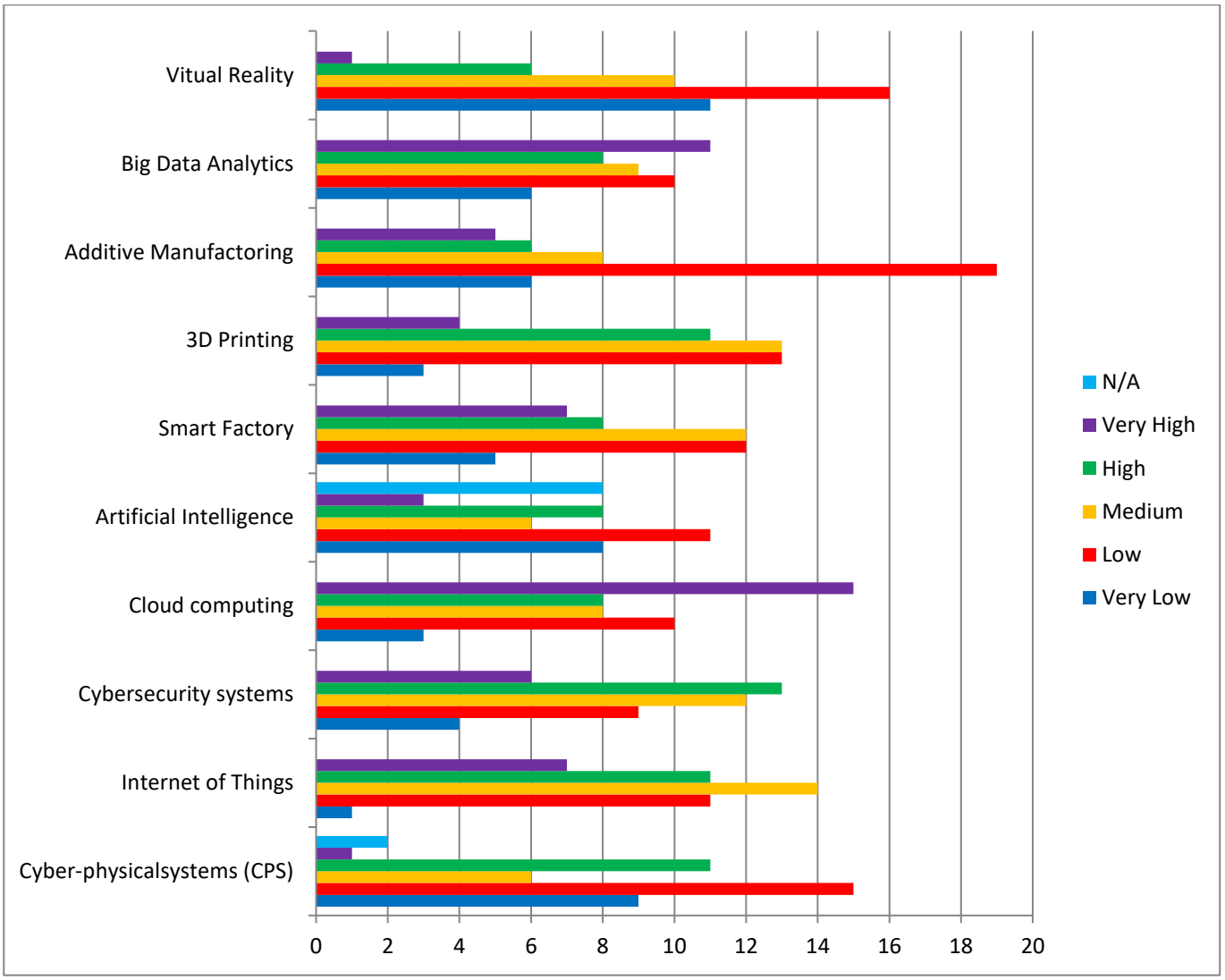
believes that people working in the manufacturing sector have a low knowledge of Industry 4.0 and are not using them in their daily work.

Figure 1. How would you rate the level of knowledge among manufacturing companies of Industry 4.0



According to the respondents, knowledge of Industry 4.0 technologies is low, in particular as far as additive manufacturing and virtual reality are concerned. In fact, the great majority of respondents believe that people working in manufacturing companies have a general understanding of these technologies although they are not using them in their daily life and work. Cloud turns out to be the only 4.0 technology that is well-known in the manufacturing field, in fact 34% of respondents stated that cloud knowledge among people working in manufacturing companies is very high, which means they have a highly specialized knowledge related to current developments and technical aspects related to cloud, which is well integrated into their daily work. A significant percentage of respondents (almost 32%) identified IoT as another well-known 4.0 technologies and rated manufacturing companies' knowledge of this kind of technology as medium meaning that they believe that it is used although not at a proficient level. According to 29,5% of respondent's cybersecurity is also known and used in the manufacturing field and rated the knowledge of this technology as high.

Figure 2. Level of Knowledge about Industry 4.0 technologies among manufacturing companies



Within manufacturing companies, the use of 4.0 technologies is still limited. Most of the 4.0 companies are using them to improve the production process (quality, speed). Big data are used to analyze customers' needs and improve production or service delivery; the use of robots allows greater precision and productivity while cloud computing is being used to ease data management within companies.

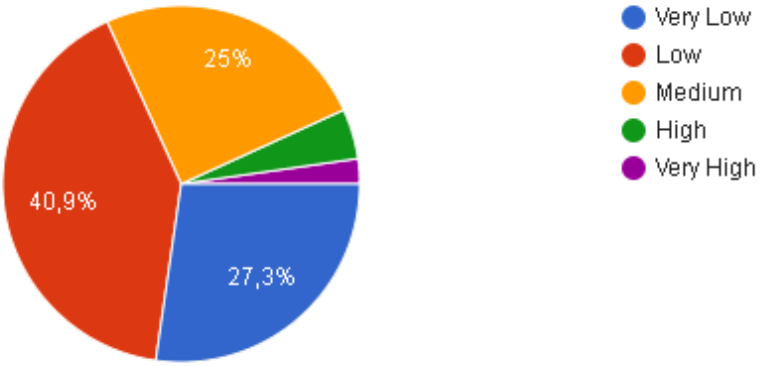
However, much more must be done for companies to become 4.0; this is due to two main obstacles:

- Lack of financial resources
- Lack of trained employees

According to the questionnaire respondents, knowledge of Industry 4.0 is even more limited among people in general; in fact, almost half respondents (40,9%) believe that people, despite having a

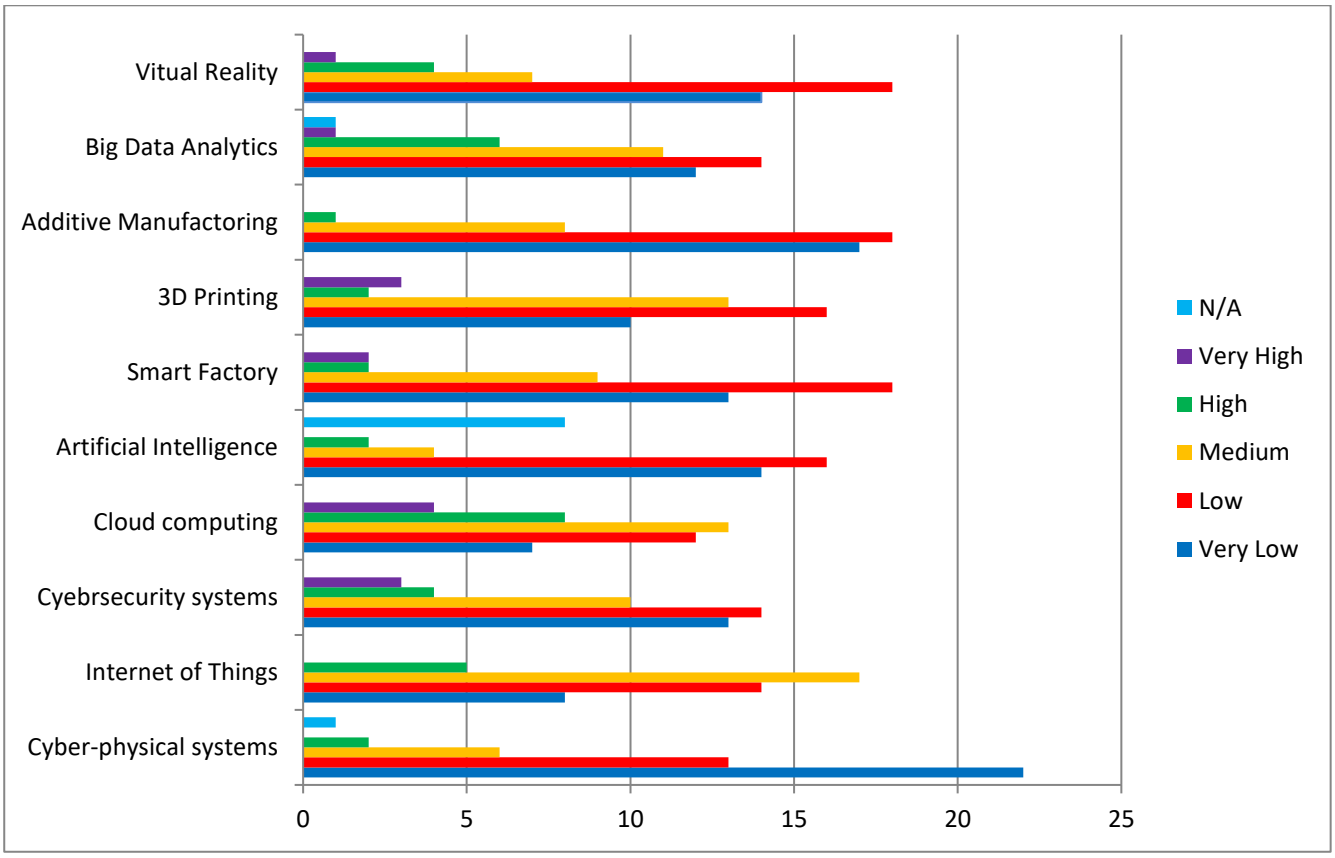
general understanding of the topic and its field of application, they are not proficient at using them in their daily life.

Figure 3. Level of Knowledge among people in general of Industry 4.0



People's knowledge of Industry 4.0 is rated as low as far as almost all 4.0 technologies are concerned. The only exceptions are Cloud computing and IoT; according to the majority of respondents (29,5% and 38,63% respectively) people have knowledge of current developments and overall benefits related to Cloud and IoT without having specialized knowledge and with limited ability to use them in a specific field. However, the 4.0 technologies that are perceived to be the least known among people are cyber-physical systems; half of respondents in fact believe that people have a very low knowledge of CBS and are barely able to identify them and understand what they are.

Figure 4. Level of Knowledge about Industry 4.0 technologies among people in general



6. Main needs in manufacturing companies

Training on 4.0 technologies is considered to be fundamental for workers and managers and has to be adapted to the needs and field of specialization of the company; managers need to understand how Industry 4.0 can benefit them and improve productivity in order to manage effectively the digital transformation of their company.

Normally, people working in companies have heard about Industry 4.0, but they do not understand what it could bring in terms of productivity and other kinds of improvements.

The training for people working in manufacturing companies should focus on specific topics based on the field of work of the employees; big data and cybersecurity are identified by several respondents as crucial.

However, there are also some cross-cutting topics for which training may be needed for everyone regardless of their field of work: Big Data + Analytics, Internet of things and Cybersecurity.

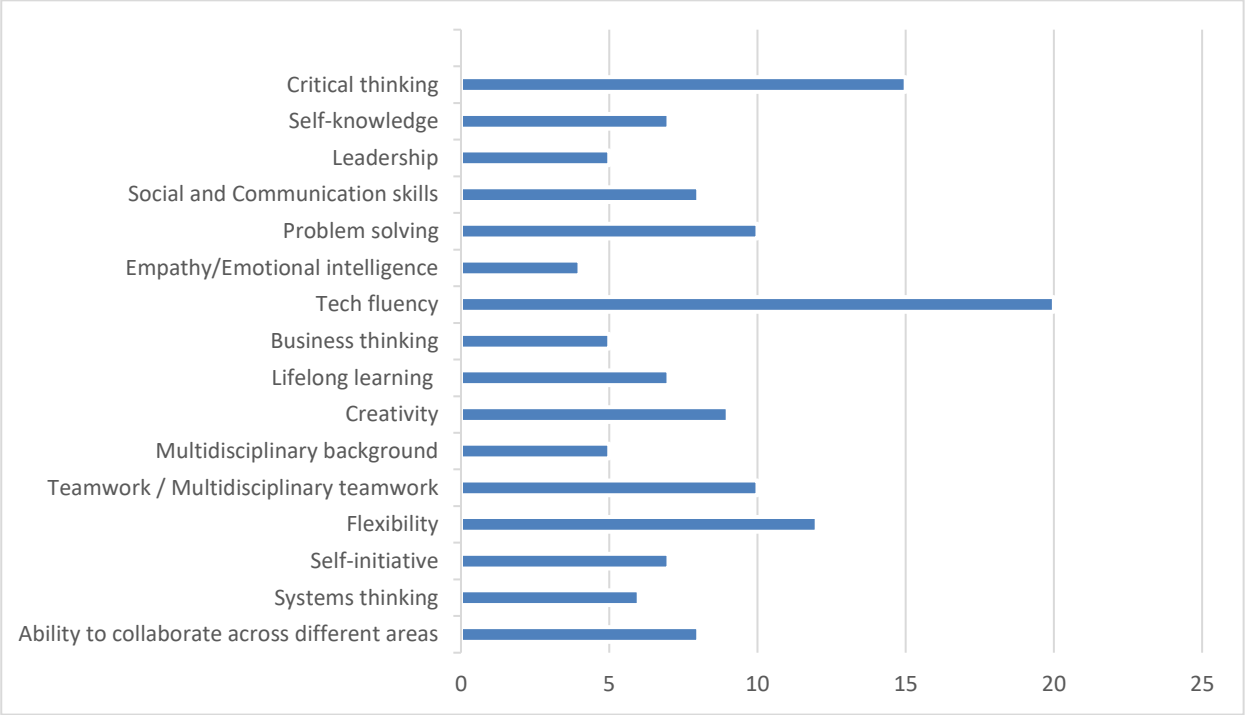
6.1 Skills required by 4.0 companies

According to the respondents the most important competences required by 4.0 companies are:

- Tech fluency (45,4% of the respondents): this skill involves the possession of well-developed ICT skills and technical competences related to the use of 4.0 technologies such as IoT, cloud and big data technologies.
- Critical thinking (34%)
- Flexibility and open-mindedness (27,3%)
- Teamwork and Problem solving (22,8%)
- Social and communication skills (18,2%)

Interviews also highlighted additional skills such as organizational skills, innovation, ability to learn quickly, commitment to quality and safety, programming skills.

Figure 5. Skills required by 4.0 companies



6.3 Professional profiles

According to the respondents, the professional profiles that will be required within 4.0 companies are mainly technical profiles able to use the new digital technologies, such as engineers and senior technicians in the ICT, automation or mechanics area, operators able to manage these technologies and take care of their maintenance (maintenance operators, production operators, electrical/electronic operators, robot operators).

The centrality and active role of customers in industry 4.0 requires new figures who are able to identify customers' requests and guide the company strategy to meet the market needs. Among these figures there is the *E-commerce Manager*, responsible for online sales and product or service launch strategies; the *Digital Strategist*, who decides web-marketing and social strategies; the *Social Media Manager*, the *Social Media Analyst, the Digital Marketing Manager.*

The huge amount of data and information available for companies requires the availability of professional figures who are able to use data to identify customers' business needs (business analyst) or analyse data to support decision-making (data analyst). Professional figures able to treat and analyse huge amount of heterogeneous data to create value, by applying a multidisciplinary process, are thus particularly needed. Companies will also need managerial profiles able to manage complex processes and work in teams.

7. Teachers/coaches/trainers' training needs

Training will be needed for trainers/coaches/teachers to equip them with knowledge and skills to digitalize the teaching experience by using new technologies and innovative teaching methodologies (online learning systems, blended learning systems).

This will allow the development of students' digital skills and increase their employability. Training curricula need to be re-designed and updated, especially those of technical VET institutions to ensure they are in line with the competence requirements of Industry 4.0; teaching methodologies will also need to be updated, giving space to the new digital technologies.

It is important that schools are more closely connected with companies, so that they have modern teaching tools in their classrooms.

8. Conclusions

The Report is based on the results of an online survey conducted with people working in 4.0 companies. The survey was conducted between August 2019 and May 2020 by the staff of the different partner institutions involved in the "INDUSTRY 4.0 for VET" project.

The survey was conducted to assess the level of knowledge of Industry 4.0 among manufacturing companies. The data collected through the survey allowed to assess the situation on the ground and contributed to identify relevant topics for the InVET Online Knowledge Platform, with which the partners involved in the project aim at promoting knowledge of Industry 4.0 and updating and aligning educational programs with the labour market needs.

Based on the data collected in all partner countries it was possible to understand that:

- the level of knowledge of Industry 4.0 is perceived as high among manufacturing companies while is low among people in general; almost half respondents (40,9%) believe that people, despite having a general understanding of the topic and its field of application, they are not proficient at using them in their daily life;
- the topics that, according to respondents, are least known among manufacturing companies are additive manufacturing and virtual reality; the knowledge of Industry 4.0 technologies is even more limited among people in general, as they have low knowledge of almost all Industry 4.0 technologies;
- IoT and Cloud are the technologies that according to respondents are more familiar to users, both in the manufacturing field and among people in general;
- people working in manufacturing companies need training on specific topics based on their company's field of work; however, some topics are cross-cutting and require additional training regardless of the field of work such as big data analytics, Internet of things and Cybersecurity.
- trainers/coaches/teachers need training to develop knowledge and skills that will allow them to digitalize the teaching experience by using new technologies and innovative teaching methodologies (online learning systems, blended learning systems); they should also be trained in the field of cybersecurity, big data and cloud.

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

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Strategic Partnerships | Adult education
Project reference: 2018-1-CZ01-KA202-048179

INDUSTRY 4.0 for VET

Summary report

IO 2 – Task 3: Summary report

Contents

Table of Figures

1. Introduction

The following report summarizes the results of the interviews and the online survey conducted as part of the "INDUSTRY 4.0 for VET" project, funded by Erasmus+ and started in October 2018. The project has been implemented by a consortium of 7 partners:

- bit cz training (Czech Republic),
- FyG (Spain),
- bit Schulungscenter (Austria)
- Centro de formación Profesional Xabec (Spain),
- LBS Murau (Austria),
- ERIFO – Ente Ricerca e Formazione (Italy),
- Istituto Tecnico Agrario Emilio Sereni (Italy).

The consortium was composed of VET schools and agencies specialized in VET, adult education, business internationalization and innovation, employment services and career counselling. The project aims at developing an online knowledge platform to fill the gap of knowledge on industry 4.0 tools and technologies and support technical and entrepreneurial education. The final objective of the project is to contribute to the alignment of VET to labour market needs.

The report is based on the results of:

- interviews with learners and teachers/trainers from VET centres and educational centres (see annex 1 and 2) whose aim was to assess the level of knowledge of Industry 4.0 among students and teachers in VET schools and learners and trainers in educational centres;
- an online survey (see annex 3) conducted with representatives of Industry 4.0 companies whose aim was to assess the level of knowledge of Industry 4.0 among people working in manufacturing companies.

The interviews were conducted between August and December 2019 in all partner countries while the online survey was conducted between August 2019 and May 2020.

The research sample consisted of:

- 20 trainers working at adult education centres
- 58 teachers working in VET schools;
- 44 people working at different levels in the field of ICT and the manufacturing sector (design and assembly of electrical appliances and devices, electronic manufacturing, steel production, automotive sector).

The interviews were conducted face-to-face or through the submission of a questionnaire by email while the online survey was developed through Google forms and was conducted online.

2. Results of the expert interviews

Based on the data collected through the Expert Interviews, in all partner countries:

- the level of knowledge of Industry 4.0 among teachers and trainers is perceived as low;
- among the trainers interviewed there was a considerable number of those that perceive their knowledge to be high;
- the level of knowledge of Industry 4.0 among students is perceived to be very low by the majority of the teachers and trainers interviewed;
- the majority of teachers and trainers interviewed reported that they have very low/low knowledge in almost all topics related to Industry 4.0;
- teachers and trainers underlined the need for additional training on IoT and cloud computing, virtual reality, use of IoT for maintenance, Big Data, 3D visualization, artificial intelligence, augmented reality, robotics.

According to the teachers and trainers a course on Industry 4.0 should:

- be implemented through blended learning
- be focused on learning practical skills and include examples/case studies from the work life
- be easy to understand and translated into national languages
- include visual contents, videos and presentations, sessions with experts.

3. Results of the online survey

Based on the results of the online survey, it was possible to understand that the level of knowledge of Industry 4.0 is perceived by experts as high among manufacturing companies and low among people in general; almost half respondents (40,9%) believe that people, despite having a general understanding of the topic and its field of application, are not proficient at using them in their daily life.

Moreover, the topics that, according to respondents, are least known among manufacturing companies are additive manufacturing and virtual reality; the knowledge of Industry 4.0 technologies is even more limited among people in general, as they have low knowledge of almost all Industry 4.0 technologies. IoT and Cloud are the technologies that, according to respondents are more familiar to users, both in the manufacturing field and among people in general.

People working in manufacturing companies need training on specific topics based on their company's field of work; however, some topics are cross-cutting and require additional training regardless of the field of work such as big data analytics, Internet of Things and Cybersecurity.

Trainers/coaches/teachers need training to develop knowledge and skills that will allow them to digitalize the teaching experience by using new technologies and innovative teaching methodologies (online learning systems, blended learning systems); they should also be trained in the field of cybersecurity, big data and cloud.

According to the respondents the most important competences required by 4.0 companies are:

- Tech fluency (45,4% of the respondents): this skill involves the possession of well-developed ICT skills and technical competences related to the use of 4.0 technologies such as IoT, cloud and big data technologies.
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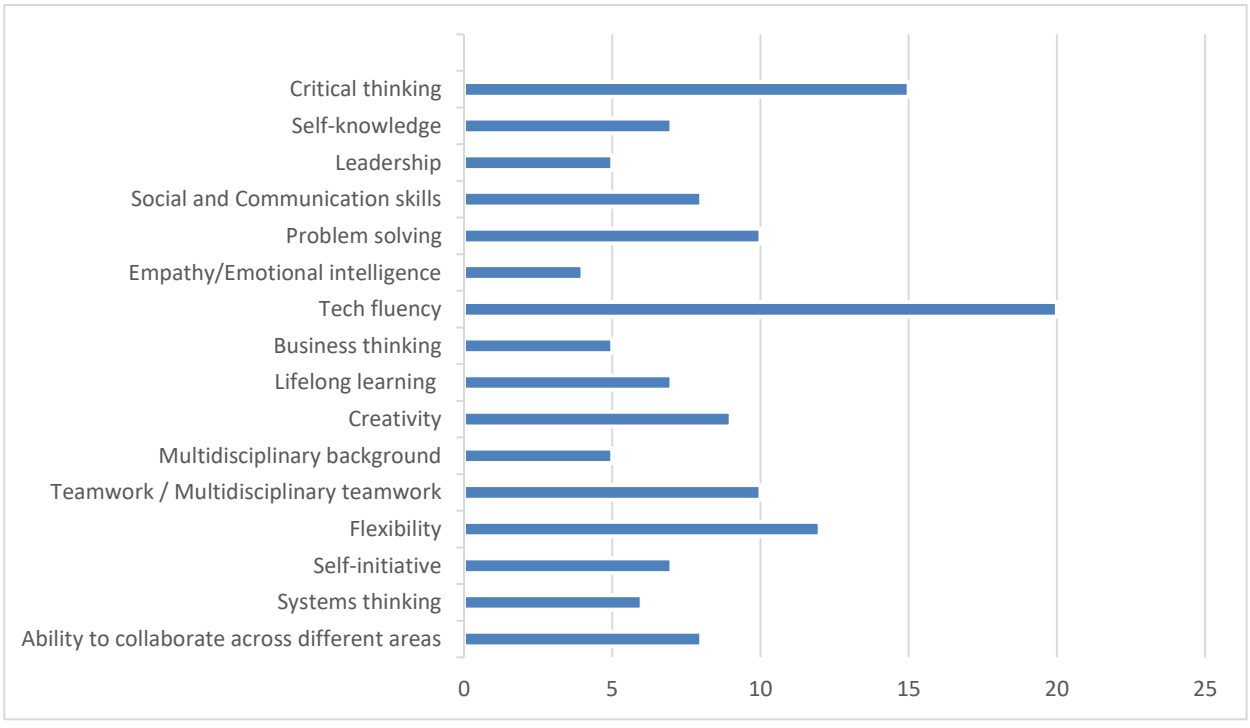
Interviews also highlighted additional skills such as organizational skills, innovation, ability to learn quickly, commitment to quality and safety, programming skills.

Figure 1 Skills required by 4.0 companies



3.1 Good practices

Partcipants in the online survey highlighted a set of good practices involving the application of the 4.0 paradigm

3.1.1 Spain

In Spain, for example, some companies use:

- **remote real time control** for fine machining;
- **smart sensors** for advanced statistical analysis of PLC sensor data along with quality input inspection to improve processes in the manufacturing field;
- **cloud** to share information with project management architecture firms;
- **inter-connection** among wrapping machines for packaging to speed up production and anticipate problems;
- **robots** to speed up the production cycle in a manufacturing company.

3.1.2 Austria: AVL Racing

AVL Racing was mentioned by Austrian respondents as an example of the world's largest independent company for the development, simulation and testing of all types of powertrain systems (hybrid, combustion engine, transmission, electric drive, batteries, fuel cell and control technology), their integration into the vehicle, assisted and autonomous driving as well as data intelligence. At AVL RACING they conduct tests with the power units using state of the art equipment. This could include component tilting, advanced simulation models, a driver simulator, artificial intelligence, as well as analytic functions for an enhanced usage of the testbed. A specially designed and developed drilling machine is used for optical drilling of PCB mounting systems. The machine, which is installed in a fully air-conditioned room, is designed for a 6σ process capability at 50µm. This is achieved through a complex interaction of high-resolution cameras, the most precise positioning devices, and perfectly coordinated software.

3.1.3 Czech Republic

The Czech respondents mainly work in the ICT and transports field; respondents working in companies specialized in ICT mentioned the use of **simulation systems and software to** simulate business systems and manufacturing processes by analysing system input and output; one of the respondents mentioned that his company developed **a Platform to monitor working conditions and allow predictive maintenance;** the platform includes software and hardware technologies and is also accessible to the suppliers with which the company collaborates. Another IT company develops

financial software for small businesses to innovate service delivery, radically changing processes and introducing new methods and practices

3.1.4 Italy: Arken

In Italy, it is worth highlighting the **automated warehouse** of Arken, equipped with automated machines able to transport semi-finished products to different sections of the warehouse where they undergo other processes; the warehouse is also equipped with an automatic air filtering and treatment systems that absorbs the dust produced by the working areas with which it is connected. This mechanism is fully automated and possesses a device that controls device to regulate the speed of the suction fans and the opening / closing of the suction vents located near the areas where dust is produced.

Arken also uses **Smart sensors t**o monitor continuously working conditions and process parameters and **ERP** to allow the integration in real time among all management processes, including administrative, logistic and commercial ones and the entire production and distribution chain: order / order confirmation / 3d cad design / order launch / cam processing for in-line processing on CNC machines / production and quality control / shipping / eventual installation / post-assembly assistance / billing / payment certificates. It makes use of the recognition of the pieces via QRcode and uses interconnected software such as: - Solidworks (cad) - Alfacam (post processor-cam) - Wodwoop (post processor-cam) - Software for data network protection.

Annexes

Annex 1

Interview framework for educational centres

Name:

Role:

Subject of your course:

Name of the educational centre:

1. **Are you familiar with Industry 4.0 or the 4th Industrial Revolution?**
   - Yes
   - No
2. **If yes, in which context and through which channels did you learn about it?**
   - Scientific magazines
   - TV
   - Workshops
   - Conferences
   - Fairs
   - Web
   - Other _____
3. **Is information over INDUSTRY 4.0 easily available (ex. Web-sites, TV, newspapers)?**
   - Yes
   - No
4. **How would you define Industry 4.0?**

5. **Please provide a list of topics you associate with Industry 4.0?**

6. **How relevant do you consider Industry 4.0 for your field and future trends?**

- Not at all relevant
- Only a little relevant
- Rather relevant
- Very relevant

7. Why do you consider Industry 4.0 relevant for your field and future trends?

8. How would you rate your knowledge about INDUSTRY 4.0?
(Ratings: 1= Very low; 2=low; 3= neutral; 4=high; 5=very high)

- 1
- 2
- 3
- 4
- 5

9. Please provide an assessment of your knowledge on the following different topics

	Very Low	Low	Medium	High	Very high
Cyber-physical systems (CPS)					
Internet of things (IoT)					
Cloud					
Cybersecurity systems					
Smart factory					
3D printing					
Additive manufacturing					
Big data Analytics					
Virtual reality					

10. Please provide your own assessment of trainees' knowledge of the different topics

	Very Low	Low	Medium	High	Very high
Cyber-physical systems (CPS)					
Internet of things (IoT)					
Cloud					
Cybersecurity systems					
Smart factory					
3D printing					
Additive manufacturing					
Big data Analytics					
Virtual reality					

11. How would you rate trainees' overall knowledge of Industry 4.0?

(Ratings: 1= Very low; 2=low; 3= neutral; 4=high; 5=very high)

- 1
- 2
- 3
- 4
- 5

12. Are Industry 4.0 topics integrated in your courses/activities? How?

Ex.: Use of ICT in a specific sector for data collection and analysis

13. What are the main obstacles for the integration of Industry 4.0 topics and tools into your institution's courses/curricula?

14. Please list any relevant courses carried out at your institution on industry 4.0 topics?

15. What are the main gaps in your knowledge about industry 4.0?

16. On which industry 4.0 topic do you think you need additional training in order to improve the quality of your course and facilitate students' transition to labour market? Why?

17. What are the main gaps in knowledge of Industry 4.0 among trainees/learners?

18. On which industry 4.0 topic do you think your learners need additional training in order to develop their technical and entrepreneurial skills and facilitate their transition to labour market? Why?

19. Are there enough efforts, provided by public authorities and your institution to promote knowledge of INDUSTRY 4.0 among young people?

20. Are there digital tools support available for trainers/coaches at your place of work?

- Yes
- No
- Don't know

21. Which ones?

22. How would you rate the quality of the technological support?
(Ratings: 1= Very low; 2=low; 3= neutral; 4=high; 5=very high)

- 1
- 2
- 3
- 4
- 5

23. Do you use digital tools in your work? Which ones?

24. Could you please estimate the time you use digital tools? (Hours/week)

25. How do you use digital skills/industry 4.0 technologies in your work?

26. Does your centre have a policy or strategy to foster and sustain industry 4.0-based innovations in course teaching?

- Yes
- No
- I don´t know

27. If yes, please explain its strategy and the areas that it covers

28. If No, do you think they may be useful for certain activities? Can you name some advantages?

29. To what extent is Industry 4.0 technology integrated into your working environment within your institution?

	Not at all	Only a little	Rather much	To a great extent
Communication and/or networking				
Development and learning				
Management tool				
…for organizing your work and keep records				
…for preparing lessons				
…for finding digital learning resources				
…for designing and producing your own digital learning resources				

30. What are the Industry 4.0 technologies used and for which purposes are they used (communication, learning, management…)?

31. What competences/skills do you think are required by companies?

- Self-knowledge
- Critical thinking
- Ability to collaborate across different areas/sectors/departments/companies
- Sistems thinking
- Self-initiative
- Flexibility/open-mindedness
- Teamwork / Multidisciplinary teamwork
- Multidisciplinary background/broad set of skills
- Creativity
- Lifelong learning
- Business thinking
- Tech fluency
- Empathy/Emotional intelligence
- Scientific process/problem solving
- Social skills/Interpersonal skills/Communication
- Leadership
- Other:_____

32. Does your course/institution train students to develop these skills?

- Yes
- No

33. If yes, how?

- Only a little
- Rather much
- To a great extent

35. Based on your experience and knowledge about learners' learning preferences, what is the most effective strategy to teach Industry 4.0 topics (presence learning/blended learning/online self-study courses?)

36. What should the content of a course on Industry 4.0 look like to be easy to read and understandable by learners?

37. What are your expectations from a course on Industry 4.0?

38. What are the benefits students can take from it?

39. What are the benefits you can take from it?

Annex 2

Interview framework for VET centres

Name:

Role:

Subject of your course:

Name of the school:

1. **Are you familiar with Industry 4.0 or the 4th Industrial Revolution?**
   - Yes
   - No
2. **If yes, in which context and through which channels did you learn about it?**
   - Scientific magazines
   - TV
   - Workshops
   - Conferences
   - Fairs
   - Web
   - other _____
3. **Is information on INDUSTRY 4.0 easily available (ex. Web-sites, TV, newspapers)?**
   - Yes
   - No
4. **How would you define Industry 4.0?**

5. **Please provide a list of topics you associate with Industry 4.0?**

6. **How relevant do you consider Industry 4.0 for your field and future trends?**
   - Not at all relevant
   - Only a little relevant
   - Rather relevant
   - Very relevant
7. **Why do you consider Industry 4.0 relevant for your field and future trends?**

8. **How would you rate your knowledge about INDUSTRY 4.0?**
   (Ratings: 1= Very low; 2=low; 3= neutral; 4=high; 5=very high)
   - 1
   - 2
   - 3
   - 4
   - 5
9. **Please provide an assessment of your knowledge on the following different topics**

	Very Low	**Low**	**Medium**	**High**	**Very high**
Cyber-physical systems (CPS)					
Internet of things (IoT)					
Cloud					
Cybersecurity systems					
Smart factory					
3D printing					
Additive manufacturing					
Big data Analytics					
Virtual reality					

10. Please provide your own assessment of your students' knowledge of the different topics

	Very Low	Low	Medium	High	Very high
Cyber-physical systems (CPS)					
Internet of things (IoT)					
Cloud					
Cybersecurity systems					
Smart factory					
3D printing					
Additive manufacturing					
Big data Analytics					
Virtual reality					

11. How would you rate students' knowledge of Industry 4.0?

(Ratings: 1= Very low; 2=low; 3= neutral; 4=high; 5=very high)

- 1
- 2
- 3
- 4
- 5

12. Are Industry 4.0 topics integrated in your course? How?

Ex.: Use of ICT in a specific sector for data collection and analysis

13. What are the main obstacles for the integration of Industry 4.0 topics and tools into VET school courses/curricula?

14. Please list any relevant courses carried out at your school on industry 4.0 topics?

15. To which extent do you agree with the idea to introduce INDUSTRY 4.0 as a normal subject in schools?

- Not at all
- Only a little
- Rather much
- To a great extent

16. Can you motivate your choice?

17. What are the main gaps in your knowledge about industry 4.0?

18. **On which industry 4.0 topic do you think you need additional training in order to improve the quality of your course and facilitate students' transition to labour market? Why?**

19. **What are the main gaps in knowledge of Industry 4.0 among students?**

20. **On which industry 4.0 topic do you think your students need additional training in order to develop their technical and entrepreneurial skills and facilitate their transition to labour market? Why?**

21. Are there enough efforts, provided by public authorities and your institution to promote knowledge of INDUSTRY 4.0 among students and teachers?

22. Are there digital tools support available for teachers in your school?

- Yes
- No
- Don't know

23. If yes, which ones?

24. How would you rate the quality of the technological support?

(Ratings: 1= Very low; 2=low; 3= neutral; 4=high; 5=very high)

- 1
- 2
- 3
- 4
- 5

25. Do you use digital tools with students? Which ones?

26. Could you please estimate the time you use digital tools? (Hours/week)

27. How do you use digital skills/industry 4.0 technologies in your courses?

28. Does your school have a policy or strategy to foster and sustain industry 4.0-based innovations in course teaching?

- Yes
- No
- I don´t know

29. If yes, please explain its strategy and the areas that it covers

30. If No, do you think they may be useful for certain activities? Can you name some advantages?

31. To what extent is Industry 4.0 technology integrated into your working environment within your institution

	Not at all	Only a little	Rather much	To a great extent
Communication and/or networking				
Development and learning				
Management tool				
…for organizing your work and keep records				
…for preparing lessons				
…for finding digital learning resources				
…for designing and producing your own digital learning resources				

32. What are the Industry 4.0 technologies used and for which purposes are they used (communication, learning, management…)?

33. What competences/skills do you think are required by companies?

- Self-knowledge
- Critical thinking
- Ability to collaborate across different areas/sectors/departments/companies
- Sistems thinking
- Self-initiative
- Flexibility/open-mindedness
- Teamwork / Multidisciplinary teamwork
- Multidisciplinary background/broad set of skills
- Creativity
- Lifelong learning
- Business thinking
- Tech fluency
- Empathy/Emotional intelligence
- Scientific process/problem solving
- Social skills/Interpersonal skills/Communication
- Leadership
- Other:_____

34. Does your course/school train students to develop these skills?

- Yes
- No

35. If yes, how?

36. **To which extent do you agree with the idea that INDUSTRY 4.0 is essential for the students to develop increasingly requested skills in the job market?**
    - Not at all
    - Only a little
    - Rather much
    - To a great extent

37. **Based on your experience and knowledge about students' learning preferences, what is the most effective strategy to teach Industry 4.0 topics (presence learning/blended learning/online self-study courses)?**

38. **What should the content of a course on Industry 4.0 look like to be easy to read and understandable by learners?**

39. **What are your expectations from a course on Industry 4.0?**

40. **What are the benefits students can take from it?**

41. What are the benefits you can take from it?

Annex 3

Questionnaire for the main leaders of innovation within the manufacturing sector

1. **What is your field of specialization?**

2. **What kind of 4.0 technologies is your company using? How?**

3. **Can you provide an example of good practice involving your company and the practical application of Industry 4.0 paradigm within the manufacturing field?**

4. **How would you rate the level of knowledge among manufacturing companies of Industry 4.0?**
   Ratings: 1) Very low; 2) low; 3) neutral; 4) high; 5) very high
   - 1
   - 2
   - 3
   - 4
   - 5

5. Please indicate the level of knowledge among manufacturing companies for each topic

	Very Low	Low	Medium	High	Very high
Cyber-physical systems (CPS)					
Internet of things (IoT)					
Cloud					
Cybersecurity systems					
Cloud computing					
Artificial Intelligence					
Smart factory					
3D printing					
Additive manufacturing					
Big data Analytics					
Virtual reality					

6. **Which knowledge do companies have about Industry 4.0 and its technologies? (Eg. IoT, Big Data…)?**

7. **How and how much are they using them?**
8. **Which obstacles are they facing?**
9. **How would you rate the level of knowledge among people in general of Industry 4.0?**
   Ratings: 1) Very low; 2) low; 3) neutral; 4) high; 5) very high
   - 1
   - 2
   - 3
   - 4
   - 5

10. Please indicate the level of knowledge among people for each topic

	Very Low	**Low**	**Medium**	**High**	**Very high**
Cyber-physical systems (CPS)					
Internet of things (IoT)					
Cloud					
Cybersecurity systems					
Industrial internet of things (IIOT)					
Cloud computing					
Cognitive computing					
Artificial Intelligence					
Smart factory					
3D printing					
Additive manufacturing					
Big data Analytics					
Smart sensors					
Virtual reality					
Wearable and Smart devices					

11. **Do you believe that employees in manufacturing companies need training on Industry 4.0? Why?**

12. **In which fields and on which topics do you believe that employees in manufacturing companies need additional training?**

13. **What competences/skills are required by 4.0 companies?**

- Self-knowledge
- Critical thinking
- Ability to collaborate across different areas/sectors/departments/companies
- Sistems thinking
- Self-initiative
- Flexibility/open-mindedness
- Teamwork / Multidisciplinary teamwork
- Multidisciplinary background/broad set of skills
- Creativity
- Lifelong learning
- Business thinking
- Tech fluency
- Empathy/Emotional intelligence
- Scientific process/problem solving
- Social skills/Interpersonal skills/Communication
- Leadership
- Other:_____

14. **Which professional profiles are required the most within 4.0 manufacturing companies?**

15. **Do you believe that teachers in VET schools and trainers/coaches in educational centres need additional training in order to prepare students to the 4.0 labour market? Why?**

16. **In which fields do you think teachers/coaches/trainers need training?**

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