

# STATE-OF-THE-ART ANALYSIS ON THE KNOWLEDGE AND SKILLS GAPS ON THE TOPIC OF INDUSTRY 4.0 AND THE REQUIREMENTS FOR WORK-BASED LEARNING IN ROMANIA

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## Abstract

*This paper reports the state-of-the-art analysis on the knowledge and skills gaps on the topic of Industry 4.0 and the requirements for work-based learning (WBL) consists of the results from a large-scale survey conducted among two target groups: manufacturing small and medium-sized enterprises (SMEs) and vocational education and training (VET) providers/trainers/consultants in Romania and cross-sectional analysis of the viewpoints of manufacturing SMEs representatives vs. VET providers. It is part of the Erasmus+ project “Work-based training approach in the field of Industry 4.0 for competitive European Industry”- iNduce 4.0. Based on the results from the researches carried out in Romania are defined the key points concerning the elaboration of the iNduce 4.0 training course and the iNduce 4.0 Practical methodology for WBL. It foresees the awareness of the Industry 4.0 topic, the training modules developed, the needed skills and the proportion of theory and practice.*

**Key words:** Industry 4.0 skills; work-based learning; manufacturing; vocational education and training

## 1. Introduction

According to PwC Global survey, 2016 regarding Industry 4.0 among SMEs, respondents report their biggest implementation challenge is lack of digital culture and skills in their organisation [1].

Cyber-physical systems [2] in lean environments [3], practice oriented learning [4], project based learning [5] enable the creation of work environments with new opportunities to purposefully facilitate learning. Also innovative tools [6, 7] and models [8] for vocational education and training and evaluation models [9] by means of mobile technology [10] may provide a learning experience that facilitates the development of Industry 4.0 skills and competences.

The “Work-based training approach in the field of Industry 4.0 for competitive European Industry”- iNduce 4.0 - project no: 2017-1-RO01-KA202-037222 is an Erasmus+ project, promoted by a consortium of organizations from 6 EU countries: Romania, Poland, Portugal, Germany, Bulgaria and Cyprus which aimed at promoting work-based learning on the topic of Industry 4.0, with special attention to apprenticeship training, by involving

social partners, companies and Vocational Education and Training (VET) providers [11].

The iNduce 4.0 consortium represents a Business-VET-research partnership on the ground, aimed at creating a flexible work-based training approach which will enable manufacturing SMEs to prepare their current and future employees (vocational students/apprentices) for the changes arising from the 4th Industrial revolution and will respectively enable VET providers/ trainers/ consultants to adequately respond to needs of the business by carrying out joint business-VET initiatives with focus on Industry 4.0 subject.

The iNduce 4.0 outcomes are:

- a) iNduce 4.0 training course that will provide the technical knowledge in the field of Industry 4.0 by encompassing all of its manifestations (ICT, smart robots, horizontal & vertical integration) and thus providing the knowledge basis for building a work-based training. It is foreseen to be

structured on 4 modules: Module1: Introduction to Industry 4.0; Module 2: Solutions for Smart Production Environments in the manufacturing; Module 3: Smart Robotics; Module 4: Application of CPS/IoT across the process chain.

- b) iNduce 4.0 Practical methodology for work-based learning will be aimed at equipping SMEs and VET providers/consultants/trainers with a step-by-step mentoring plan and apprenticeship programme tailored to the iNduce 4.0 training course, enabling SMEs as well as VET providers/consultants to organize work-based trainings on the topic of Industry 4.0 and thus create on the ground results.

In order to achieve this results it is performed a state-of-the-art analysis on the knowledge & skills gaps on the topic of Industry 4.0 and the requirements for WBL. It is aimed at mapping the most important knowledge and skills gaps in the field of Industry 4.0 and hardships manufacturing SMEs encounter in organisation of WBL initiatives in order to tailor all other outputs to the real needs of the manufacturing business and VET as well as to provide policy recommendations in the field of WBL. This paper presents the results of the study performed in Romania.

## 2. The survey

The survey is focused in 3 main directions:

- 1) defining the knowledge & skills gaps in the field of Industry 4.0 according to manufacturing SMEs and VET providers/consultants/trainers
- 2) defining the main hardships SMEs and VET providers encounter when organising work-based trainings
- 3) providing policy recommendations in the field of WBL and serving as supporting tool for evidence-based policy making

The activities that led to the creation of this result involved representatives of both VET and business with the aim of performing a cross-sectional analysis of both business and VET perspectives on WBL and Industry 4.0 knowledge and skills gaps that would enable tailoring the iNduce 4.0 training course and Practical methodology for WBL to the real needs of SMEs as well as formulating of recommendations for policy making in the field of WBL.

Results were obtained from a large-scale survey conducted among 2 target groups manufacturing SMEs and VET providers/trainers/consultants, providing information in 4 directions:

- extent of information regarding Industry 4.0 (identification of training needs)
- assessment of most relevant skills in regard to Industry 4.0 in the manufacturing sector
- preferences on learning structure (choosing best structure and interactive tools)
- hardships to organisation and carrying out of WBL activities/ training of apprentices.

## 3. The questionnaire

The distributed questionnaires to the two target groups manufacturing SMEs / VET providers/trainers/consultants are structured in 4 sections:

Section I: Identification of respondents – the group belonging to manages, executive, skilled worker, unskilled worker etc / owner, manager, trainer, etc.; the industry in which the enterprise is currently operating / the type of vocational education provider.

Section II: Industry 4.0 skills and knowledge gaps, identifies the importance of the concept of Industry 4.0, which of the topics from the four modules are useful in the company training:

Module1: Introduction to Industry 4.0: The concept of Industry 4.0; What are the benefits for SMEs; Module 2: Solutions for Smart Production Environments in the manufacturing sector: Machine learning & Machine-to-machine (M2M) communications in smart production; Application of Cyber-Physical-Systems (CPS)/ Internet of Things (IoT) in smart production; Application of 3-D printing in smart production; Application of Big Data and Cloud computing in smart production; Module 3: Smart Robotics: Programmable logic controllers and industrial computers; Industrial Robots – Programming and Applications; Mobile Robots and Their Applications; Module 4: Application of CPS/IoT across the process chain: Vertical networking of smart production systems; Horizontal integration via a new generation of global value chain networks; Acceleration through exponential technologies.

Then it is investigated which of the skills illustrated on figure 1 are deemed most important for successful implementation of Industry 4.0 in company.

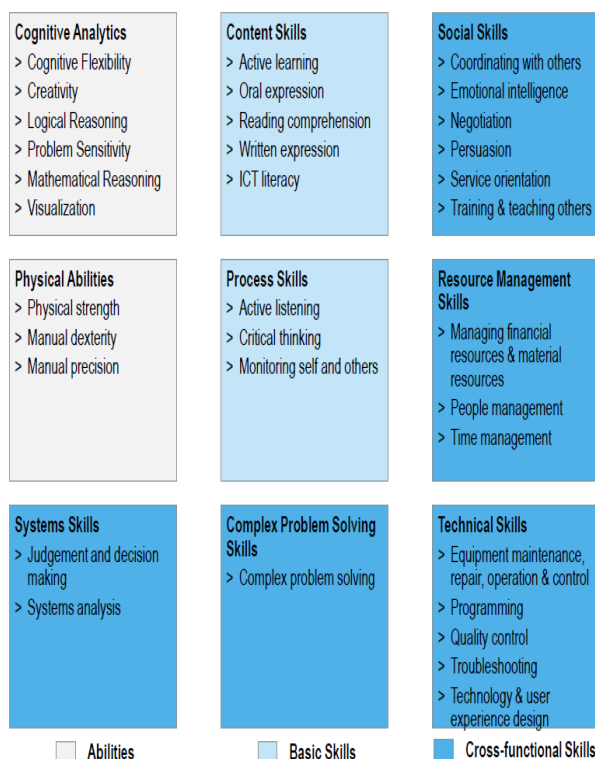


Fig. 1: Categorization of skills in skill family

Section III is dedicated to the experience with work-based learning, if the company/ VET provider ever participated/ organized WBL initiatives (internships, mentorship programmes, apprenticeships, work side field trips, job shadowing etc.), special onsite training programmes and main obstacles.

Section IV: Preferences and training needs, investigates the technological solutions/functions the company value the most in an interactive educational website and the best proportion of theory and practical on the job training when organizing WBL in the field of Industry 4.0

#### 4. Conclusion

The country analysis report in Romania collects the answers after the distribution of the questionnaires to 16 VET providers and 20 SMEs in the period November 2017- January 2018. It reveals the following conclusion:

(1)–Respondents of the surveys have a wide distribution from managers to trainers or workers so it was interviewed different positions from strategic management to operational management. The type of VET providers interviewed is mainly from continuous formal and non-formal vocational education. The

industry in which enterprises are operating is mainly from machinery, than textiles.

(2)–People from EFP provider institutions are less familiar with the concept of Industry 4.0, in comparison with people from SMEs which are more familiar, for whom the topic is somewhat important. Module 1 should be the most preferred as it is introductory, than Module 2 but also the others are needed. People from VET appreciate as important skills creativity, cognitive flexibility, basic skills, social skills, while people from SMEs appreciate complex problem solving, cognitive flexibility, critical thinking, technology and design of user experience. The skills people lack are the complex problems solving, system skills, creativity for VET people and technical skills, time management, coordination with others, service orientation, scheduling in SMEs. Training focused on specific topics and practical activities, dual training and on-the-job training are preferred by EFP people, while training of technical skills is most preferred in companies.

(3)–Approximate 1/3 of VET providers have participated/organized WBL initiatives in cooperation with companies, the main obstacles being the lack of time for resources, reluctance on the part of companies, logistics, adequate training materials, reluctance of companies and people. Most of the companies have participated/organized WBL initiatives, the main obstacles being the lack of time, resources, confidence in the method, information resources, theoretical materials to be combined with practical elements.

(4)–Preferences of training needs for EFP are: documents download; exchange messages with trainers and colleague trainees; powerpoint contents availability, etc. Preferences of training needs for SMEs are: exchange messages with trainers and colleague trainees; documents download; PDF contents availability; Powerpoint contents availability, etc.

(5)– The best proportion of theory and practical on the job training when organizing WBL in the field of Industry 4.0 is appreciated to be 40% theoretical and 60% practical on the job training.

#### References

- [1]PWC (2016) Global Industry 4.0 Survey, available at:<https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf>.
- [2] Schuh G., Gartzel T., Rodenhauser T., Marks A. (2015), *Promoting Work-based learning through Industry 4.0. Procedia CIRP*, vol. 32, pp. 82-87.

- [3] Moldovan F. (2018), *New approaches and trends in health care*, Procedia Manufacturing, vol. 22, pp. 947-951.
- [4] Karre H., et al. (2017), *Transition towards an Industry 4.0 State of the art LeanLab at Graz University of Technology*, Procedia Manufacturing, vol. 9, pp. 2013-2016.
- [5] Villa C., et al. (2017), *Project-based collaborative engineering learning to develop Industry 4.0 skills within a PLM framework*, Procedia Manufacturing, vol. 13, pp. 1269-1276.
- [6] Moldovan L. (2010), *Design and development of innovative tools and models for e-learning in central and western Romania*, Quality Management in Higher Education, vol. 2, pp. 543-546.
- [7] Moldovan L. (2010), *Innovative tools and models for vocational education and training*, Review of Management and Economic Engineering, pp. 282-290.
- [8] Moldovan L. (2012), *Innovative models for vocational education and training in Romania*, Procedia SBS, vol. 46, pp. 5425-5429.
- [9] Moldovan L. (2016), *Training outcome evaluation model*, Procedia Technology, vol. 22, pp. 1184-1190.
- [10] Moldovan L. (2015), *New evaluation model by means of mobile technology*, Procedia Technology, vol. 19, pp. 1094-1101.
- [11] iNduce 4.0 project website: <http://induce-project.eu/ro>.