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Work Competencies for Industry 4.0 Developed by Non-formal Education

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***Abstract*—This paper focuses on the characterization of the main challenges posed by the development of Industry 4.0 in the field of human capital formation in Slovakia. It follows the field of new job requirements, focusing on the analysis of demand for job competencies corresponding to the Industry 4.0 requirements. This paper is based on the analysis of empirical surveys in the field of work competencies demand in relation to Industry 4.0 development, which supports the idea of adopting procedures for greater recognition of non-formal education.**

Keywords—Industry 4.0, work competencies, non-formal learning

I. INTRODUCTION

A Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the 20th century. A fusion of technologies blurs the lines between the physical, digital, and biological spheres. "There are three reasons why today's transformations represent not merely a prolongation of the Third Industrial Revolution but rather the arrival of a Fourth and distinct one: velocity, scope, and systems impact. The speed of current breakthroughs has no historical precedent. When compared with previous industrial revolutions, the Fourth is evolving at an exponential rather than a linear pace. Moreover, it is disrupting almost every industry in every country. And the breadth and depth of these changes herald the transformation of entire systems of production, management, and governance" [1]. The innovative process of technological change, whose technological base is the Internet, formed the basis for analyzing Industry 4.0 concept as a new stage of the production process. The concept of "Industry 4.0" was recognized in Germany to refer to the development of "cyber-physical systems" (CPS) and dynamic data processes that use massive amounts of data to drive smart machines [2]. In the current strategic materials, the concepts Intelligent Industry, Industry 4.0 and Smart Industry or Industrie 4.0 are used to designate a production system based on information processing using the Internet. Schwab is sure that in its scale, scope, and complexity, the transformation will be unlike anything humankind has experienced before and the response to it must be integrated and comprehensive, involving all stakeholders of the global polity, from the public and private sectors to academia and civil society [1]. Industry development concepts 4.0 have a specific character in a variety of environments, such as the Industrie 4.0 concept in the German environment, the Smart Industry concept or Industrial Internet in the US, or initiatives in Japan and China. According to Boyes et all, the German concept of Industrie 4.0 that is characterized by its "reliance on the use of CPS capable of communication with one another and of making autonomous, de-centralized decisions, with the aim of increasing industrial efficiency, productivity, safety, and transparency" [3], is synonymous with Industrial Internet of Things (IIoT).

A. New job requirements - development of demand for work competencies on the way to Industry 4.0

Several foreign studies devote considerable attention towards theoretical and empirical analysis of qualification requirements development within the Industry 4.0 concept. In the German environment, the authors are focusing on the analysis of the teamwork competencies as well as the networking of all the elements that are part of the production process. In this context, collaborating team members are, in addition to people, also the machines themselves.

Requirements for teamwork in new types of work teams are, according to authors, key requirements, transforming qualifications needs and developing teaching and training towards Education 4.0. Similarly, Quint, Sebastian and Gorecky placed emphasis on working in mixed reality, combining elements of the real world and the virtual information world. Already in the process of education and training, the potential offered by a mixed reality, combining sensory experience and experience and information from the digital environment, should be exploited [4].

Defining the strategic goals of the Industry Concept 4.0 is a prerequisite for identifying future demand of manufacturing businesses in work competencies. It should

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be emphasized that the field of work competencies is terminologically diverse - in terms of innovative developments, the concepts of key competencies, critical competences, universal competencies, transferable competencies or skills can be found in the literature. The concept of transferable skills currently used in strategic materials is part of the upcoming revision of the concept of key competences which has been defined as a set of core competencies required for the Information society [5].

Analysis of new job requirements includes not only professional knowledge in terms of professional qualifications, but also skills in the sense of higher, universal, transportable competencies. Schwab was convinced that in the future, talent, more than capital, would represent the critical factor of production which would give rise to a job market increasingly segregated into "low-skill/low-pay" and "high-skill/high-pay" segments [1]. It can be assumed that the analysis of new job requirements in the context of the development of industry 4.0 will include competencies in three main categories of work competencies that are (Innovation in Education): a) subject-based skills - in terms of professional qualifications, including knowledge and skills related to the performance within a work place; b) higher order skills (HOTS) [6] - in terms of intellectual ability, from which the authors identify the capabilities of analytical, creative and critical thinking as the target ability; c) behavioral and social skills - such as the ability to work in a team.

B. Increasing recognition of the importance of soft skills

The new work requirements, which can be considered as the core of the formation of the most desirable subject-based skills, include the readiness to move away from the strict division between professions and the creation of decentralized structures in the formation of the content of professional qualifications. According to Schwab technology is one of the main reasons why incomes have stagnated, or even decreased, for a majority of the population in high-income countries: the demand for highly skilled workers has increased while the demand for workers with less education and lower skills has decreased [1]. The new requirements in computer skills should enrich the content of the professional qualification of workers. Although not at the highest level of professional computer skills, workers in manufacturing will use it to communicate with machines that are their collaborators. The work of Industry 4.0 worker will acquire the character of working with machines that can not only accurately, efficiently perform physically demanding tasks but with which a worker can communicate efficiently and quickly [7].

According to UK Centre for Legal Education [8] preparing the concept of a career in law (but it is also suitable for general education of each student and which they can use in a wider range of activities, both in employment and outside) divided general transferable skills into:

- problem solving
- intellectual skills
- communication

The concept of transferable skills should be created with a similar goal as the key competencies concept, identifying a set of key competencies in EU. According to the strategy New Skills Agenda, the original concept of core competencies (K8) containing competences communication in the mother tongue, communication in foreign languages, mathematical skills, digital competences, involvement in civic life, the competence of entrepreneurship and cultural sensitivity, is currently enriched with new generally important transferable skills, that include ability to solve problems and the competence of financial literacy [9].

C. Empirical studies on the dynamics of work skills requirements

The ongoing innovation process of Industry 4.0, whose technology base is the Internet, raises the need to monitor the work requirements development and human capital formation with its relevance to the needs of practice. The international studies bring data in the assessed importance of competencies needed in highly innovative work positions, according to which degree and focus of innovation on a work position differentiates the nature of desirable work competencies. The findings of Avvisati, Jacotim and Vincet-Lancrin, who analyzed the importance of the competences used, confirmed the diversity of preferred competencies, assessed not only by degree, but also by the different focus of innovation activity carried out within the job. The obtained data analyzes in detail the importance of the competencies in relation to the degree of innovation at work position [10]. Based on the empirical findings, respondents have highlighted some common as well as some specific capabilities in each of the innovation areas studied – in innovation overall, in product innovation activities, in process innovation and in method innovation activities.

In all the monitored innovation areas, the respondents emphasized the importance of creativity and critical thinking. Communication skills were rated as the most important in all areas, except for process innovations, where respondents highly valued the importance of IT skills at a similar level as analytical skill. These competencies are highly valued in other areas of innovation activity, except for product innovation activities, where the ability to coordinate joint activities reached higher level of importance. In summary, innovative workers assessed the "ability to come up with new ideas and solutions (creativity)", "readiness to think, judge (critical thinking)", and "ability to present ideas or product of the audience (communication skills)" at the highest level [10].

D. Soft skills developement and non-formal learning

In the current literature there are several claims that employers' demands for the necessary competencies for job

seekers are not sufficiently acquired and developed in the formal education process [11,12]. The capabilities identified as soft-skills can be developed during the academic studies or even better in the non-formal learning process. Young people can form in a complex series of competencies, including: teamwork and networking capacity; ability to communicate; personal effectiveness; self-development; creative and innovative thinking; leadership skills [13]. Non-formal education is a type of education that is realized through planned activities and is provided with some kind of support for education. Work-related learning, media and digital literacy as well as on-the-job training, where organizations can improve their employees' skills, include online learning and courses provided by civil society organizations [14].

Based on previous knowledge, we allow to formulating and verifying research questions:

Which key competencies are most developed by non-formal learning from the perspective of the participants?

Is there any relationship between soft skills development and the improvement of labor market opportunities from the perspective of the non-formal learning participants?

II. METHODS

To answer these research questions we use a secondary analysis of data that were collected in the Research Based Monitoring of Youth in Action Program (RAY) Project, which focuses on evaluating non-formal learning Erasmus+ projects. Our data analysis is based on standardized multilingual online surveys with project participants and project leaders/team members were conducted. Based on concepts and research instruments designed by the Institute of Educational Science at the University of Innsbruck in Austria and further developed by the RAY Network between 2009 and 2013, two multilingual online questionnaires – one for participants and one for project leaders/team members of E+/YiA-funded projects – were created, taking into account the experiences of the previous studies on YiA and adapting the questionnaires to the new programme E+/YiA [15].

This study indicates that participation in E+/YiA projects contributes to the development of key competences for lifelong learning in both participants and project leaders/team members [16].

Research data based on multilingual online survey were collected in two sequences - first in November 2015 and second in March 2016 on national Slovak level (508 participants) and international level. Data were collected in 27 countries: Austria, Belgium (Flemish-speaking community), Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Hungary, Italy, Latvia, Lichtenstein, Lithuania, Luxemburg, Malta, Netherlands, Portugal, Romania, Spain, Poland, Slovakia, Slovenia, Sweden and Turkey.

III. RESULTS

In presenting the results, it should first be recalled that the collected data are subjective, given that respondents subjectively assess the development of their own competences through participation in Erasmus+ projects. Considering this fact, we can observe that the quantitative analysis of results confirms competencies development via informal learning of project participants (answers to the question: "Through my participation in this project I learned better …").

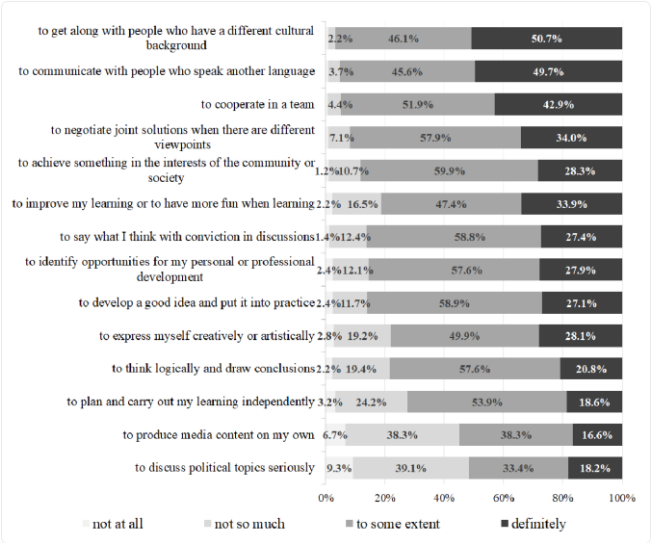

Fig. 1. Competences development focused on conducted analysis of survey participants (N=508). (*Source: Drawn by authors*)

We can observe in figure 1 competencies focused on common interests and solutions (like … *to get along with people who have a different cultural background, to achieve something in the interest of the community or society, to negotiate joint solutions when there are different viewpoints and to cooperate in a team*). We note that around 90% of all participants or more gave their consent answers recognizing development of mentioned competencies. Similarly, we noticed clear prevalence of opinion that projects gave a strong support for the development of their future professional perspectives and practical skills, when 5/6 of respondents agree with statement that through the participation in this project they learned better to develop a good idea and put it into practice and to identify opportunities for their personal or professional future. Conversely, participants have learned at least these competences which are related to the critical use of computers and current technologies, or the ability to discuss political topics seriously, where more than half respondents did not, or even did not, learn anything at all.

Differences by age: when comparing age groups we come to the basic finding that differences are mostly minimal and in only two cases we observe statistically significant differences. Both are related to participants from the oldest age group (26+), who, compared to others, have

learned significantly better to create a media content independently (Cramer V = 0.119; $p < 0.05$), but on the contrary, to a much lesser extent than others have learned to get along with people from different cultural backgrounds (Cramer V = 0.125; $p < 0.05$). At the same time, it can be stated that the participants from this age group (26+) have the highest overall score, which indicates that they have learned the most during the projects compared to the others, however these differences are not statistically significant, $p > 0.05$. The youngest participants youngest compared to others, have learned better to communicate with people who speak other languages and how to work together in the team (also these differences are not statistically significant, $p > 0.05$.)

If we focus on analyzing the relationship between age (instead of age categories) and the development of work competences, we reveal some new connections. There are a positive relationships between age and the development of ability to find opportunities for their personal or professional development (Spearman's rho = 0.103; $p < 0.05$) and ability to discuss political topics seriously (Spearman's rho = 0.090, $p < 0.05$) by participating in the project.

Subconsequently we focus on relationship analysis between soft skills development and the improvement of labor market opportunities from the perspective of the non-formal learning participants.

TABLE I. CORRELATION BETWEEN COMPETENCY DEVELOPMENT AND LABOUR MARKET OPPORTUNITIES PERSPECTIVE

Competency	**Answer: *I believe that my chances of getting a job have increased.***	
	Spearman's rho	***Statistic signif.***
to identify opportunities for my personal or professional development	0.380	p<0.001
to communicate with people who speak another language	0.319	p<0.001
to negotiate joint solutions when there are different viewpoints	0.312	p<0.001
to get along with people who have a different cultural background	0.297	p<0.001
to achieve something in the interests of the community or society	0.292	p<0.001
to cooperate in a team	0.282	p<0.001
to develop a good idea and put it into practice	0.221	p<0.001

Source: Elaborated by authors

In the Table 1, we can clearly observe the strongest correlation between participants' beliefs that their chances in the labor market have improved and the development of competence to identify opportunities for their personal or professional development (Spearman's rho = 0.380; $p < 0.001$), to communicate with people who speak another language (Spearman's rho = 0.319; $p < 0.001$) and to negotiate joint solutions when there are different viewpoints (Spearman's rho = 0.312; $p < 0.001$).

Differences by gender: the conviction of men that their job opportunities have increased is most correlated with the development of key competences to learn, digital competence and media literacy, and at least with the development of core competences of entrepreneurship, communication in foreign languages and cultural awareness and expression.

Women's conviction that their job opportunities have increased is most correlated with the development of key competences to learn, initiative and entrepreneurship, and at least with the development of key competences, cultural awareness, media literacy and civic competence.

IV. CONCLUSION

Defining the strategic goals of the Industry Concept 4.0 is a prerequisite for identifying future demand of manufacturing businesses in work competencies. As we have noticed, in addition to the growing demand for the development of digital and mathematical skills that we perceive as hard skills, several experts in the field emphasize the growing requirements for soft skills, which transforming qualifications needs and developing teaching and training towards Education 4.0. As well, examining the effective ways of upskilling and retraining of work force offers the possibility to maintain sustainable human capital developing in the context of Industry 4.0 formation. On the other hand, the idea of competence development by lifelong learning is also supported by results of conducted analysis focused on competences in Slovakia support importance of long-life learning and non-formal learning will be increased.

According to a document from Pešek and Dudáč [17], the development of competences through non-formal education can be a response to youth unemployment. Youth organizations form the basis of non-formal education and the projects in which young people have participated support the development of competences needed for their employability, as evidenced by research on the impact of non-formal education in youth organizations on the employability of young people. Because the labor market demands competencies that are being promoted here. The experience gained and the competences acquired in these organizations, in their projects, contribute to employability. In our analysis, we found that there is a positive link between employability and the development of key competences from the perspective of participants in youth projects, which supports the idea of adopting procedures for greater recognition of non-formal education.

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