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Thesis of Doctoral Dissertation

**Changes in future Human Resource (HR) demands,
considering robotization and sustainable development**

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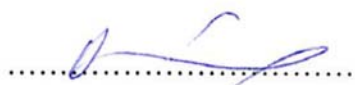
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A handwritten signature in blue ink, appearing to be 'J. Lehota', written over a horizontal dotted line.

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1. BACKGROUND, OBJECTIVES AND TASKS

“How will humans live after 2025, and where is the need for a smaller labor force in the changed economy?” (Frey and Osborne 2017)

The development of technology has repeatedly transformed the labor market throughout history. This development and constant change require different attitudes other competencies and thinking. The accelerating pace of change is demanding more and quick responses in all areas.

A prerequisite for achieving and maintaining a competitive advantage is a human resource strategy that responds to the radical challenges in all areas of robotization and digitalization, following an initial flow of Industry 4.0 and Industry 5.0, based on multidisciplinary thinking, with a global vision and design according to long-term sustainable plan. By analyzing the pull sectors of robotization and evaluating global processes, we can prepare for the impact in the next decades on the labor market.

The labor market requires a different structure, a new working environment and work culture, competencies and paradigm shift in response to the challenges. Higher education must clearly respond to and prepare for changing needs in order to work effectively. Changes in demand can be examined on the demands generated by employers, and employees.

Their expectations towards higher education are not only expressed by employers but by students as prospective employees who will work under changed circumstances. Therefore, it is important to assess how they see the processes, because it is also a reflection of their preparedness for robotization.

1. Table: Research topic's goals and hypotheses.

Goals	Hypotheses	Method of analysis / level of measurement
G1	<p>H1. Among the global factors of technological innovation, the Industry 4.0 will mainly influence the future of work, the most important factor is the need for a highly qualified workforce, primarily with technological and IT skills. Decisions are influenced by age, educational attainment, and specialization of workplace and study. ✓ hypothesis partially verified</p>	<ul style="list-style-type: none"> • Traditional Content Analysis • Descriptive statistics • Average, standard deviation, average deviation, median, • Visual analysis of the results of the Likert scale, using a bar chart, • Crosstabs. • Multidimensional scaling
	<p>H2. The radical impact of Industry 4.0 may have a positive impact on the labor market, as the flexibility of working, the importance of special fields and the importance of creativity are increasing, and the role of small businesses is increasing. ✓ hypothesis partially verified</p>	<ul style="list-style-type: none"> • Traditional Content Analysis • Descriptive statistics • Average, standard deviation, average deviation, median, • Visual analysis of the results of the Likert scale, using a bar chart,
G2	<p>H3. Industry 5.0 is not a straightforward continuation of Industry 4.0's key features that affect the labor market, based on Keynes's theory of non-linear but complex systems ✓ hypothesis partially verified.</p>	<ul style="list-style-type: none"> • Content analysis, secondary data analysis, literature research
G3	<p>H4. Analyzing the impact of digitization and robotization on the demand for competencies in the labor market: Based on data from secondary research, problem solving is the most important expected skill. Creative thinking and fast information processing (fast learning and proficiency in info communications) will become important skill in the future. ✓ I fully accept the hypothesis</p>	<ul style="list-style-type: none"> • Traditional Content Analysis • Descriptive statistics • Average, standard deviation, average deviation, median, • Visual analysis of the results of the Likert scale, • using a bar chart, • Crosstabs. • Multidimensional scaling
	<p>H5. Industry 4.0 and Industry 5.0 is reducing the scope of routine tasks, increasing the importance of soft skills, and the demand for highly and multidisciplinary skilled workforce. The role of problem solving, flexibility and creativity is increasing. On the threshold of industry 5.0, besides technological knowledge, the individual characteristics of human beings become important. ✓ I fully accept the hypothesis</p>	<ul style="list-style-type: none"> • Content analysis, secondary data analysis, literature research • Visual analysis of the results of the Likert scale, • using a bar chart,
G4	<p>H6. Students are open to cooperation with humanoid robots during training and work, and want to develop their knowledge according to the demand of the labor market by introducing the new technologies developed by Industry 4.0 and Industry 5.0. ✓ hypothesis partially verified.</p>	<ul style="list-style-type: none"> • Descriptive statistics • Average, standard deviation, average deviation, median, • Visual analysis of the results of the Likert scale, • using a bar chart. • Crosstabs

C1. Investigation of the elements and impact of Industry 4.0 and Industry 5.0 on the labor market, with particular emphasis on robotization. My attention at this stage was examining the impact of future megatrends on future of work, especially with Industry 4.0 and technological innovations, globalization, climate change, demographic change, urbanization, and the global economy. Changes in labor market demand, and the main focus can be identified, underlining the factors that will primarily affect human work in the coming decades.

C2. An in-depth study of Industry 4.0 and Industry 5.0 and analysis of secondary statistics on the subject. My research focused on the market effects of robotization, including industrial and service robots, and employment. I focus on sectors requiring high-tech solutions, research and development, small business activities and robotics, predominantly evaluating the potential and situation of the Visegrad Countries (V4) and Hungary.

C3. Examine empirical and secondary data for new competencies and, skill needs generated by robotization in the future workplace. The possibility of using the result is not only important for the selection or motivation of the workforce, but also has an impact on general education, including higher education.

C4: Utilize empirical research, to assess how the challenges of Industry 4.0 and 5.0 might have a strong impact on the training of future labor market players. In doing so, I analyzed which factors play a key role in preparing trainers and students for future market conditions, which require special attention when developing training strategies.

1.1 Research topics

My research topic is based on the radical processes that are generated by robotization and digitization, taking into account sustainability - which, according to the literature, surpasses the effects of any industrial revolution. Their global impact is exacerbated by the interplay of the economic and natural effects of climate change and other global energy factors. The research focuses on three topics.

- Industry 4.0 and Industry 5.0, as well as factors that radically affect working conditions
- The effects of technological breakthroughs, key competencies, which are essential elements for the future efficiency of human work, based on the idea that if we anticipate the effects of robotisation, then not the technological unemployment described

by Keynes will be the future. Prepared for the new challenges, labor force able to find new possibilities and tendencies.

- The third topic, based on the first two successive thoughts, raises the need for restructured education that meets the expectations of the future workplace. The expectations for other competences, soft skills, also preparation for new challenges, the implementation of new attitude is an integral part of the preparation.

I focused on global influences, and examined it from the perspective of the future employee with empirical research.

1.2 Introduction of empirical research

During my research in the field of future of work I joined the research team of the Szent István University Management and HR Research Center “Shortage of specialists and retention in key jobs 2017”. The leader of the research team Professor Dr. József Poór, the member of the Hungarian Academy of Sciences.

At Óbuda University, University Research, Innovation and Service Center, I am working on biographical research of Prof. Dr. Antal K. Bejczy NASA researchers oeuvre. During my biographical research in the field of robotics I joined the scientific research of robotization and impact of the labor market. I have more than 17 years of experience in the field of HRM at multinational technical companies. My research is based on the results of latest theoretical and empirical researches of the Industry 4.0, based on the analysis of the factors influencing human work, secondary research data, new statistical data of the KSH, high-tech industry and knowledge intensive services database of EUROSTAT and International Federation of Robotics. Based on primary online research of students at Óbuda University, I examined main influential factors of labor market as the global effects in the future and the new expectations of the competencies at future workplace. During my research I focused on the student’s attitude to cooperation of the humanoids in training and work and openness to teach and learn new technologies.

2. MATERIAL AND METHODS

2.1 Presentation of the research phases and samples

My research uses the elements of deductive theory, which is characteristic of social sciences, and focuses on the most important explanatory factors. In terms of time dimension, research is a longitudinal study, the essence is to observe over a longer period, and so detailed information about temporal processes can be obtained. By literature research, the published relevant materials of international

and domestic publications, literature on literature, periodicals, statements by professionals and politicians who have significant influence on the subject have been reviewed. The methodology of the literature research is mixed, selecting the relevant documents after the definition of the keywords, using the method of the literature chain. An analysis of quantitative, statistical data and analysis of primary data by questionnaire survey was performed. The questionnaire survey used the so-called closed and semi-closed question types. At the beginning of my empirical research, based on the data of secondary research, I formulated research topics and hypotheses. The main method was the online anonym questionnaire method. The questions were grouped around three large, interacting key areas, after that I incorporated the questions formulated by the experiences of the secondary research. I analyzed the result of the online survey by Evasys software, and IBM SPSS statistical program. I compared the results with the results of the secondary research. After summarizing the results, I highlight the key points as further research proposals

2.2 Data collection method, experience of empirical research

The empirical social science research by method of online questionnaire based on primarily quantitative variables, provides an opportunity to study the relationships and relationships between variables. According to Bertram (2014), the Likert-scale was named after Rensis Likert American psychologist and sociologist who developed his method to study attitudes in 1932. The essence of the method is, -according to Zerényi (2016), - that different statements are evaluated on a scale of five or seven degrees between two extreme endpoints. In both cases, one endpoint shows total consensus and the other extreme represents total denial. Due to the odd number of stages, it is possible to give a shaded and neutral response.

The collected answers and data were processed and analyzed in IBM SPSS Statistics. The characteristics of the respondents are nominal and ordinal variables.

3. RESULTS OF EMPIRICAL RESEARCH

3.1 Characteristics of participants in empirical research

The basis of the empirical research and questionnaire was the literature, the methodology of the research is mixed, the selection of the relevant documents after the definition of the keywords, the use of the literature chain method. The survey was an anonymous online questionnaire survey at the Óbuda University, with non-compulsory completion. The total number of students in the examined period was 11436. The sample consists of students from a higher education institution focusing on the technical and IT field. They will working in the key sectors in the future, and feel the effects of robotisation

radically. Their opinions reflect not only their attitudes, but also show how much knowledge they have about robotization.

Students' opinions were received through a voluntary online questionnaire in Evasys System. Students in the sample were dominated by technical (OE total: 7989 persons) and IT field (OE total: 2261 persons), and as experienced in the world of work, in the sample, men are overrepresented in the field of IT and engineering. Sampling is random.

I. Research phase

Time: April 2017 - June 2017

Data collection method: questionnaire online survey

Sample: Students of Óbuda University

Sampling size: 282

Outcome: Recasting the questionnaire

II. Research phase

Time: September 2017 - January 2018

Data collection method: questionnaire online survey

Elderly: Students of Óbuda University

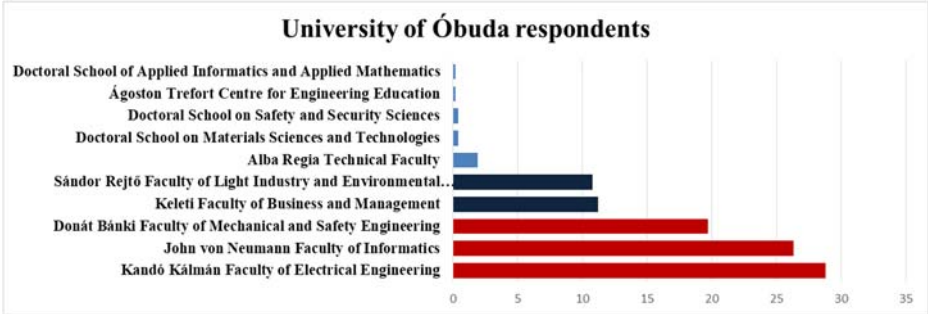
Sampling size: 489

Result: The sample is qualitatively and quantitatively relevant to the basic population.

The research method of online questionnaire empirical social science research, primarily for quantitative variables, provides an opportunity to examine relationships between variables, as well as relationships, using theories, methodologies, and hypotheses from published statistical data. Following the modifications, the questionnaire query can be divided into two phases, a 282 person interviewed in 2017, mainly a 5 degree Likert scaling questionnaire on the main topics. The five-degree scale was ineffective because of the large number of answers in the middle. The questionnaire survey used the so-called closed and semi-closed question types to clarify the topic with the answers provided by the respondents, not only along with the answers offered. With dichotomic and multiple output questions start to clarify possible responses then the six-point Likert-scale and importance scale was mostly used to compel middle responders based on secondary research and the test questionnaire.

The online survey was compiled and the primary evaluations in Evasys system, regarding element number, mean, median, standard deviation, and average deviation. Descriptive summaries form the basis for more complex statistical analyzes. After processing, the data is represented in bar graph.

I analyzed the multivariate sample in a cross table and then graphically represented it. Following the introduction of multiple variables, I made a Pearson Chi-square test. The Chi-square examines the relationship between the variables, our null hypothesis is that the two variables are independent of each other. The Pearson's Chi-square (X²) test, named after Karl Pearson's English mathematician, is suitable for examining discrete or similar variables, and refers to the relationship between two variables, whether there is a significant relationship between two variables. According to the statistical data of Óbuda University in 2017, male students were overrepresented in technical and IT fields. Women are overrepresented in the economic field compared to male students. While in natural sciences, the headcount was insignificant, but it was almost the same in terms of gender distribution. 79.4% of the students who participated in the research 79,4% were men and 20.6% were women. One of the questions asked by the research about student work showing interesting results. Nearly 55.3% of respondents was working. The respondents of the empirical research belong primarily to the Y and Z generations. The 49.4% of respondents belongs to the Y generation, 39.3% to Z generation. After test version total of 489 responses were received in 2017. Based on the job classification, 27.1% work for multinational companies, 18.7% work for their own businesses, 15.1% at small businesses, 15.1% for the public sector, and 14.1% for medium-sized companies. Respondents by workplace overrepresented from the technical field, and the others from the manufacturing sector to service, IT and other sectors are mixed. Professional area of respondents have typically engineering / engineering / quality management (56.6%) and 18.4% IT and telecommunication. Respondents typically have secondary education, 49.3% high school, 33.7% vocational secondary education, they are undergoing basic education. The students who participated in the questionnaire survey responded in the following proportions according to faculties. (Figure 1)



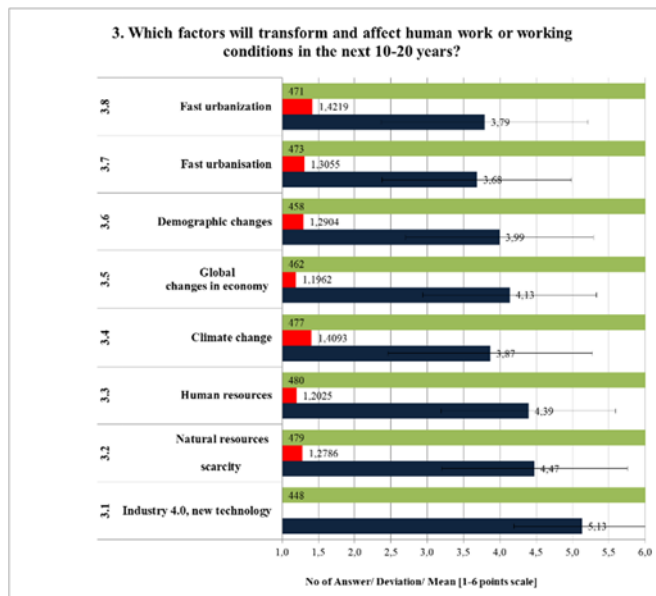
1. Figure. Data of empirical research respondents broken down by Faculties. Source: Edited by Author.

Summarized the result, half of the respondents are working addition to studies, primarily in multinational companies, or in a mixed sector in their own business, but they are mainly students in the technical field, typically employees, and bachelor.

3.2 Results of hypothesis tests

H1: Among the global factors of technological innovation, the Industry 4.0 will mainly influence the future of work, the most important factor is the need for a highly qualified workforce, primarily with technological and IT skills. Decisions are influenced by age, educational attainment, and specialization of workplace and study. The question of global effects was represented in a column diagram, on which I calculated the mean and standard deviation, and the element number. In high response rates, respondents set the following order of importance on the 6-points Likert scale. (Figure 2)

- Technological innovations, the impact of Industry 4.0 is considered to be the most radical factor,
- scarcity of natural resources, and
- human resources, appropriately trained are the three key factors.



2. Figure. Results of the empirical research questionnaire: 3.0-3.8.

Source: Edited by author

Changes in the global power, the economy and demographic are among the top five influencing factors. According to the respondents, the impact of climate change, migration and urbanization are the least powerful influencing factors of future work. Climate change is also a key issue for sustainability, but weak role in the responses. Therefore,

it is also an important result for decision-makers that the factors that really influence radically in the thinking of future employees are not sufficiently weighted. The global effects underlying my hypothesis were further investigated by multivariate cross-table analysis of the fact that generations (X, Y, Z) have the highest educational attainment data and the classification of the workplace influences this decision to consider a global impact to be important. The significant correlation between the variables was checked with the Chi-square test. The Chi-square test can be used to check the null hypothesis (H0), which is the following in a correlation test. There is no correlation between the variables examined. If the significance level for the Chi-square value is lower than 0.05, the null hypothesis is discarded, otherwise it is retained. The significance value comes from comparing the theoretical value of the Chi-square distribution with the value of Chi-square calculated from our data. Checking the null hypothesis (H0) with the Chi-square test, there is no significant correlation between the variables because $P > 0.05$, which means that in the job of the future the three most influential factors like age, educational level and job influences cannot be justified, the variables do not depend on each other. Looking further the variables, however, the Chi-square test showed a significant correlation between the level of education and the two low-impact megatrends. According to high level educated responders the demographical change has stronger impact for future work. This shows that higher qualification give more accurate information about demographic changes. (Table 2.)

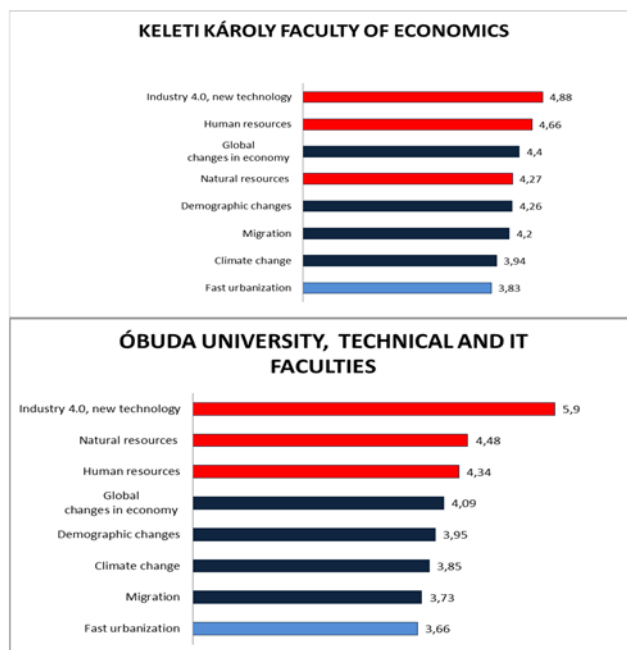
2. Table. Significant correlation between variables with Chi-square test

Pearson-Chi-square test	X, Y Z gen.	Y, Z gen.	Level of education	Gender	Workplace classification	Faculty
Technological innovations	0,962	0,808	0,239	0,071	0,184	0,622
scarcity of natural resources	0,213	0,214	0,701	0,311	0,077	0,808
Human resources	0,522	0,555	0,324	0,223	0,408	0,009
Climate change	0,688	0,345	0,408	0,269	0,989	0,568
Change of global power	0,570	0,704	0,595	0,177	0,454	0,835
Demographic changes	0,434	0,387	0,035	0,418	0,251	0,090
Urbanization	0,884	0,842	0,454	0,037	0,571	0,906
Migration	0,168	0,600	0,032	0,126	0,676	0,052

Source: Edited by Author

Although respondents considered the importance of fast urbanization as the least important, analyzing the significant correlation shows that male students are divided on the scale, while female students consider this factor to be more radical. Looking at all factors, we can say that female students are more determined than male students, evaluating scaling responses. Considering the significant result between highest

level of education, and migration, - filtering out a small-numbered PhD respondent - and analyzing the result of cross table the data shown interesting result. The students at Faculty of Light Industry and Environmental Protection Engineering chose the most six point on the Likert-scala for scarcity of natural resources, so the result also confirms that the knowledge of the topic influences the answers according to the learned field. Analyzing significant correlation between the influential impact of human resources and faculties, more students in the field of Economics and Mechanical and Security Engineering chose higher importance level answer, rather than Electrical, IT Engineers and Light Industry and Environmental Engineers. The breakdown of the respondents into the economic, technical and IT faculties can be seen in the fact that students of technical sciences consider the technological changes as more radical than students studying in economics. However, students of economic sciences consider the impact of human resources stronger than influence of natural resources. According to them, natural resources are only the fourth influencing factor rather than the second, and the third is the global changes in the economy. (Figure 3)



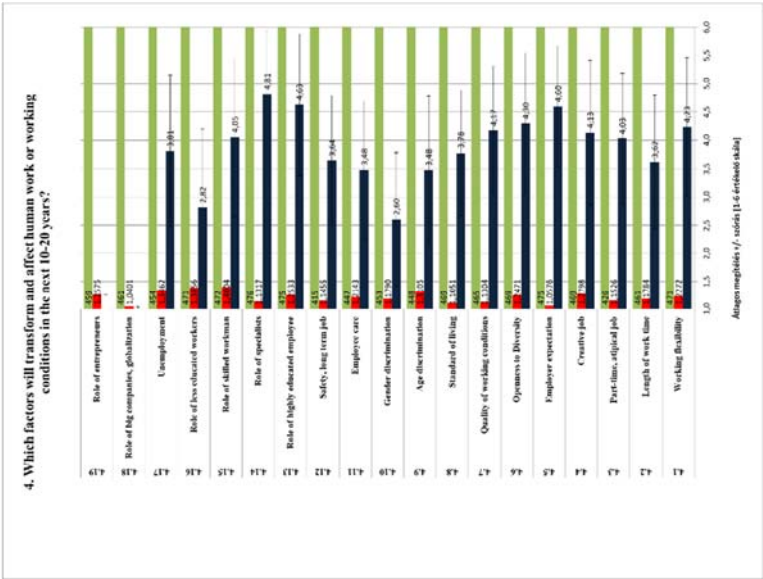
3. Figure. The importance of megatrends by faculties.

Sources: Edited by author

According to the responses of students in the field of economics and technology and IT, was still the least important factor the rapid urbanization in the future. It can be said that global factors are assessed as influencing factors for future work based on six-point

Likert scaling responses. Responding students therefore think that every global factor will have an impact on the future workplace, but the impact of robotization and digitalization and the lack of a properly trained workforce will be the most radical. In their opinion the impact of lack of natural resources more important than impact of climate change. Although the impact of migration and urbanization and demographic changes are considered important, but they are not taken seriously. It is clear from the breakdown of students in economics and technology and IT that the field of study has an influence on the way of thinking, the vision, and the attitude.

H2. The radical impact of Industry 4.0 may have a positive impact on the labor market, as the flexibility of working, the importance of special fields and the importance of creativity are increasing, and the role of small enterprises increasing. According to respondents, the number of jobs requiring special skills is increase most radical which supports the hypothesis for these variables. According to the respondents, however, the dominance of large companies will be characteristic of, the number of small enterprises will be decrease, so the hypothesis is not supported by the questionnaire survey. (Figure 4.)



4. Figure: Results of empirical research questionnaire: 4.1.-4.19.
Source: Edited by author

According to the respondents, half of whom already have already professional practice, thing that the strengthening of globalization is still more decisive than the vision of small companies in the context of changing labor market factors. According to their future vision,

instead of working time, their flexibility is changing, though not radically, typically with more atypical work opportunity. Highly skilled, specialized knowledge will be more important than low-skilled jobs. Job security, workplace care and standard of living less grow than quality of working conditions. Openness increases, discrimination decreases.

H3. Industry 5.0 is not a straightforward continuation of Industry 4.0's key features that affect the labor market, based on Keynes's theory of non-linear but complex systems. Hypothesis H3 was not based on empirical research, but on the analysis of literature in the previous chapters and the analysis of secondary statistics. Based on the research, Industry 4.0 still in most parts of the world is at the beginning, but in parallel has already started proliferation of Industry 5.0, from cobots to synthetic biology. Although there has been an overlap between industrial revolutions, the accelerated process is also exemplified by the parallel development of Industry 4.0 and Industry 5.0. With the help of the STEM and HECI models I explain the basic difference between Industry 4.0 and 5.0. Singularity and network research are good examples of parallel processes, in context, connected by certain hubs, but content and processes are accelerating and escalating unpredictably. On the basis of multidiscipline sciences and the elements of Industry 4.0 evolving the seeds of Industry's 5.0. in parallel develop, interrelate and branch together with the Industry 4.0 processes. This parallelism can not only be explained that Industry 5.0 return back the human touch by human creativity unlike fully robotized factories as part of Industry 4.0. During parallel development of Industry 4.0 and 5.0 according to my secondary research there are some special solutions and needs that are more efficient with solution of Industry 5.0, and others by Industry 4.0. Industry 5.0 will increase collaboration between people and intelligent systems, combining high-speed industrial automation with the ability of cognitive, critical, innovative thinking.

H4. Analyzing the impact of digitization and robotisation on the demand for competencies in the labor market: Based on data from secondary research, problem solving is the most important expected skill. Creative thinking and fast information processing (fast learning and proficiency in info communications) will become important skill in the future. Data from both the secondary and the online surveys clearly show that respondents consider problem-solving skills a key competence in their future workplace. The problem-solving ability did not share the respondents, as see the lowest standard deviation.

H4, H5: The survey participants assessed the following competencies on the six-point Likert scale with an average of over 5 or 5 in the future workplace, ranking. (Figure 8)

- Problem Solving (5,3)
- Use of modern information technologies (5,2)
- Speed of obtaining information (5,1)
- High-quality knowledge, up-to-date expertise (5,1)
- Fast Learning (5,1)
- Innovative thinking (5)
- Self-precise work (5)
- Advanced knowledge of at least one foreign language (5)
- Flexibility, openness to change (5)
- Interest in advanced technologies (5).

H4, H5: In my opinion the context of the changes generated by Industry 5.0, next to robotization, in addition to the appearance of cobots and synthetic biology, the creativity and high level innovation can be the major, so-called positioning factor for humans compare to robots. Nevertheless, the result of the empirical research did not bring any outstanding results in terms of creativity, and this factor was not classified as the most important category. But innovative thinking is relevant according to literature and empirical research it will be an important breakthrough against robotization. Least-important competencies according to respondents who gave the lowest average rating on the 6-grade scale

- High level of writing skills (3.8)
- Monotony tolerance (3.9).

The Chi-square test in relation to faculties and the first six most important competencies shows significant correlation in the case of fast learning (Table 3).

3. Table. Significant correlation between variables with Chi-square test

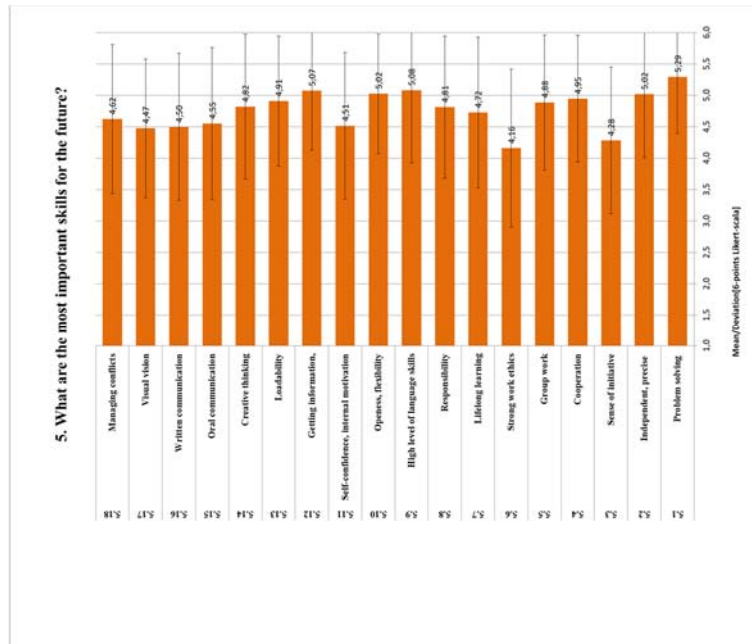
Pearson-Chi-square test	Faculties
Problem solving	0,564
Use of modern information technologies	0,448
Speed of obtaining information	0,596
High-quality knowledge, up-to-date expertise	0,180
Fast learning	0,022
Innovative thinking	0,639

Source: Edited by author

Further analyzing of the cross-table data generated by SPSS, for economists the fast learning and innovative thinking competencies more important with lower deviation. In the case of fast learning,

It is interesting result that work ethic not so important. This value is inconsistent with the result of secondary research, where ethical work

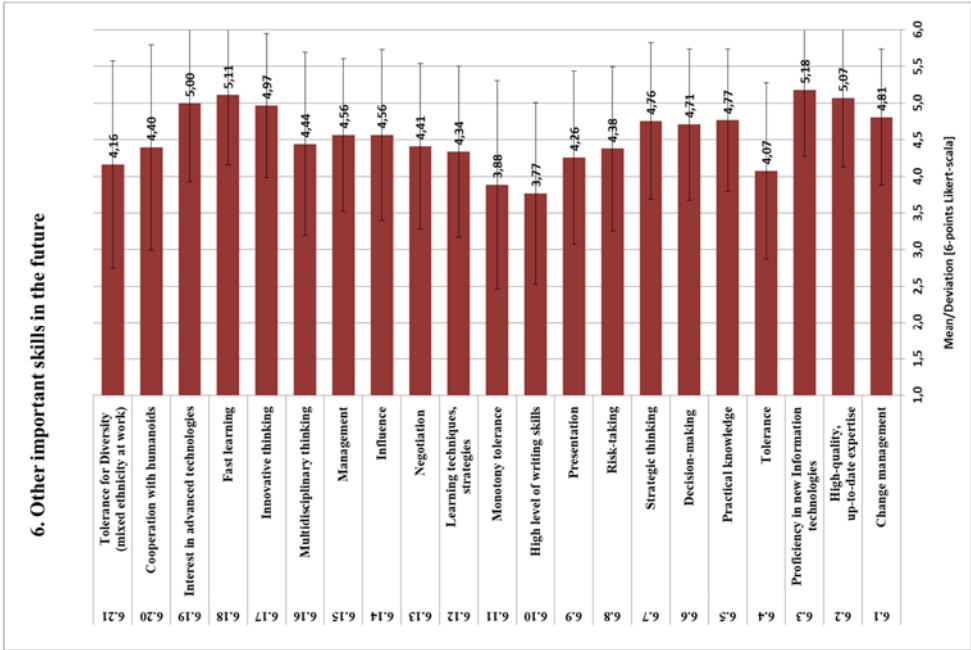
is also emphasized by the increasing demand for cyber security. Summary the vision of students about future work, the problem solving, independent, accurate work, fast learning of information and high level knowledge of modern technologies more important than today's much-emphasized collaboration or teamwork. Respondents consider up-to-date, high-quality expertise to be more important than multidisciplinary field of expertise. Respondents from the Óbuda University believe that the age of specialists will come. Future studies opinion on this issue are divided. (Figure 5.)



5. Figure. Results of the empirical research questionnaire: 5.0 - 5.18.
Source: Edited by author

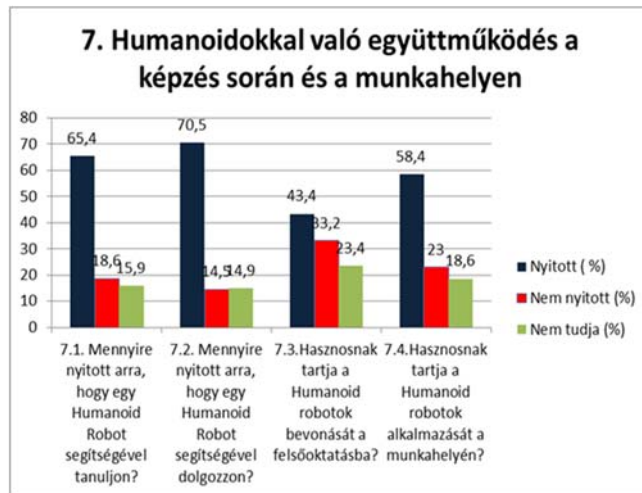
According to the respondents, innovative thinking is emphasized in the future workplace, which related to higher level of creativity, innovations, patents, non-standard, not simply creative solutions. Knowledge of new technologies, proficiency in multiple disciplines is essential for respondents in the future, including high-level practical language skills. Students continue to emphasize oral communication in the future workplace, independent of the fact that their generation has switched to written communication, also shortened, often with special signs. The willingness to cooperate with humanoid robots is considered to be an important factor in the future employee's success. Diversity and tolerance on the 6-points Scale have been estimated at around four average, which can also be explained by the fact that currently this is not yet relevant in the

practice. However, digital technology and multinational companies have led to an increase day-to-day work with mixed national colleagues, this is not simple linguistic differences for workers. A clear result of the impact of robotisation is that tolerance of monotony is not considered important in the future as, according to surveys, modern technology is already replacing the easily robotized jobs. (Figure 6.)



6. Figure. Results of the empirical research questionnaire: 6.0 - 6.21.
 Source: Edited by author

H6. Students are open to cooperation with humanoid robots during training and work, and want to develop their knowledge according to the demand of the labor market by introducing the new technologies developed by Industry 4.0 and Industry 5.0. Individuals generally 70% open think are more open to working with humanoids at workplace. The 65.4% of students are open to learn with humanoid robots. Overall, this topic is completely new to students, while industrial robots can be seen regularly, while learning robots are still experimental. According to 43% of respondents humanoids can be useful in higher education 32% do not consider it useful, 23.4% do not know. The division of respondents in the issue of higher education confirms the former fact. (Figure 7.)



7. Figure. Results of the Empirical Research Questionnaire: 7.0 - 7.04.
Source: Edited by author

Based on Pearson's Chi-square test, we can observe that there is a significant correlation between type of faculty and openness for cooperation and attitude with humanoids at workplace. (Table 4)

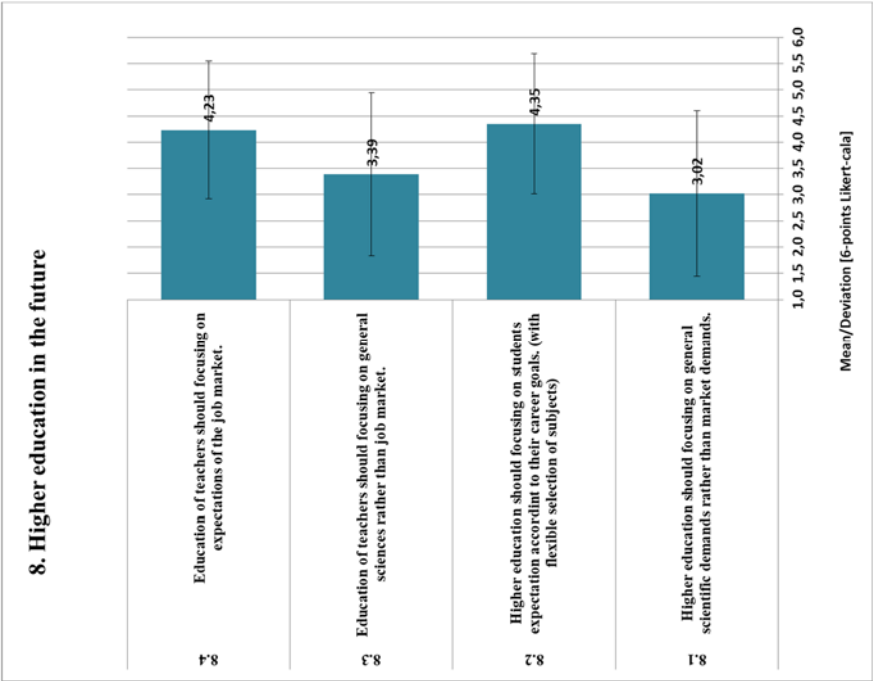
4. Table. Significant correlation between variables with Chi-square test

Pearson Chi-square test	faculty
How open to learn with humanoids?	0,274
How open to work with humanoids?	0,027
Do you consider the inclusion of humanoids in higher education useful?	0,075
Do you consider the inclusion of humanoids in workplace useful?	0,001

Source: Edited by author

Further examining the results more detailed in cross-table, it shows that for collaboration with humanoids at workplace the mechanical and safety engineers, electrical engineering and IT students were mostly open. Analyzing open answers can see that the 64.8% of students at faculty of economics, and only 53.8% of students from light industry and environmental engineering are open to work with humanoids. Analyzing negative answers of the responses, light industry and environmental engineer students are the least open for co-operation with humanoids in their workplace. Mostly mechanical and security engineers, electrical engineers and IT engineers think humanoids useful at their workplace. Only half of students at Faculty of Economics, and only 36.5% of students from Faculty of Light Industry and Environmental Engineering think useful to use humanoids in this case.

Obviously the mechanical and electrical engineers think useful the robots at workplace. What is surprising is that the IT students are divided in the issue. Students in the field of light industry and environmental engineering are clearly opposed to it, which can be linked to the strong presence of environmental protection in the training. Also in connection with the human resources training at Faculty of Economics emphasizing the importance of human resources, it can be related that only 50% result of economist students. The theoretical knowledge gained during the training, as well as the practical experience, influence the answer for questions. The responses shows that, according to students opinion, the training of trainers should mostly focusing on market conditions rather than on a traditional basis. In the case of general scientific requirements, rather teachers than students education should focusing on general scientific requirements. Students want to shape their own training path along their own career path, and they want a great deal of insight into what they are learn. (Figure 8.)



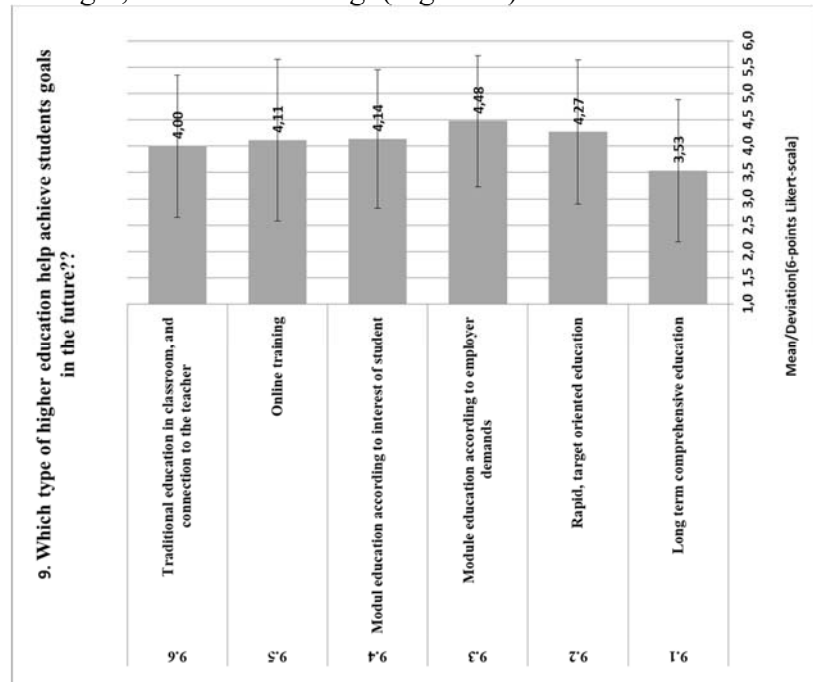
8. Figure. Results of the empirical research questionnaire: 8.1 - 8.4.

Source: Edited by author

Ranking that makes future higher education the most successful based on the results of a questionnaire survey.

- Modular training based on employer needs

- Shorter, rapid, targeted training
- Modular training based on student interest
- Online training
- Longer, extensive training. (Figure 9.)



9. Figure. Results of the empirical research questionnaire: 9.1 -9.6.

Source: Edited by author

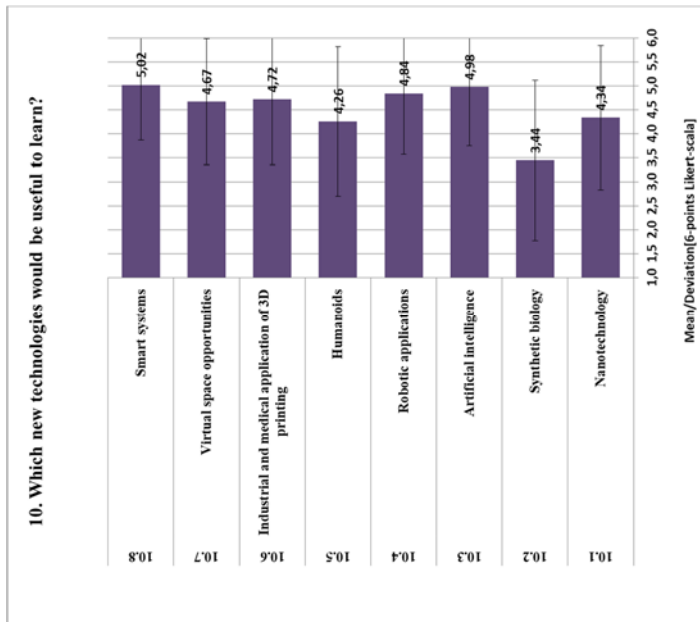
Students answering the online questionnaire would consider it important to train new technologies in their respective fields according to the ranking below.

- Smart systems
- Artificial Intelligence
- Robotic Applications
- Industrial and medical application of 3D printing
- Nanotechnology

He doesn't consider it important

- Synthetic biology

Synthetic biology, which, unlike the foregoing, is less known, the topic of Industry 5.0. Analyzing the result shows the highest standard deviation. This is mainly due to the lack of knowledge and the fact that the multidisciplinary approach is not typical, and the wide application areas are not known to the respondents. (Figure 10.)



10. Figure. Results of the empirical research questionnaire: 10.1 -10.8.

Source: Edited by author

Overall, for the future, students consider the opinion of employers and training tailored to their career goals more important, which is designed to be flexible, shorter. Longer-term, broader training is considered to be of little use in preparing for the future work. Although not significant, but online training has attracted lot of people as a success factor, but it is not considered the most stressed. During their studies, they would like to gain insight into the mysteries of robotic systems and artificial intelligence.

In case of faculties the artificial intelligence significant, with further analyzed the data clearly shows the domination of IT student's answer and surprisingly for the students of the Faculty of Economics. Considering the significant results in the field of robot applications, the students from mechanical and safety considered the subject to be very important, followed by the students from Faculty of Electrical Engineering. Robot applications were regarded as very important by the economist and IT faculties. The subject was least favored by students from the light industry and environmental engineering faculty. (Table 5)

5. Table. Significant correlation between variables with Chi-square test

Pearson Chi-square Test	Faculties
Artificial Intelligence	0,000
Robotic applications	0,038
Nanotechnology	0,287
Synthetic Biology	0,251
Humanoid	0,212
Industrial and medical application of 3D printing	0,015
Virtual space	0,111
Smart system	0,066

Source: Edited by author

Nanotechnology did not show significant results, but further analyzing the data, it can be seen that it divided the respondents on the six-point Likert-scale. The industrial and medical applications of 3D printing showed significant results. In terms of the Likert-scale assessment, most of the very important values were given by students from Faculty of Mechanical and Safety Engineers and from Faculty of Light Industry and Environmental Engineering, so they would consider it the least useful in their field of expertise. Surprisingly, the students of the Faculty of Informatics were shared in the issue. The virtual space did not show significant results in case of faculties, which I regard as a positive result, as in the future the virtual space will be a new place for education as a low cost modeling place, which can not only be related to IT and engineering applications. The same result was shown by the Pearson Chi-square test for smart systems. (Table 5)

4. NOVEL SCIENTIFIC RESULTS

E1. Based on the results of my empirical research, I found that the impact of future workplace on competencies is diverse, problem-solving ability is of paramount importance in all research, but students participating in empirical research do not consider creativity and ethical work to be particularly important. These differences indicate that they don't understand the processes and effects of Industry 4.0 and especially Industry 5.0, as with HECI's (human, ethical, creative, imaginary) elements that can repositioning the human against robots. On the basis of my research results, it can be said that although we envisioning robotisation of whole factories and factories in the public consciousness, a more radical effect has started in the background, the market of the service robots is coming to forefront, which also means that the service sector considered as a medicine against robotisation is at risk at all levels. Increasing sales of service robots clearly leads to increased applications, and radical price cuts accelerate this

process. This is true for both professional and individual-use service robots, but the big breakthrough is the market for custom-made service robots, as their investment cost is lower than the deployment of an industrial robotic production line. International trends indicate that even large multinational companies are joining the market through startup companies, which is a great opportunity for innovative small enterprises and entrepreneurs.

E2. Based on my secondary research, I have found that globalization combines the effects of robotization with radical and completely unpredictable effects based on the results of both futures researchers and global statistics. The preparation is only possible with the global thinking of the disciplines, global vision, comprehensive strategy for sustainable development and the shift of paradigm. Technological innovation, radical and rapid change is not a disadvantage, but a competitive advantage for small enterprises and start-ups, as they are able to respond faster and more flexibly. So far, the "big fish better than little fish", in the future changes to faster, smaller and more flexible will be better advantageous in the marketplace. This can be the breakthrough for small enterprises and the Hungarian economy.

E3. Industry 5.0 is nonlinear but parallel continuation of Industry 4.0. In terms of robotization, we can talk about in case of human-machine cooperation, the two extremes like perfect and the unique. In the absence of significant capital - to orient themselves towards an innovative, knowledge-based, online or human-oriented direction to industry 5.0, rather than lining up in the competition for big, strong companies of Industry 4.0, taking loans and other risks. A good example of this is the post-regime period, when the influx of Chinese low-cost textiles has made the Hungarian textile industry - at least large-scale, cheap mass production impossible. With this, it was not worth competing, the alternative to domestic manufacturers was the unique or small series, crafted quality goods. In the robotics market of Hungary, the number of robots projected to employees is high, although the EU is below the EU average but in the mid-range, thanks to the strong presence of the German automotive industry. China, which represents global economic power, is also below the EU average. The education system is inflexible and requires a paradigm shift. At the same time, innovative, creative, IT-knowledgeable, STEM-skilled workers need to be provided for the labor market in soft competences. Based on my empirical research, students are partially open to new technologies and processes, but have not enough information. They are not aware of the order of importance, they are thinking in the short term, they are more open to the information they find familiar from somewhere, so there is huge responsibility of

education. Result of empirical research show that the curriculum of their field of study is a determining factor in their decisions.

E4. Based on the results of my empirical research (online surveys), I have found that by adapting their own and employer expectations the students prefer shorter training courses as a future successful form of training. Clearly, market-based adaptation is seen as a priority opposite traditional scientific content. Studying the literature and tendencies, I found that if we put this new thinking into the inflexible education system, it would result in failure because quick response and development are also a key point here. It should also be taken into account that human cannot compete in certain areas as the computer can respond more quickly to its application. However, combining human creativity and innovation, uniqueness with science, we can train highly qualified, innovative, successful employees who can launch future successful companies. Industry 4.0 is typically based on STEM sciences. But HECI competencies depicts human's distinctive knowledge and skills. In my opinion, Industry 5.0 is based on a combination of both. This may be the basis for how and in what area and which competencies the employee can be positioned in the future workplace, creating creative, unique products with the cobots, implementing new, innovative solutions that combine human's innovative ideas with perfect, precise and fast work of robots.

5. CONCLUSIONS AND RECOMMENDATIONS

From the global factors of the world to the impact of technological development on the workforce, it is clear that there is an interaction between them, but in fact, all global factors interact with each other at the time. If we treat this statement as a fact, then it is clear all the strategy is inadequate, if we only examines it in its own field of application, and works only with the involvement of specialist in that field. In an ever-changing global economy, all phenomena have an impact on the each other, so working groups with experts in individual economic areas need to develop a global approach to developments. At this moment, this interaction is clear to the decision-makers, but they do not often make the right decision that affect to development. Adding to this, the majority of people do not understand and do not perceive the responsibility of the individual in the absence of sufficient information or, if they see the responsibility as they have limited information, they cannot make optimal decisions. My suggestion is that the disciplines shouldn't work individually, but in a complex group of experts using global and multidisciplinary thinking, exploiting the potential of digitalization not only within a company or country, but also in transnational cooperation.

Similar work relationships can build on the learning process and the development of Artificial Intelligence. As a basic principle, it is reasonable to confirm that - although the basic law of robotics is used in a different sense - this result and application should be used for the benefit of mankind and fixed in global economic regulations.

K1. Assessing the impact of industrial revolutions is always two-edged, and many who are unable to adapt cannot acquire the new technology, increase the number of technological unemployed. The inadequate education system, which is completely lagging behind in terms of technological progress and because of short-term thinking can together provide a dark vision for future against sustainable development. The impact of Industry 5.0 - in my opinion, unlike the previous theory of Mokyr (1998), concerning industrial revolutions process - is not step by step. Mokyr's theory is based on the impact on an industry that generates structural changes in the sector by expanding dynamic development, increasing emissions and employment over time to other sectors. Based on my literary research, Industry 5.0 skips these steps and has an immediate, and complete impact on all sectors.

K2. In my opinion, the notion of a guaranteed income as right of the individual is not a viable option. Productivity is growing continuously on the basis of statistical data, but globally the wages have not risen in proportion. This means that companies looking to maximize profits do not return to employees proportionally the benefits of increasing per capita performance. In a changed environment, employee competitiveness is ensured by their preparedness, one of which is continuous training or additional training.

K3. Another important factor is identify the jumping points in the competition at the level of the country or the individual. On the basis of my research results, the competitive advantage at the product level is the individual market of service robots, and in case of business organizations, the rapid response of innovative, creative startup companies and enterprises, as well as, on individual levels of the education with new technology and soft skills.

K4. As a result of technological advances, distances disappear online or in virtual space. There is no big investment to access online markets, so you can even compete from home, even in big companies.

K5. Companies using new technologies have begun at “war” for seeking and retaining a high-skilled, innovative workforce. By eliminating physical boundaries through new technologies, the entire global labor market is already available for searching on both sides. However, it is difficult to find a suitable candidate in many areas of shortage. That is why it not so important for the employer the age and gender of the candidate because the narrow market framework does

not allow it from economics point of view. The best workforce criterion is the most important. The relevant part of my empirical research also supported this, according to which gender and age discrimination will decrease in the coming decades.

K6. Global power changes favor Asia, and they have outstanding and extreme results in robotization. Technological advances also mean a reduction in the price of the new application, which brings with it the growth of individual applications. The high cost of robotization at the outset meant an increase in industrial robots, but the new trend in service / service robots for individual use shows great potential, in education and in healthcare and entertainment. Europe and above all in Hungary, need to focus on training for highly qualified, creative, innovative, HECI-skilled and STEM-qualified workers, the two being effective together with forecasts of changed labor market needs.

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Lajstromszám:201366; Ügyszám: 1572/88
Nemzetközi Szabadalmi osztályozás (NSZO) DO6P 5/00