IPAR 4.0 ÉS OKTATÁS 4.0
ELVÁRT KOMPETENCIÁK ÉS KÉSZSÉGEK A TÁRSADALOM 5.0-BAN

Tumentsetseg Enkhjav – Varga Erika

Összefoglalás

Jelenleg a negyedik ipari forradalom közepén vagyunk, amely minden korábbi ipari forradalomnál mélyrehatóbb változásokat hoz. Cikkünk az Ipar 4.0, az Oktatás 4.0 fogalmát, valamint a digitalizáció, az automatizálás és a számítógépesítés új korszakával kapcsolatos HR-kihívásokat vizsgálja. A kutatás fő célja annak hangsúlyozása, hogy figyelmet kell fordítani ennek az intelligens technológiai trendnek a terjedésére és irányára, valamint azokra a kompetenciákra és képességekre, amelyekre a jövő munkahelyein szükség lesz. Felsoroljuk a technikai és a puha készségeket egyaránt, és kiemeljük az intelligens technológiák néhány gyakorlati felhasználási lehetőségét az oktatásban. Az egyetemek szerepe kulcsfontosságú egy erősen digitalizált és automatizált társadalom felé történő gyors elmozdulásban, így a Társadalom 5.0-ra való áttérés felgyorsításában. A cikk zárásaként a rendelkezésre álló szakirodalom és néhány statisztikai jelentés alapján a következtetések és javaslatok találhatók.

Kulcsszavak*: Ipar 4.0, Oktatás 4.0, Társadalom 5.0, automatizáció és digitalizáció, kompetenciák és készségek*
JEL: *J24, O14*

INDUSTRY 4.0 AND EDUCATION 4.0
EXPECTED COMPETENCES AND SKILLS IN SOCIETY 5.0

Abstract

We are currently in the midst of the fourth industrial revolution, which will bring about more profound changes than any previous industrial revolution. This article examines the concept of Industry 4.0, Education 4.0 as well as certain HR challenges associated with this new era of digitalization, automation, and computerization. The major goal of this research is to emphasize the need of paying attention to the growth and direction of this smart technology trend, as well as the competencies and abilities that will be required in future workplaces. Technical as well as soft skills are listed and some practical usage of the smart technologies in the educational sector is highlighted. The critical role of the universities in accelerating the transition to a highly digitalized and automated society, like Society 5.0 is emphasized. Based on the previously available literature and some reports, the conclusion and recommendation part is drawn.

Keywords: *Industry 4.0, Education 4.0, Society 5.0, automation and digitalization, competence and skills*
JEL: *J24, O14*

Introduction

Almost everyone around the globe has been affected by the consequences of the COVID pandemic, the war in Europe, and the new technology transformation known as the fourth industrial revolution (IR 4.0). This is an incredibly challenging time for everyone as we are entering the era of a new technological revolution which will eventually revolutionize the way we think, live, work and connect with one another (Schwab, 2017).

Despite the fact that fights against the COVID-19 disease are still ongoing in many countries around the world, and the war between Russia and Ukraine has claimed to touch the lives of approximately 2072 Ukrainian civilians, as well as 4.1 million refugees in neighbouring countries, the researchers wanted to draw readers' attention more to the topic of IR 4 and its unpredictable impact on the labour market because this new trend has expanded to a variety of industries including Education 4.0 and Society 5.0. The IR 4.0, in particular, necessarily requires us to reform our educational system in order to prepare and train the next generation of workers in various industries, as well as encouraging us to change our lifestyle in order to live smartly without falling behind society or the rest of the globe.

Industry is a major source of income and a vital vein of the economy for any society because it allows a nation to be economically self-sufficient without relying too heavily on outside assistance. That is why the Industrial Revolutions 1,2,3 have shifted our lifestyles dramatically from time to time.

Humans have progressed through different stages of the industrial revolution, starting with mechanization (IR 1.0), electrical energy (IR 2.0), advanced adoption of digitalization (IR 3.0), and finally automation and smart internet-based technologies (IR 4.0). Due to a combination of sophisticated digitalization and internet technology, businesses are increasingly being compelled to use more impressive digitized industrial processes in order to keep their competitive advantages in the market. This rapid trend of digitalization and automation has welcomed us all into IR 4.0, and it is defined as IT-driven transformations in manufacturing systems at enterprises (Lasi et al., 2014).

The previous studies have shown and stated that many current jobs will disappear and will be taken over by automation and smart technologies in the future. So, it is vital to discuss and study about Education 4,0 as well as skills and abilities that will be required by the future job applicants in the labour market. In this period of change and transformation toward the adoption of smart technology and automation, the researchers believe that educators and university play a critical role in training and educating the future workforce in the labour market, as each employee in the workplace requires a unique set of technical and non-technical skills. Therefore, the objective of this paper is to highlight concepts of the fourth industrial revolution as well as Education 4.0 along with necessary competencies and skills that are projected to be demanded by employees in the future workplaces.

Research questions

After evaluating the relevant literature on the topic of IR 4.0 and education 4.0 along with the objective of this study, the researchers developed the following research questions:

- What is the Fourth Industrial Revolution and how does it relate to Education 4.0?
- What are the negative aspects of the IR 4.0?
- What qualifications and skills do the IR 4.0 require?

Material and Method

This is a descriptive research study. Conclusions are reached at the end based on accessible literature and statistics reports related to the fourth industrial revolution as well as Education 4.0.

Results

Industrial Revolution 4.0

Klaus Schwab, founder of the World Economic Forum, coined the term Industry 4.0 in 2011, in his article titled Mastering the Fourth Industrial Revolution. In other words, IR 4.0 can be described by the ability of different people and machines to interact effectively with one another through technological support (Juhász, 2018). Despite the fact that this term originated in Germany, it has since become widely popular, and various industries such as Construction 4.0, Agriculture 4.0, and Education 4.0 have been influenced by its significance and effectiveness of implications in manufacturers all over the world. Table 1 shows some countries that have already recognized the importance of IR 4.0 and have launched a national campaign to implement IR 4.0-related projects.

Table 1 National projects related to IR 4.0 in various countries

Countries	Project name	Source
Germany	Industry 4.0	(Federal Ministry of Education and Research of Germany (BMBF) 2014)
United Kingdom	Eight big technologies	(UK Department for Business, Innovation & Skills 2010, 2012)
France	The Nouvelle France Industrielle in France	Liao et al (2017)
China	The Made in China 2025 initiative	Zhong et al, (2017)
Hungary	The industry 4.0 National Technology Platform (abbreviation I4.0 NTP) Artificial Intelligence Strategy 2020	Svačinová (2021)

Source: authors' own editing

Smart technologies such as artificial intelligence, machine learning, the Internet of things, autonomous vehicles, drones, precision medicine, genomics, advanced materials, smart grids, robotics, and big data so on are the main components of the IR 4.0 which are anticipated to bring many exciting changes and challenges in our daily lives (Samans, 2019). Most importantly, this technological advancement will result in the transformation of global industries (Xu Min et al., 2018). Therefore, in order to strengthen its competitiveness in the global market, each country must act quickly and begin taking this smart technological revolution seriously.

Changes in the labour market or Employability 4.0

There are two lines of debate among researchers and practitioner all over the world about how IR 4.0 will affect the labour market and what the labour market will look like in 2050 or 2100.

In IR4.0, there will be a greater emphasis on the introduction of new products and services, as well as the creation of new jobs (Thomas – Gerold, 2016), but significant job losses are also expected in the labour market if we are not well-prepared and equipped with a required set of skills and abilities in society 5.0. Since the end of the 18th century, humans have gone through three different industrial revolutions. Recently, it has appeared that experts from nearly all industries have begun to investigate how Artificial Intelligence (AI) optimizes the use of limited resources to improve the outcomes of operational systems in various fields. In other words, automation and machine learning may affect every line of work in the future, from diagnosing patients to producing various types of consumer goods, providing legal advice, or teaching yoga, among other things (Harari, 2018).

Based on the literature reviewed by the researchers, Table 2 summarizes the anticipated positive and negative aspects of IR 4.0 in the labour market.

Table 2 The expected positive and negative side of IR 4.0 in the labour market

Side effect	Statement	Source
Positive	In Western Europe, there will be 1.4 million new job openings. The number of people employed in industry rises at first, then falls by 5 million. Approximately 10 million new jobs will be created in the service industries	Berger (2014)
Positive	Approximately one-tenth of the current workforce is employed in occupations that are expected to grow as a result of Industry 4.0.	Bakhshi et al., (2017)
Positive	Industry 4.0 activities in Hungary could result in a 20-30% increase in GDP In 2030, artificial intelligence will contribute 14% to GDP	Haiddeger - Paniti (2016)
Positive	The demand for highly skilled workers will rise	Rodrik (2016).
Negative	Approximately 9% of jobs in OECD countries will be automated	Arnzt, et al. (2016)
Negative	The automation of IR 4.0 will have a significant impact on low-skilled workers.	Rodrik (2016).
Negative	The automation and digitalization of IR 4.0 will result in the loss of 500 thousand job positions	Nábelek et al., (2016)
Negative	One-fifth of all jobs will be lost because they are no longer needed in the labour market.	Bakhshi et al., (2017)
Negative	Because the majority of mechanizable processes take place in the manufacturing industry, the number of people employed may decrease.	Fülöp (2018)

Source: authors' own editing

Education 4.0

IR4.0, which focuses on automation and digitalization through technologies such as Artificial Intelligence, Internet of Things (IoT), and Big Data, has transformed the education system. Education 4.0 refers to the technology or devices that students use to learn and develop new skills. Education 4.0 is a life-long process (Schwab, 2016) for everyone who is willing to be employed in the society 5.0 in the future.

Several previous studies have discovered that students' learning has improved as a result of their use of technologies (Halili – Nurul – Rafiza, 2018) in the educational sector.

Education 4.0 was born because IR 4.0 has an impact on not just business, governance, and people, but also education. Education 4.0 is a solution to the needs of IR4.0, in which humans and machines work together to create new possibilities. More specifically, Education 4.0 will provide students with the environment and tools they need to acquire or improve the skills and abilities needed in future professions or in a globalized knowledge society like Society 5.0 in the future.

The new learning vision, according to Fisk (2017), pushes students to learn not only the skills and knowledge they require, but also where they can obtain them. Furthermore, Education 4.0 is primarily concerned with how to prepare future generations (Rajan – Vinod, 2017), or how to assist future employees in obtaining jobs in a digitalized society like Society 5.0.

Introducing innovative technology into the teaching and learning process is one possibility for strengthening our educational system. Students will benefit from smart technology associated with IR 4.0, which will assist them in correctly assimilating the learning materials. Therefore, the researchers investigated and reviewed the literature in relation to the use and application of suggested smart technologies in the educational sector, and the key findings are presented in Table 3. The following is an example of how the latest technological breakthroughs in education 4.0 could be used.

Table 3 The example of the possible application of the latest smart technologies in the educational sector

Advanced smart technology (IR 4.0)	Possible application
Artificial Intelligence	The usage of this technology has the potential to boost student learning by speeding up the teaching and learning process.
3D printing	Students will be able to engage with 3D models of various learning subjects using the 3D printer, which will help them gain a better understanding of the subjects.
Virtual Reality	Students will benefit from this technology because it will help them engage more deeply and provide visual elements, allowing them to establish more effective connections between learning concepts and information.
Internet of Things	With the increased use of mobile devices, the internet of things has an impact on education. This technology enables students and teachers to communicate and interact quickly both within and outside the classroom.
Cloud Computing	The usage of this technological advancement allows students to have access to their classroom materials and homework at any time and from any location.
Multi-touch LCD screen	This technology provides the ideal presentation solution. Students will be seated around the table tablets, swiping on the board to modify and drag images around the screen, or typing notes on the online keyboard.

Biometrics	Educators can save time by using facial recognition or fingerprints to collect student attendance. It may enable instructors to monitor each student's participation in class and so on.

Source: Created by the authors on the basis of Halili (2019)

Educators and universities are encouraged to take smart technologies connected to education 4.0 and IR 4.0 very seriously as well as to conduct more research on the concept of education 4.0 since its application and implication has already begun to gain attention among academics as well as educators all around the world.

Discussion on competencies and skills in the context of IR 4.0

Human capital has long been regarded as one of an organization's most valuable assets. It is necessary to acquire the appropriate competences in order to successfully manage work and career, which are also important in team building and job satisfaction (Sunil – Kailash, 2018).

Job competencies are components of knowledge, skill, and ability that are important in career management and can be altered by the individual.

It is very vital to start discussing about a set of necessary competence set for the future workers in the society 5.0 because machines now lack the ability to replace some of human skills like judgment, empathy, persuasion, collaboration, and communication so on (Letellier, 2018), but more AI transformation is on the way (Heaven, 2017) to improve and optimize machine performance in the future. Therefore, after reviewing the relevant literature, the researchers have compiled a list of future skills in table 4.

Table 4 The list of the future skills

Skills and abilities required by IR 4.0	Source
Interpersonal skills, cognitive development, active learning, change management skill, problem solving, judgment and decision making	Bakhshi et al., (2017)
deeper relationship development skills, flexible and innovative thinking, social and emotional intelligence, virtual collaboration, design mind-sets, new media competencies (data-scientist)	Ramge - Schwochow (2018)
Digital skills	Salmon, (2019)
E-skills	Eurostat (2019)
Technical skills *(Knowledge, Manufacturing, IT, Computer Science and Robotics and Automation)* and non-technical skills *(problem-solving, creativity, decision-making and adaptive)*	Enkhjav - Davaasambuu, (2019); Janis – Alias (2017)

Source: authors' own editing

Conclusions and recommendations

Apart from developed countries, many developing nations are involved in the concept of IR 4.0 in order to remain competitive in the global market. Therefore, it is very important to discuss the Fourth Industrial Revolution and Education 4.0 in relation to the expected competences, abilities and skills required by all types of employees in the future. It is highly recommended for all stakeholders and practitioners to revise and have a close look at the competences within their organisations, make decisions on what items to opt out and withdraw, and what parts need further development and strengthening.

Employees in future workplaces around the world may be expected to have digital and e-skills, as well as other soft skills, because the AI revolution is on its way to entering the workplace massively. As a continuation of this research, the authors are planning to analyse digital competences: their emergence and appreciation during the pandemic, as well as tis future implications.

Collaboration between industry and academics could be an effective way to implement Industry 4.0. Because today's students will be working in an industry 4.0 atmosphere very soon, it is critical that they will be prepared for this vast and novel technological revolution or new way of working in their workplaces. Therefore, collaboration between businesses and higher education institutions will become increasingly important in the future.

Students must also be prepared for Industry 4.0, in which the framework built based on education 4.0 could help to reduce unemployment in the future. Also, employees in all industries, even small businesses, will need to upgrade or learn new ICT skills and competences in order to properly operate and interact with sophisticated modern technology and equipment in the future.

The government assists practitioners in recognizing the significance of emerging technologies such as the Internet of Things, cloud computing, big data, robotics, 3D printing, simulation, and prototyping. As a result, practitioners may be motivated to work hard to overcome the issues in IR 4.0.

As previously stated, we are entering the fourth industrial revolution, so now is the time to reconsider what is expected of us and how we can prepare for the upcoming automation era.

References

[1]. Arntz, M. – Gregory, T. – U. Zierahn (2016): The Risk of Automation for Jobs in OECD Countries. *OECD Social, Employment and Migration Working Papers*, No.189, OECD. DOI: 10.1787/1815199X.

[2]. Berger, R. (2014): *Industry 4.0. The new industrial revolution How Europe will succeed*. Accessed: 19. 04. 2022. source: http://www.iberglobal.com/files/Roland_Berger_Industry.pdf.

[3]. Bakhshi, H. – Downing, J. – Osborne, M. – Schneider, P. (2017): *The future of skills: employment in 2030*. London: Pearson & Nesta. Accessed 18. 04. 2022. source: https://media.nesta.org.uk/documents/the_future_of_skills_employment_in_2030_0.pdf.

[4]. Eurostat Database, (2019): *Employed ICT specialists-total, proceedings from Eurostat*. Accessed: 19. 04. 2022. source: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_sks_itspt&lang=en.

[5]. Enkhjav, T. – Davaasambuu, A., (2019): Industrial and agricultural 4.0: competencies and skills. *Modern Science-Moderní věda*, 6, 76–86.

[6]. Fisk, P. (2017): *Education 4.0. the future of learning will be dramatically different, in school and throughout life*. Accessed: 15. 04. 2022. source: https://www.peterfisk.com/2017/01/future-education-young-everyone-taught-together/.

[7]. Fülöp, Z. (2018): *Az Ipar 4.0 munkaerőpiacra gyakorolt hatása*. Munkaügyi Szemle. Accessed: 18. 04. 2022. source: https://www.munkaugyiszemle.hu/az-ipar-40-foglalkoztatasra-gyakorolt-hatasa.

[8]. Haiddeger, G. –Paniti, I. (2016): *Industry 4.0 Platform activities in Hungary, past – present – plans*. Hungarian Academy of Sciences, Institute for Computer Science and Control, MTA SZTAKI, Hungary. Accessed: 19. 04. 2022. source: http://eprints.sztaki.hu/8917/1/Haidegger_14_3154242_ny.pdf.

[9]. Halili S.H. – Nurul, H., – Rafiza, A.R. (2018): Traditional versus virtual learning: How engaged are the students in learning English literature. *Indonesian Journal of Applied Linguistics*, 8(1), 79–90. DOI: 10.17509/ijal.v8i1.11467.

[10]. Halili, S.H. (2019): Technological advancements in education 4.0. *The Online Journal of Distance Education and e-Learning*, 7(1), 63–69.

[11]. Harari, Y. N. (2018): *21 Lessons for the 21st Century*. London: Jonathan Cape Publishing.

[12]. Heaven, D. (Ed.) (2017): *Machines that think*. Boston: Nicholas Barley Publishing.

[13]. Herzberg, F. (2003): One more time: How do you motivate employees?. *Harvard Business Review*, 81 (1), 3–11.

[14]. Janis, I. – Alias, M. (2017): A systematic literature review: Human roles, competencies, and skills in industry 4.0. In *Proceeding of Asia International Multidisciplinary Conference*. Accessed: 15. 04. 2022. source: https://www.europeanproceedings.com/article/10.15405/epsbs.2018.05.84.

[15]. Juhász, L. (2018). *The Fourth Industrial Revolution in Hungary*. IEEE 18th International Symposium on Computational Intelligence and Informatics (CINTI). Budapest: IEEE 167–172. DOI: 10.1109/CINTI.2018.8928236.

[16]. Lasi, H. – Fettke, P. – Kemper, H.G. – Feld, T. - Hoffmann, M. (2014): Industry 4.0. *Business & information systems engineering*, 6(4), 239–242. DOI: 10.1007/s12599-014-0334-4.

[17]. Liao, Y. – Deschamps, F. – Loures, E.D.F.R. – Ramos, L.F.P. (2017): Past, present and future of Industry 4.0-a systematic literature review and research agenda proposal. *International journal of production research,* 55(12), 3609–3629. DOI: 10.1080/00207543.2017.1308576.

[18]. Nábelek, F. – Sturcz, A., – Tóth, I. J. (2016): *Az automatizáció munkaerő-piaci hatásai. Járási munkaerő-piacok automatizációs kitettségének becslése*. Budapest: Magyarország: MKIK Gazdaság- és Vállalkozáskutató Intézet. Accessed: 18. 04. 2022. source: http://gvi.hu/kutatas/483/az_automatizacio_munkaero_piaci_hatasai.

[19]. Misra, S. - Srivastava, K.B., (2018): Team-building competencies, personal effectiveness and job satisfaction: The mediating effect of transformational leadership and technology. *Management and Labour Studies,* 43(1–2), 109–122. DOI: 10.1177/0258042X17753178.

[20]. Schwab, K. (2016): *The Fourth Industrial Revolution*. United States: Crown Business, Crown Publishing Group.

[21]. Svačinová, K., (2021): Industry 4.0 Overview Based on Selected Indicators: the Case of Hungary. *Studies of Socio-Economics & Humanities/Socioekonomické a Humanitní Studie*, 13(1), 87–116.

[22]. Samans, R. (2019): *Globalization 4.0 shaping a new global architecture in the age of the Fourth Industrial Revolution: A call for engagement*. World Economic Forum Report. Accessed: 15. 04. 2022. source: http://www3.weforum.org/docs/WEF_Globalization_4.0_Call_for_Engagement.pdf.

[23]. Salmon, G. (2019): May the fourth be with you: Creating Education 4.0. *Journal of Learning for Development*, 6(2), 95–115.

[24]. Wallner, T. – Wagner, G. – Costa, Y.J. – Pell, A. – Lengauer, E. – Halmerbauer, G. (2016): Academic Education 4.0. In: Calmo M.(ed.): *International Conference on Education and New Developments*. Lisbon,

Portugal: World Institute for Advanced Research and Science, pp. 155–159. Accessed: 17.04.2022. source: https://www.researchgate.net/publication/304115292_ACADEMIC_ EDUCATION_40.

[25]. Rajan, S. – Vinod, B. (2017): Leapfrogging to Education 4.0: Student at the core. Accessed: 17. 04. 2022. source: https://www.businessworld.in/article/Leapfrogging-To-Education-4-0-Student-At-The-Core-/05-11-2017-130561/.

[26]. Ramge, T. – Schwochow, J. (2018): *The global economy as you've never seen it: 99 ingenious infographics that put it all together.* New York: The Experiment.

[27]. Rodrik, D. (2016): Premature deindustrialization. *Journal of Economic Growth, 21*(1), 1–33. DOI: 10.1007/s10887-015-9122-3.

[28]. Zhong, R.Y. – Xu, X. – Klotz, E. – Newman, S.T. (2017): Intelligent manufacturing in the context of industry 4.0: a review. *Engineering,* 3(5), 616–630. DOI: 10.1016/J.ENG.2017.05.015.

Authors

Tumentsetseg Enkhjav
ORCID: 0000-0003-3976-0851
PhD candidate
Hungarian University of Agriculture and Life Sciences
Doctoral School of Economic and Regional Sciences
e-mail: tumee5332@gmail.com

Erika Varga
ORCID: 0000-0001-5105-7187
Dr. habil., PhD
associate professor
Hungarian University of Agriculture and Life Sciences
Institute of f Rural Development and Sustainable Economy, Department of Foreign Languages
e-mail: varga.erika@uni-mate.hu