

UKRAINE'S PERSPECTIVES IN INDUSTRY 4.0

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Abstract

Globalization processes and technology innovations trends point out the importance of determining the role of Fourth Industrial Revolution on countries' socio-economic development. Key features of Industry 4.0 are identified in the paper. Fourth Industrial Revolution Initiatives of World Economic Forum are determined. Analysis of countries by their digital infrastructure and ability to use Information and Communication Technologies (ICTs) is conducted with regard to interrelation between levels of technological and socio-economic developments of the country. Reasons of these countries being ranked as top-10 are identified. Ukraine's economy performance according to Networked Readiness Index (NRI) is analyzed. The analysis of Ukraine's competitive advantages, key competencies and factors of long-term demand at domestic and foreign markets is given. Government Programs aimed at innovative economic development are described. Higher Education Institutions and Scientific Institutions activities on Technology Transfer and Academic Entrepreneurship are described.

Keywords: technology, digital era, network readiness index, R&D, Industry 4.0

"We are at the beginning of a global transformation that is characterized by the convergence of digital, physical, and biological technologies in ways that are changing both the world around us and our very idea of what it means to be human. One of the main features of the fourth industrial revolution is that it will not change what we do, it will change who we are"

Klaus Schwab,

Founder and permanent president of the World Economic Forum

INTRODUCTION

Globalization opens wide range of opportunities for humanity to expand the exchange of goods, services, information, technology and capital, humanitarian engagement, and spiritual enrichment of the individual. Globalization and technology are transforming our economies, workplaces, communities and families. At the same time, for many people in particular as well as for countries in general, globalization poses significant threats, causing the division of countries into "civilization centers" and "peripheral zones", deepening their differentiation in socio-economic, scientific and technological development. For example, R&D (research and development) spending in North America accounts for more than 40% of global R&D expenditures, while in Latin America and Africa together it contributes to less than "1%."

More and more experts from various fields associate technological growth with economic prosperity of the country. Nations with developed economies are considered to be more capable of fostering educational and research growth. Conversely, poor nations that are unable to provide basic needs to their citizens not only develop fewer technologies but have more difficulties accessing them.

The exponential speed of technologies developments; their impact on the entire systems of production, management, and governance bring many benefits as well as

risks for the society. If managed well, they have the potential to give rise to innovation that will drive growth and social impact. If not handled appropriately, challenges brought up by the introduction of technologies, especially on labor markets could derail those benefits. Countries and businesses that embrace these developments, meet challenges, and deal with them are more likely to prosper, while those that do not that are more likely to lag behind. Information and communication technologies (ICTs) are the backbone of this revolution. The future of countries, businesses, and individuals will depend more than ever on whether they embrace digital technologies.

Richard Samans and Margareta Drzeniek Hanouz mention that “the future holds an even higher potential for human development as the full effects of new technologies such as the Internet of Things, artificial intelligence, 3-D Printing, energy storage, and quantum computing unfold” [1].

This research paper is devoted to the review of Ukraine innovation policies and technologies development analysis in the era of “Industry 4.0”.

RESEARCH RESULTS AND DISCUSSION

To better understand and define trends, features and risks of technologies usage in modern world, interrelation between level technological and socio-economic development of the country, there were analyzed different stages of technological innovations called “technological waves”. By observing them it can be seen a significant jump in the society development in general as well as for companies that understood the essence of the new wave and benefits it brings.

The first industrial revolution used steam power to mechanise production. The second used electric power to mass produce products while the third introduced computers to automate production. The fourth revolution is happening now, disruptive technologies including the internet of things, virtual reality, robotics, and artificial intelligence are changing the way we interact, work, and live. Highly automated, intelligent systems promise to transform people’s lives and even question the very role of humans [2].

According to the OECD Science, Technology and Innovation Outlook 2018 the simplest and most obvious indicator of technology diffusion and transfer is improvement of production, exports which leads to economic growth. Education is defined as one of the core component in this process, especially those educational initiatives that specialize in technical fields. It is defined that the host country must develop the educational infrastructure necessary to take advantage of this new technology [3].

That is why it is considered to be essential the collaboration between universities, R&D institutions and business entities. At the same time, it is fairly clear that the ground basis for such cooperation is set withing the Government policies. With government support, foreign and domestic investments can help launch countries as the global tech hubs. The importance of such cooperation is proved also by the fact that World Economic Forum is partnering with civil society, companies, philanthropy and other stakeholders through cross-sector learning, collaboration and investment to investigate shared challenge areas and accelerate systems change interventions

needed to influence civil society readiness and impact in the Fourth Industrial Revolution. Fourth Industrial Revolution Initiative (CS4IR) includes [4]:

1. Providing a broader multi-stakeholder platform for discussion and cross-sector learning across ongoing expert civil society networks on innovation and technology.

2. Connecting academia, philanthropy and the private sector with a network of 200 regional and global expert civil society leaders in innovation, digital and emerging technologies.

3. Helping to create, contextualize and disseminate critical strategic intelligence on digital and emerging technology for broader understanding and guidance for civil society organisations.

4. Building evidence for change through both accelerating existing initiatives and co-creating multi-stakeholder “prototypes” for collective action and evidence aimed to scale civil society learning and innovation.

The use of technology in country’s economic life make interests of the individual to become increasingly important and interest in their material being and the wellbeing is entirely legitimate and ground for more innovations to come up. Thus, the potential for production can be developed through investment and one of the possible forms of investment is in technological innovations, which are the product of scientific development and the application of scientific thought in practice [5].

The Fourth Industrial Revolution is rapidly driving transformational disruption across every sector. By 2022, over 60% of global GDP will be digitized. An estimated 70% of new value created in the economy over the next decade will be based on digitally enabled platforms [6].

If to have a look at top-10 countries by their digital infrastructure and ability to use Information and Communication Technologies (ICTs) it is seen that there is interrelation between levels of technological and socio-economic developments of the country. These countries are considered to be the ones who generate economic growth, foster innovation and improve the well-being of their citizens. They are: Finland, Singapore, Sweden, The Netherlands, Norway, Switzerland, The United States, Hong Kong, The United Kingdom, South Korea [7]. Having analyzed the reasons why these countries ranked as top-10 the following conclusions come up:

1. Countries with high level of the ability to use ICTs have also have high levels of innovation, making truly knowledge-based society with stable business and innovation environment.

2. It is essential the support of the government with a clear digital strategy, which offers an ICT infrastructure which also contributes to quality education system and makes it possible for the country to become a knowledge-intensive economy and ICT powerhouse with a large number of government services available online.

3. Governments in these countries are aware of the importance of connectivity for the economic and social development of the country.

4. Countries have strong education systems that provide the necessary skills to create a knowledge-based, technology-rich economy.

5. Stable political and regulatory environment are excellent conditions for innovation and entrepreneurship, which have resulted in outstanding digital uptake and use by businesses.

6. Countries' focus on developing their technological capacity as part of their economic development strategy improved their reputation for innovation.

7. These countries are leading the world when it comes to generating economic impact from investments in ICT.

The Global Information Technology Report 2016 (which is the latest edition available currently) highlights the ways in which the digital revolution is changing both the nature of innovation and the rising pressure for firms to innovate continuously. The analysis yields four key findings [1]:

Key Finding 1: The digital revolution changes the nature of innovation.

Key Finding 2: Firms will face increasing pressure to innovate continuously.

Key Finding 3: Businesses and governments are missing out on a rapidly growing digital population

Key Finding 4: A new economy is shaping, requiring urgent innovations in governance and regulation.

Moreover Klaus Schwab, talking about the Fourth Industrial Revolution says that changes it brings "...are historic in terms of their size, speed, and scope... these individual technologies will fundamentally alter the way we produce, consume, communicate, move, generate energy, and interact with one another.." [1]. He points out attention at the fact that this revolution is already affecting labor markets, income inequality, and geopolitical security as well as social value systems and ethical frameworks.

Talking about the impact on labor market, it is necessarily to mention that digital technologies are already harming many existing jobs and entire sets of skills, creating necessity in new ones. At the same time, it is visible more freelance activity. That is why it is important to ensure that policies regulating technologies usage will not lead to the loss of social protection for workers. In this term it is defined that education and life-long learning will play key roles in ensuring economic and social stability in digital era. Thus it is proved that cooperation between policy makers, business, education and science must be on continuous mode. Therefore technology era creates winners and losers at the labor market and has huge impact on the employment trends in the country. Automation of jobs which is possible because of technology usage, decreases the necessity of people to conduct them which at the end leads to higher level of unemployment in the country. On the other hand, it might have a positive impact at the labor market situation in a sense of the necessity to improve upgrade workers' skills and makes population also receive the necessary training to prosper in the digital globalized world.

Another important feature of digital era is that it puts pressure on firms working at the market because of "winner-take-all" dynamics which means that it matters who gets there first. As a result companies have to innovate continuously not to be displaced. It has to be taken into account the following ways digital technologies affect innovation:

– boosting R&D and basic research;

- product and process innovation;
- business model innovation;
- increasing market size;
- reducing barriers to entry;
- acquiring and leveraging knowledge of consumer preferences.

The above mentioned shows the importance of technologies usage in creating an attractive business and innovation environment.

According to The Global Information Technology Report 2016 which presents data on the Networked Readiness Index (NRI), 139 countries were analyzed. The research presents country's economy performance in each of the 53 indicators composing the NRI. The indicators are organized by pillars, evaluated as [1 = not effective at all – it is deadlocked; 7 = extremely effective etc.] Ukraine's position in this ranking is presented in Table 1.

Table 1. Ukraine's performance according to Networked Readiness Index (2016)

NRI pillar	Rank Value (out of 139)	Value (1-7)
Networked Readiness Index	64	4.2
<i>Environment subindex</i>	94	3.8
1 st pillar: Political and regulatory environment	113	3.2
2 nd pillar: Business and innovation environment	67	4.3
<i>Readiness subindex</i>	30	5.7
3 rd pillar: Infrastructure	51	4.7
4 th pillar: Affordability	6	6.6
5 th pillar: Skills	33	5.6
<i>Usage subindex</i>	88	3.6
6 th pillar: Individual usage	76	3.9
7 th pillar: Business usage	63	3.6
8 th pillar: Government usage	114	3.1
<i>Impact subindex</i>	69	3.7
9 th pillar: Economic impacts	59	3.4
10 th pillar: Social impacts	75	4.0

Source: Insight Report The Global Information Technology Report, (2016). Innovating in the Digital Economy Silja Baller, World Economic Forum Soumitra Dutta, Cornell University Bruno Lanvin, INSEAD Editors [Online]. Available at: <http://weforum.org>.

Based on data shown in the Table 1, Ukraine has potential in ensuring proper innovative development which will lead to better socio-economic development. The most beneficial feedback from innovation implementation is shown in Figure 1.

The analysis of Ukraine competitive advantages (CA) shows that main of them are as following: qualified and educated human capital [9]; low cost of labor; land resources (33% of the world's black earth reserves); geographical location; raw materials resource base.

Key competencies (C) can be defined as: high level of training and a significant number of specialists in engineering and natural sciences; IT specialists (in the top-3 countries in Central and Eastern Europe); distributed transit infrastructure; existing

multi-sectoral industrial infrastructure; aerospace; a growing agro-industrial complex (AIC).

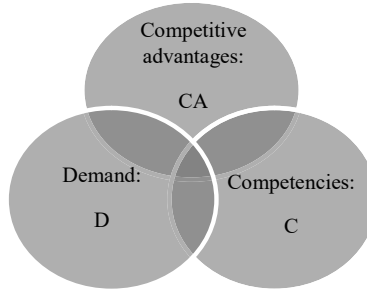


Figure 1. Conditions for most effective feedback from technologies usage

Source: What can be the future of Ukraine with Industry 4.0 like? (2016). Available at: <https://knn-systems.com/en/what-can-be-the-future-of-ukraine-with-industry-4-0-like/>

Factors of long-term demand (D) at domestic and foreign markets are:

– *domestic market* demand is determined by: modernization of transport and energy infrastructure; development of military-industrial complex; reduction of energy consumption of products, energy saving; import substitution; growth of industrial productivity and agroindustrial complex;

– *foreign market* demand is caused by: increase of labor productivity; increase of the level of agricultural products competitiveness industry; creation of new materials and components; creation of high-tech services and digital jobs; cost reduction and business process outsourcing.

Ukraine has been home for technological innovators for years. De facto, IT is the only industry that is integrated into the global market [8].

Taking into account the will to get most effective feedback from technologies usage and with the aim to boost the development of high-tech industries as well as to join the Revolution 4.0 it requires crucial reforms of all spheres of Ukraine, development and implementation the new strategies which meet new challenges. In this regards it was established the Strategy of high tech industries development till 2025 (Table 2).

The mentioned programs in Table 2 aim at creating attractive environment for innovations to be implemented in business, educational sector and households activities.

For further analysis of Ukraine’s potential for technologies transfer and successful joining to Industry 4.0, it was conducted a survey “Activities of Higher Education Institutions and Scientific Institutions on Technology Transfer and Academic Entrepreneurship” [11].

The survey evaluated 147 higher education institutions (hereinafter – HEA) and scientific institutions of the Ministry of Education and Science of Ukraine.

Table 2. Government Programs aimed at innovative economic development

Program	Purpose	Expected outcomes
1. High Tech Office	Support and stimulation of innovative enterprises and start-ups development by providing funding and the necessary expert and technical assistance at all stages of innovation development from the idea to the final product	<ul style="list-style-type: none"> - improvement of legislation in the field of innovation development; - improvement of legislation on innovation finance instruments; - strengthening the protection of intellectual property rights, promoting their registration in Ukraine; - facilitating access to finance for innovative businesses and startups; - strengthening cooperation with local authorities and businesses to support innovation; - financing innovative projects at early risky stages and increasing the number of innovative companies in Ukraine; - creation of a "manufactory" of start-ups and strengthening the venture capital industry; - motivation of innovators and entrepreneurs to create and conduct business in Ukraine
2. Development of export-oriented innovative ecosystem	Development of high-tech products and services export, integration of Ukraine into the world scientific and technical information space and laying the foundations for the development of high technologies in Ukraine	<ul style="list-style-type: none"> - deepening scientific and technical cooperation between Ukraine and developed countries, increasing the number of joint research and development; - strengthening and developing links between Ukrainian and foreign scientists; - increase in the share of high-tech products and services in the overall export structure; - harmonization of national standards in high-tech industries with international standards; - growth of scientific and research activity
3. Digital Agenda	Creation and implementation of a digital agenda for Ukraine that will include both the development of ICT infrastructure and the "digitalisation" of the public sector and the economy as a whole	<ul style="list-style-type: none"> - increasing the level of high-speed broadband Internet access penetration; - reduction of "digital inequality"; - modernization of public administration through optimization and automation of business processes; - forming a strategy for a rapid transition to Industry 4.0.
4. Welcome Multinational Corporations	Encouragement of world high-tech leaders to develop production and conduct researches in Ukraine, working with leading global companies and improving technology transfer mechanisms	<ul style="list-style-type: none"> - creation of new jobs in high-tech industries and related fields; - introduction of modern innovative technologies and advanced training of Ukrainian specialists; - creation of an effective technology transfer system; - strengthening of cooperation between scientific organizations, universities and business; - increasing the investment attractiveness of Ukraine
5. High Tech Nation	Promotion of STEM technologies and science among young people, improving the quality of specialists training and creating the conditions for retaining talents in Ukraine as well attracting talented young people from abroad	<ul style="list-style-type: none"> - increase in the number of students and graduates of STEM specialties; - modernization of curricula in higher education with a focus on digital technologies; - reduction of the level of "brain drain" abroad; - increase in the number of foreigners studying and creating innovative businesses in Ukraine

Source: Strategy of high tech industries development till 2025, (2016). <http://www.me.gov.ua/Documents/Detail?lang=uk-UA&id=c9b6f0b0-1ed5-4aba-a25e-f824405ccc64&title=ProektRozporiadzhenniaKabinetuMinistrivUkrainiproSkhvalenniaStrategiiRozvitkuVisokotekhnologichnikhGaluzeiDo2025-RokuTaZatverdzhenniaPlanuZakhodivSchodoYiiRealizatsii>

The results were as following: 29 respondents reported lack of technology transfer activities and academic entrepreneurship, 118 provided relevant information.

Regarding the use of technology transfer networks, 79 HEAs mentioned that they do not use the opportunities of national and international technology transfer networks, 40 – use such opportunities; 28 HEAs indicated that they are registered users of the National Technology Transfer Network (NTTN), 4 – use the capabilities of the Ukrainian Integrated Technology Transfer System (UITTS) and 3 – use the resources of the Automated System Formation of Integrated Interstate Information Resources (ASFIIR); 15 HEAs use opportunities of International Technology Transfer Network, including 11 HEAs using EEN (Enterprise Europe Network); 1 HEA – International Innovation Transfer Network; 1 – International Technology and Knowledge Transfer Network; 1 – International Ukrainian-Slovak Center for Innovation and Technology Transfer; 1 – Technology and Innovation Support Center of the World Intellectual Property Organization.

With regard to cooperation with small and medium-sized enterprises (hereinafter referred to as SMEs), 39 HEAs indicated absence of such cooperation and 76 HEAs indicated existence of cooperation with SMEs. In total, according to the information provided, the number of SMEs whom the HEAs cooperate with is over 1800.

Another aspect of analysis of country's readiness to technologies introduction is enterprises involvement into innovative activities. Enterprises' expenditures for innovation activities are an important economic factor for both their development and the development of the country as a whole. Data on the volume of enterprises' expenditures by areas of innovation is presented in Table 3.

Table 3. The total amount of expenditures by areas of innovation

Year	Share of innovation driven business	Total Costs	including					
			research and development ¹	including		acquisition of other external R&D	purchase of machinery and software	other expenditures
				internal R&D	external R&D			
%		UAH, mln						
2013	16.8	9562.6	1638.5	1312.1	326.4	87.0	5546.3	2290.9
2014 ¹	16.1	7695.9	1754.6	1221.5	533.1	47.2	5115.3	778.8
2015 ¹	17.3	13813.7	2039.5	1834.1	205.4	84.9	11141.3	548.0
2016 ¹	18.9	23229.5	2457.8	2063.8	394.0	64.2	19829.0	878.4
2017 ¹	16.2	9117.5	2169.8	1941.3	228.5	21.8	5898.8	1027.1

¹ data are given without taking into account the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol and parts of the temporarily occupied territories in Donetsk and Luhansk regions

Source: State Statistics Service of Ukraine [Online]. Available at: <http://www.ukrstat.gov.ua>

Despite of the problem of weak interconnection between business and science, there is a considerable interest from enterprises side in financing R&D - they make up almost a quarter of all the expenses for the implementation of scientific researches, while in industrialized countries this share reaches 50%.

From the above mentioned, it is seen the role of collaboration between governments, businesses, R&D centers, HEAs and individuals for maintaining sustainable growth of each of them as well as country as a whole. Moreover the public sector can help identify and realize the benefits of technologies innovations, primarily by providing a framework for collaboration across different sectors of the economy.

CONCLUSION

Thus, in competitive economies, the only way to further development is more innovations activities to be conducted. Although it is essential to distinguish positive and negative outcomes it has on country's socio-economic development. Careful government policies should be established as they play a very important role here. Work between governments, companies, and the emerging industries is an essential building block for realizing the massive potential of the Fourth Industrial Revolution. This includes both economic potential and social benefits.

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