THE FOURTH INDUSTRIAL REVOLUTION IS HERE. IS EUROPEAN UNION PREPARED TO ADOPT IT?

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Abstract
We are currently witnessing major changes in production systems, diversification and service delivery as well as business models. A new concept was introduced approx. 6 years ago - Industry 4.0. or The Fourth Industrial Revolution. This new concept refers not only to industrial branches, but encompasses the whole business environment, meaning the digitization of all physical assets in an economic entity and integration into digital eco-systems with partners in the value chain, partners that can be individuals or other economic entities. This paper aims to study the implications that the Fourth Industrial Revolution will have on production systems, services and human resources, to see how prepared we are to cope with the changes that will come in a very short horizon of time. For this purpose, the case study analyzes a number of relevant indicators at the level of the European Union and other developed countries that provide information on adapting economies to the requirements of the Industry 4.0 concept.

Key words: *digitized economy; digitization of products and services; fourth industrial revolution; Industry 4.0.; knowledge intensive sectors;*

JEL Classification: *O32, L86*

I. INTRODUCTION

The history of mankind is a continuous evolution based on application of knowledge and innovation in all areas. The accumulation of knowledge is a process formed by incremental steps which lead, from time to time, to qualitative leaps, which represents disruptive stages with major impact on the future evolution of the society. In all these processes, innovation played a fundamental role and still represents the engine of the development and progress (Albu, 2017). According to a big number of scientists preoccupied by the new trends of the world economies, we are just passing through a disruption process which characterizes the end of the third industrial revolution and the beginning of a new era, called The Fourth Industrial Revolution or Industry 4.0. The fundamental changes, focused at the beginning on the industrial production, are provoked by the unprecedented evolution of information technology and its impact in all areas. The changes far exceeded the limits of the industrial sector, they are seen or will be seen in a short horizon of time in service field, in administration, education, transportation and the list can continue. The whole business environment will be reshaped on different basis through the digitization of all physical assets in an economic entity and integration into digital ecosystems with partners in the value chain, partners that can be individuals or other economic entities. The new concept of Fourth Industrial Revolution will lead to a paradigm shift due to the multiple, diverse and unpredictable implications on the social life, human relationships, security, environmental protection, resources management, consumer patterns, job creation, and last but not least, on military and political issues. There are a lot unknown and uncertainties aspects connected with the new concept, but no one can deny the big potential brought by the Industry 4.0: (i) the most important impact will be felt on the productivity and competitiveness, due to the capacity to produce customized goods, perfect adapted to the customers' needs; (ii) with the same degree of importance we can appreciate that the potential of Industry 4.0 increases energy and resource efficiency and effectiveness; this aspect has a major importance in our current situation in which all nations are facing the problem of resource depletion, increasing the costs of resources, especially of energetic ones. The new technologies and devices developed in the frame of Industry 4.0 concept, are designed to use less energy with better efficiency. (iii) the third big potential is associated to the capacity of environmental protection, pollution

reduction, improving the consumption of the resources and finding solutions to reduce the emissions. It will give the possibility to implement the principles of circular economy or industrial economy in which there are no waste; at the end of their life, the products are recycled, reused or remanufactured, with an important positive economic and environmental impact. This big potential addresses not only to the developed countries, but also, to the developing countries which have the opportunity to develop more rapid and reduce the gap between them and the group of developed countries (Smit J. et. al, 2016).

II. CONCEPT AND MAIN FEATURES

Although we are talking about a very new concept, which has become very quickly a buzz word discussed all over the world, it has already a clear meaning and set of features which define and characterize it; it is important to specify from the beginning that there are different terms used in different parts of the world with the same or very close meaning for this new concept. Germany, which launched the concept, uses the name Industry 4.0 or the Fourth Industrial Revolution, while in USA more known is the term Smart manufacturing or Smart factory; in China and in India the name is neutral - Made in China, i.e. Made in India, but in other European countries, the concept is named more specific like Fabricca inteligente (in Italy) or Factory of the future (in France). Japan proposes another name for the concept which shows the essence of the term - Innovation 2025, while UK is more suggestive with the name Catapult. All in one, these names associated to the new concept want to say that the changes we are witnesses in production processes and services area are dramatic and will lead to a new level of development of the economy and society, in general. According to the different names of the concept, there were developed several definitions which are highlighting one or more particular aspect of the term. The table no. 1 sums the main definitions from the scientific research.

Table no.1 Definitions of the concept Industry 4.0.

No.	Definition	Source
1.	"Industry 4.0 describes the organisation of production processes based on technology and devices autonomously communicating with each other along the value chain".	Smit J. et. al, 2016
2.	"... the fourth industrial revolution applying the principles of cyber-physical systems (CPS), Internet and future-oriented technologies and smart systems with enhanced human-machine interaction paradigms".	Sanders et al, 2016
3.	"A new economic model for the industrial world, based on the evolution of the production paradigm, through the technological change and the adoption of processes logics."	Peressotti, V., 2016
4.	"Collective term for technologies and concepts of value chain organization. Within the modular structured Smart Factories of Industry 4.0, CPS monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. Over the Internet of Things (IoT), CPSs communicate and cooperate with each other and humans in real time. Via the Internet of Services (IoS), both internal and cross-organizational services are offered and utilized by participants of the value chain".	Hermann, M. et al, 2015
5.	"... industrial production ... characterized by the strong individualization of products under the conditions of highly flexible (large series) production, the extensive integration of customers and business partners in business and value-added processes, and the linking of production and high-quality services that leads to so-called hybrid products"	Thoben, K.D. et al, 2017

The definitions mentioned above show that the fourth industrial revolution will change the concept of production and service providing which will lead to the creation of new systems formed by persons and smart cyber devices (cyber-physical systems) and to new business models adapted to the specific requirements of all type of customers or business partners. Also, the definitions refer to a horizontal integration of the components of a production process and to a vertical integration of the process in the economic value chain. These aspects are relevant for the implication of the new concept which will cover all industrial branches and an important part

of service area, making less important the differences between production and services; the use of digital technologies will lead to results which can't be defined as 100% products or services because will have hybrid characteristics.

The central structure of the Industry 4.0 concept is the cyber-physical system (CPS), consisting from a combination of physical and cybernetic systems which communicate and acts together as one. The advantages of the new production system are obvious, but the change from the current manner of production to the new one, is not simple, takes time and investments both in technology and human resource preparation. According to different studies developed in Europe (Berger, R., 2014), (Crnjac, M. et al, 2017), (Thoben, K.D. et al, 2017) there were identified some precondition necessary to be fulfilled before the implementation of the fourth industrial revolution's principles:

- Standardization was identified as the main precondition for the big step of adoption of Industry 4.0; it means that the partners involved in the production process must have a set of common standards as baseline;
- Process and work management - refers to the fact that complex processes and their associated activities must have an appropriate management, adapted to their complexity; the employees will have more freedom but, in the same time, bigger responsibilities;
- Access to broadband infrastructure for industry; communication in cyberspace is vital for Industry 4.0 and for its integrated processes, like IoT;
- Safety and security is a critical issue in the concept of the fourth industrial revolution. The information is organized in big data structure which must be protected from harmful interventions. For the success of Industry 4.0 it is necessary to assure the security of all the data and the information; furthermore, the access at the information requires an authorization;
- Regulatory framework - refers to the fact that the legislation must reflect the changes introduced by the fourth industrial revolution;
- Training for professional and personal development of the employees - is one of the most important precondition because they must have the knowledge, skills and capabilities to work with the new devices and technologies; also, human resources are important due to their creative potential, all the innovation and the changes associated to the Industry 4.0 concept being creations of human intelligence and creativity. Human resources are vital for the success of new production processes and services delivery.

Analysing the preconditions required by the Industry 4.0 concept we can conclude that some of them are already fulfilled for almost all the countries, e.g. standardization through the international standards issued especially by ISO, but other preconditions will be difficult to reach even for developed countries. Here we are talking about safety and security which is still a big problem for the future development and implementation of Industry 4.0.

Beside this preconditions the specialists identified a set of questions related with the fourth industrial revolution; one of the most important is focusing the business models. Are the actual business models fit with the new way of production and service delivery? If not, what type of business model must adopt? What are the costs of changing the business model and what risks are associated with the implementation of a new business model? There are no very clear answers at these questions, but the change of the business models is a certainty. The possibility to customize the production, to have information in real time and to process a big volume of information in a very short time will change the manner of decision making process, will create new type of connection between economic entity and its stakeholders, will open new possibilities to satisfy the clients and to do business. Another questions are focused on the research activities, which represent the foundation of the fourth industrial revolution. Research, innovation and technology transfer need a strong financial support and the questions refer to how much it is necessary to invest in this area and what is the optimum ratio between public and private funding for research. The experience acquired in implementation and the future development of the concept of Industry 4.0 will provide answers at the problems mentioned above and, for sure, will bring new questions and challenges.

According to a study elaborated by the Directorate General for Internal Policies, Policy Department of European Parliament, (Smit, J. et. al, 2016), the concept of Industry 4.0 has the following main features, represented in fig. no.1:

Fig. no. 1 The main features of Industry 4.0 concept
Source: Smit, J., Kreutzer. S., Moeller. C., & Carlberg. M. (2016). *Industry 4.0. Study for the ITRE Committee* European Parliament's Committee on Industry, Research and Energy. Brussels. p. 21. Retrieved from http://www.europarl.europa.eu/RegData/etudes/STUD/2016/570007/IPOL_STU(2016)570007_EN.pdf

- Interoperability - refers to the wide possibility to connect and to communicate between humans and cyber - physical system; in smart factories all the devices, machines and other assets are connected through Internet of Things (IoT) and cloud connectivity and connected with humans in a wide system;
- Virtualisation - new technologies associated to Industry 4.0 will allow to simulate the whole production process or smart factory before the real activity takes place, based on process model and the links between the process and its smart devices.
- Decentralisation - is based on the capacity of smart devices to make decisions for the specific tasks they execute; the decentralisation allows a better control and improvement for each action or step from a production process. It will be supported by the 3D printing technology which will allow a local production.
- Real-time capability (responsiveness) - is a key features which highlights the capacity of Industry 4.0 to work with big data, to collect, analyse and store it for the purposes of the process. Due to this capacity of use the data, the system can answer in real time at the changes expressed by a customer, or can simulate the possibility to fulfill the new requirements with the available resources of the system.
- Service orientation - is a concept from computer design and used by the fourth industrial revolution to show the capability of the cyber-physical systems to provide several, independent services, like a team of workers in which each person has specific tasks. Also, we can add the fact that we are witnesses at the dematerialisation of the products - a product is useful due to the services it provides to the user. In the future, the producers will not sell only the products, but the products and the associated services.
- Modularity - represents a basic feature of Industry 4.0 which involves the structure of a future smart production process; it is made from different modules with different functions that can be used according to the requirements of the production. If the requirements are changing, the structure of the process can be reconfigured and adapted to the new requirements.

The description of the main characteristics of the concept Industry 4.0 gives us an image of the increasing interconnection and digitization of production and services delivery in an extended network, with humans and smart devices which are changing and sharing information in real time. The process is only at the beginning, but will evolve with a tremendous speed, according to a big number of studies developed during the last 5-6 years, both by scientists and business environment. Today, only one fifth of the companies from production area have digitized processes, but in five years' time, approx. 85% of companies will have implemented Industry 4.0 solutions in their main processes (Geissbauer, R. et al, 2014).

III. ECONOMIC AND SOCIAL IMPLICATIONS OF THE DIGITIZATION

Although the Industry 4.0. term is still in the crystallization phase, it will cause a paradigm shift. The first industrial revolution was marked by the introduction of mechanical devices powered by water and steam; the second stage is distinguished by the launch of the mass production concept based on electricity. The next step done in this evolution has been made through the introduction of integrated circuits, of information technology in mechatronic systems for production automation, a period known as the digital revolution. Industry 4.0 will offer a number of principles that help companies implement a Smart Factory vision, an action that will have affect the

value chain, workforce, and business models. Internet of Things, Big Data & Analytics, 3D Printers, Augmented Reality and Autonomous Robots are proofs of countless possibilities for development in the future digitized economy (Banabic, D., 2016).

Considering that over the past 15 years, the variety of products has doubled, while the life cycle has been reduced by 25%, it is obvious that the development and manufacturing process has a growing complexity and requires new models and technological solutions to be able to answer at the customer needs. From this point of view, it can be said that Industry 4.0 has emerged as a necessity for the efficiency of production processes. From an economic point of view, Industry 4.0 is a chance to relaunch, re-technologize production and evolve business models for services and products (Moavenzadeh, J., 2015).

A global study made by PwC in 2016 shows that firms have high expectations from the fourth industrial revolution, from which, the cost reduction is one of the most important aspect; regarding the cost reduction, results are expected to be almost immediately visible by 2020. Figure 2 shows the cost-cutting values, according to the PwC study, at the level of the main industrial branches.

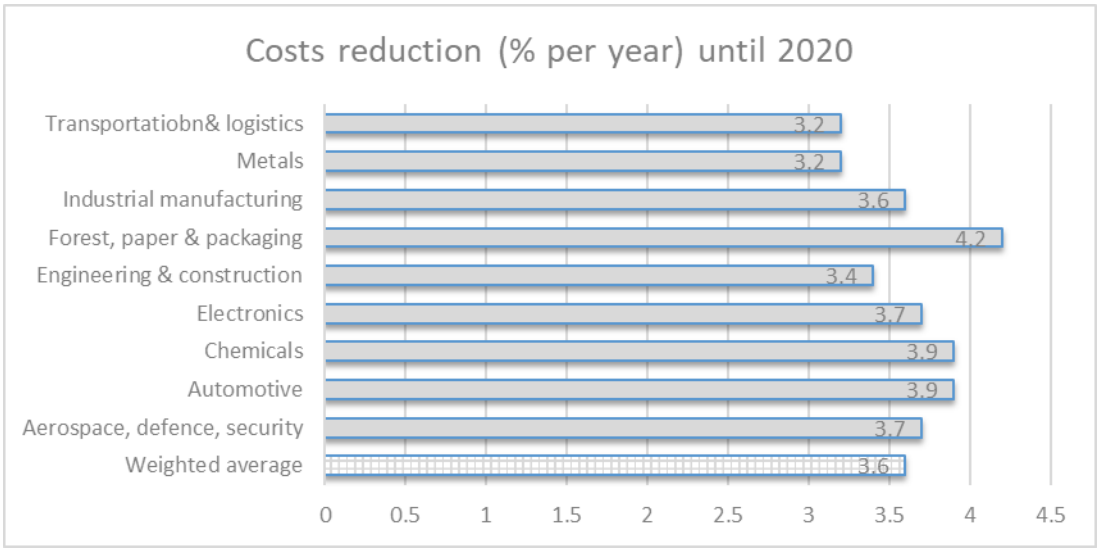

Figure no. 2 Expected costs reduction due to the implementation of Industry 4.0 principles
Source: Geissbauer, R., Vedso, J., Schrauf, S., (2016). Global Industry 4.0 Survey: Building the digital enterprise. Retrieved from https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf

The reduction of costs can be achieved from different activities such: predictive maintenance, integrated planning and scheduling for manufacturing or implementation of track-and-trace devices to reduce logistics costs. In addition, the costs due to wrong decisions are reduced (wrong information and mistaken decisions taken in their base, cost 25% of the income of companies). Resources are used more efficiently by minimizing the losses resulted from the technological processes.

Another benefits expected from the implementation of Industry 4.0 principles are time benefits: each employee becomes more productive working in an optimized process, like the digitized one; engineers spend 31% of the working hours searching for information, time that can be used for activities that produce value. Digital manufacturing involves the simultaneous development of the product and the production process. Companies reduce the production interruption periods by 80% if they use digital validation.

With the same importance we can mentioned the expectation regarding the management of activities; in a digital factory, the management will be based on real-time data analysis. This will allow the optimization of all the phases in the life cycle of the product. Virtual simulations of design and functionality developed in parallel with manufacturing planning will lead to a much faster market launch, significant cost reduction and higher quality. The management must provide new strategies and business models.

The implications of the digitized economy will be seen both in production and services fields, but with different weights. According to the specialists, it is obvious that production processes will be the main beneficiary of the implementation of Industry 4.0 concept, but there are a lot of services which will be dramatically changed due to the digitization process. In the table no. 2 there are summarized some considerations regarding the implication of the digitization of products, production processes and services.

Table no. 2 Implication of the digitization in business environment

Field of activity	Implications
Transport sector	Progress made regarding artificial intelligence, the Internet of Things, clean energy and other technologies can improve the safety of drivers and pedestrians. Finally, it could lead to a wider use of public transport and car sharing services. The concept of having a car is changing because you can have it as a service and not as a good, which fundamentally changes the business models of the car companies. This change can lead to agglomeration and pollution decreasing, to faster and cheaper traveling, and health improvement.
Insurances	The insurances companies will use smart devices to have more information about the customers or to offer information to the insured persons; with the help of the devices and sensors, insurance companies will establish differentiated prices, customized for insurance policies. Also, the sensors mounted in cars can warn the drivers about malfunctions or can record useful information to establish the causes of the accident which will simplify the claim processes.
Retail businesses	The main feature of retail will be personalization, in order to understand and meet the individual needs of customers. Virtual customer service agents can make day-to-day transactions and make smart referrals to customers. Machine learning algorithms can analyze billions of signals to direct customer calls to the most appropriate agent. Using augmented reality devices such as smart glasses or other portable items, buyers can look at a product in a store and receive, in the same time, relevant information about the product. Currently, businesses in this sector are running by the "order and send" model, i.e. the person makes an order and the company packs and sends it, but the artificial intelligence and the IoT will revolutionize the field. Smart devices will know in advance what are your needs and will order commodities in your place.
Finance sector	Financial institutions can use artificial intelligence to detect fraud and investigate different actions. They even use machine learning data to manage customer relationships. For example, artificial intelligence helps financial counselors to predict what prospects are the most valuable in the sales cycle, to decide on the next actions and create personalized journeys based on financial targets, life events and other client-specific variables.
Production sector	Will be the main beneficiary of the fourth industrial revolution by changing the whole concept of production process. Steps which now are taking place in a certain order, will be performed almost in the same time, shortening and overlapping the periods. Another impact will be on raw materials and materials: by 2025, the primary resources for chemical industry will shift from oil and gas to biobased and recycled materials; the mineral production will come from new sources, considered now impossible to be exploited. New technologies will allow the efficient exploitation of deep sea bed, seawater, deep solution mining and asteroids. Pollution regulations will influence directly the investments strategies.

Source: own elaboration with information from: Impactul celei de-a Patra Revoluții Industriale asupra afacerilor, (2017). Retrieved from http://www.managerexpress.ro/idei-resurse/impactul-celei-de-patra-revolutii-industriale-asupra-afacerilor-ii.html and Moavenzadeh, J. (2015) The 4th Industrial Revolution: Reshaping the Future of Production. Retrieved from https://www.eiseverywhere.com/file_uploads/fe238270f05e2dbf187e2a60cbcdd68e_2_Keynote_John_Moavenzadeh_World_Economic_Forum.pdf

A group of major implications will be on the labor force. Certainly, the skills required in the factories of the future will be other than the current ones. Many of today's activities such as production machinery, precision positioning, assembly, quality control will be done by robots. The risk is a massive unemployment for certain categories or, in some areas, the lack of staff with digital skills. Specialists realize that, in fact, the main challenges will not come from technologies, but from people; while digital technologies are becoming more and more accessible, the success of organizations depends largely on organizational measures and how managers are leading and communicating to employees the transformations that will take place. In order to have a well prepared workforce, there were identified two directions of action: first is focused on organization of very

specialized trainings, capable to provide the skills needed for a digitized job; second direction is a long-term one and refers to the education system which must be adapted to the new requirements that will appear on the labor market. However, specialists unanimously agree that it is very difficult to evaluate, at this time, the impact that the labor market will have to face, and the scale of unemployment for certain categories of people, which will certainly lead to serious social problems. One of the solutions for the people left without a job and the ones that will not be able to acquire sufficient digital skills, remains the sector of services which, although will be strongly connected to the new changes, will also maintain a less digitized element (World Economic Forum, 2016).

A special attention must be paid to the ”dark side” of the concept of the fourth industrial revolution, that is the enhancement of computer terrorism, fraudulent access to information and their use for destructive and criminal purposes. Therefore, some of the research in this field are directed towards data security systems and other tools designed to reduce risks and ensure a positive use of the achievements brought by Industry 4.0. The general term used is cyberterrorism defined as: “an unlawful activity to intimidate or coerce a government or its people for a political or social objective; attacks and threats of attacks against computers, networks, and the information stored therein and attack that results in violence against persons or property, or at least causes enough harm to generate fear” (MacKinnon, L. et al, 2013). The cyberterrorism has a very clear purpose (steal money or information) and uses sophisticated tools and methods to penetrate the target networks. The size and effects of cyber attacks are significant and very difficult to assess, especially because we don’t know where will be next attack of the cyber terrorists. Generally, it is possible to identify some additional effects of these cyber strikes, beside money and information theft (Cashell, B. et al, 2004); these effects have the same importance because affect the organization on long term:

- Reputation or confidence effect - when a company reports cyber breaches, its reputation is affected and the customers and other business partners lose the confidence in the company. The competition can use this weakness to gain competitive advantage.
- Litigations concerns - the stakeholders of an organisation which is subject of the cyberterrorism can ask for recovery of damages at court if they consider that the company hasn’t taken all the security measures to prevent this type of attacks.
- Financial market impacts - security breaches have a negative impact on stock and credit markets, which lead to a raise of the cost of capital. The main consequence is that this companies are considered riskier for a bank loan.
- Loss of intellectual property - the breaches in the security system will allow the access at the innovations, inventions, designs, trademarks and other results of the human creativity, protected by the intellectual property rights.
- Signal to attackers - an organisation attacked by the cyber terrorism which admits publicly that it has security problems, attracts the attention of other hackers on its inner problems.
- Job problems - refers to the IT personnel which monitor the security system of the company. They can hide incidents regarding breaches, fearing for their jobs.
- Violation of regulations and laws on data security or data privacy - results from the criminal characteristic of the cyber terrorist attacks.

Due to the extended use of internet and other cyber tools, Industry 4.0 faces a serious problem regarding the security of products, services, assets, processes and humans involved in activity. There were proposed different solutions to improve the security of cyber-physical systems, like: making security an integral part of the whole system, no something added after the process/system was already design and built, enhancing the international cooperation in cyber security area, more research, both from public and private directions, greater information sharing, less militarizing cyberspace. According to the report of PwC network of organizations, Industry 4.0 must build a digital trust on three pillars: transparency, legitimacy and effectiveness (Geissbauer, R et al, 2016).

IV. CASE STUDY: HOW WELL IS THE EU READY FOR THE ADOPTION OF INDUSTRY 4.0. CONCEPT?

The study of the scientific literature has risen for us some questions about the capability of different countries to implement the Industry 4.0 concept. To answer at these questions, we have searched and analysed several indicators which provide information about the level of readiness of EU at the challenges of fourth industrial revolution. The implementation of Industry 4.0 concept is seen at European level as the solution for a sustainable re-industrialization, after two decades in which the production was transferred to Asia and only one in ten EU companies are involved in products manufacturing.

As has been shown earlier, the adoption of the Industry 4.0 concept. will have considerable effects on the workforce; on the one hand, there will be a lack of skilled people with digital skills, and on the other hand those who will not be able to improve their level of training will lose their jobs and will be very hard to find another one. Starting from the implications for human resources, in the case study we studied the existing situation at EU level regarding the workforce with higher education, graduates of university education - bachelor and master degree, as well as doctoral graduates compared to the main international competitors USA, Japan, South Korea, Australia and Canada; we added, also, China due to its rapid development and due to the fact that this country has initiated a program for the rapid implementation of the Industry 4.0 concept (Made in China 2025). We considered these groups of people to have the skills and training required to meet Industry 4.0 requirements. Figure no. 3 shows the evolution of the number of persons with higher education from 2013 to 2016 and a linear extrapolation of this indicator for the future period.

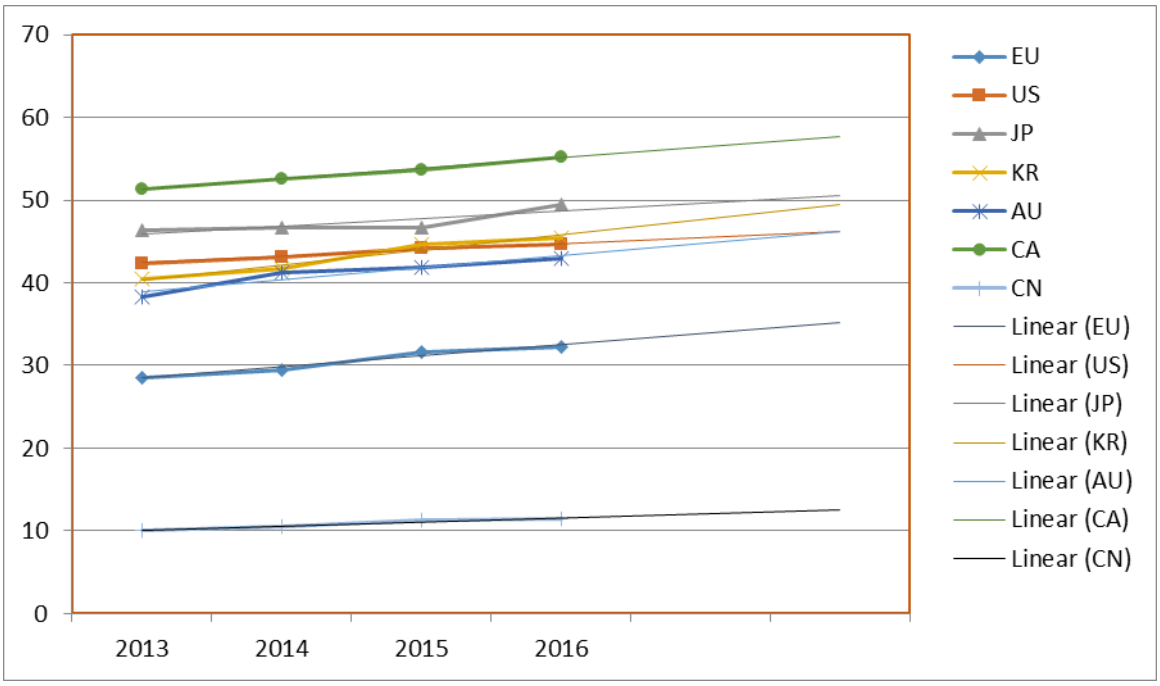

Figure no.3 Percentage of population with higher education

Source: own elaboration with information from Innovation Union Scoreboard (2014), Innovation Union Scoreboard (2015), European Innovation Scoreboard (2016) and European Innovation Scoreboard (2017)

From the figure above, it can be seen that the EU is not in a favorable position, being overtaken by all international competitors except China; it can be said that the union has to recover an important gap, which is quite difficult to achieve, given that the growth rate of the indicator has decreased between 2015 and 2016 (with 32.2% in 2016). The best position is Canada, followed by Japan, which reaches 55.2% and 49.5%, respectively in 2016, both with an upward trend. The worst position is occupied by China, with a maximum of 11.5% in 2016. The forecasts for the evolution of the number of graduates with higher education for the following years, obtained by linear extrapolation, were represented by thin lines. It can be noticed that Australia will overtake the US, and South Korea will overtake Japan over the next 2-3 years, while Canada will maintain its position.

Another indicator analyzed was the number of PhD graduates, expressed as a percentage of the population for the same period, 2013-2016. We considered that the holders of a doctorate in science represent highly educated people able to cope with the requirements of the labor market in the conditions of the expansion of the Industry 4.0 phenomenon but, above all, involved in the innovation and creativity process in the field their activity.

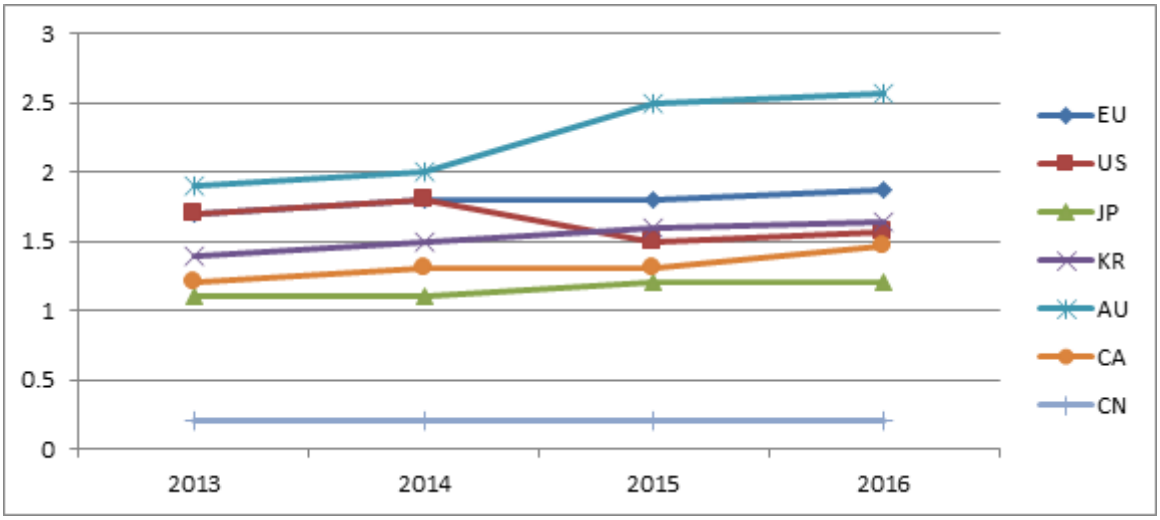

Figure no. 4 Percentage of population which holds a PhD title
Source: own elaboration with information from Innovation Union Scoreboard (2014), Innovation Union Scoreboard (2015), European Innovation Scoreboard (2016) and European Innovation Scoreboard (2017)

For doctoral graduates, the EU has a much better position, being overtaken only by Australia throughout the analyzed period; in 2016, overtaking is 36%, and, moreover, there is a slight increase, similar to that of Japan and South Korea. Canada, after a period of stagnation, has been rising since 2015, while in the US there is a decline in 2015 and a very slow recovery. China is again far from the group of other states, with constant values throughout the period.

Regarding the quality of qualified human resources, we have further analyzed one of the results with a significant impact on the implementation of the Industry 4.0 concept, namely the number of patents in the PCT system registered by the European Union and other competing countries. From figure no. 5 it can be noticed that Japan and South Korea have a much higher number of patents than the other countries, the overshooting being significant (about 7 times higher, Japan to China in 2015). Positions no. 3 and 4 are occupied by the EU and the US, which occupy them alternately, with a more pronounced fall for the union between 2014 and 2016. Australia and Canada have the same trend, while China is showing a slight increase after 2015.

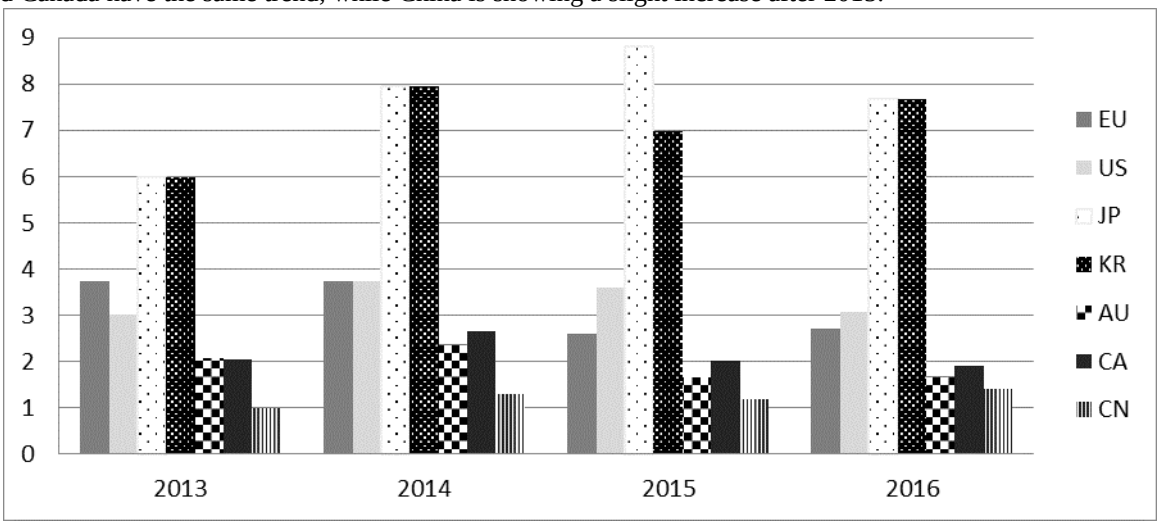

Figure no. 5 Number of PCT patents applications registered by EU and its international competitors, expressed as number of applications per GDP
Source: own elaboration with information from Innovation Union Scoreboard (2014), Innovation Union Scoreboard (2015), European Innovation Scoreboard (2016) and European Innovation Scoreboard (2017)

A final indicator reflecting the level of EU human resource preparedness for the challenges of the fourth industrial revolution was the percentage of employees in the intensive knowledge sectors, compared with the percentage of the employees which hold an university diploma.

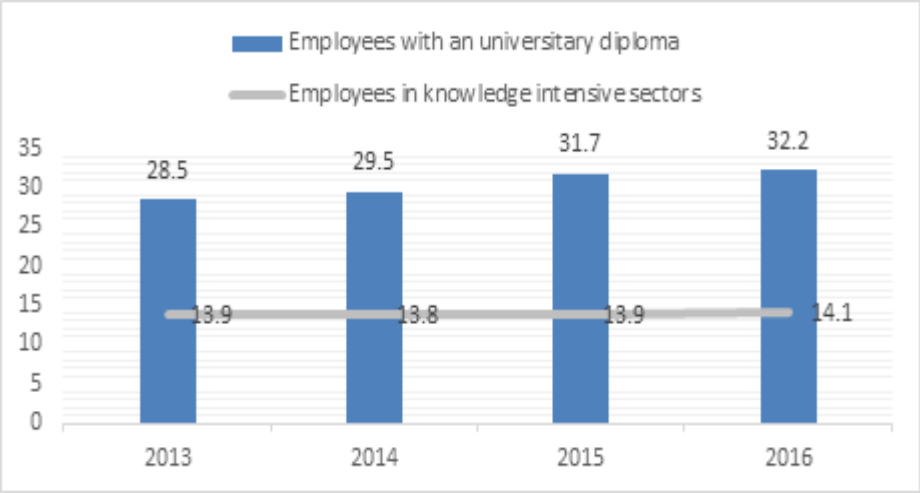

Figure no. 6 Employees in the intensive knowledge sectors compared to the higher education population in the EU

Source: own elaboration with information from Innovation Union Scoreboard (2014), Innovation Union Scoreboard (2015), European Innovation Scoreboard (2016) and European Innovation Scoreboard (2017)

It can be noticed that, although the European Union has launched the concept of Industry 4.0, it has a low percentage of employees in the knowledge intensive sectors, which have been in very slight growth in recent years. The indicator is calculated as the ratio between the employees in the intensive knowledge sectors and the total number of employees.

A second category of indicators analyzed in the study were those related to internet access of companies and individuals (households) at EU level during the same period, 2013-2016. In Figure no. 7 was represented the evolution of Internet access, this being the first step towards digital integration.

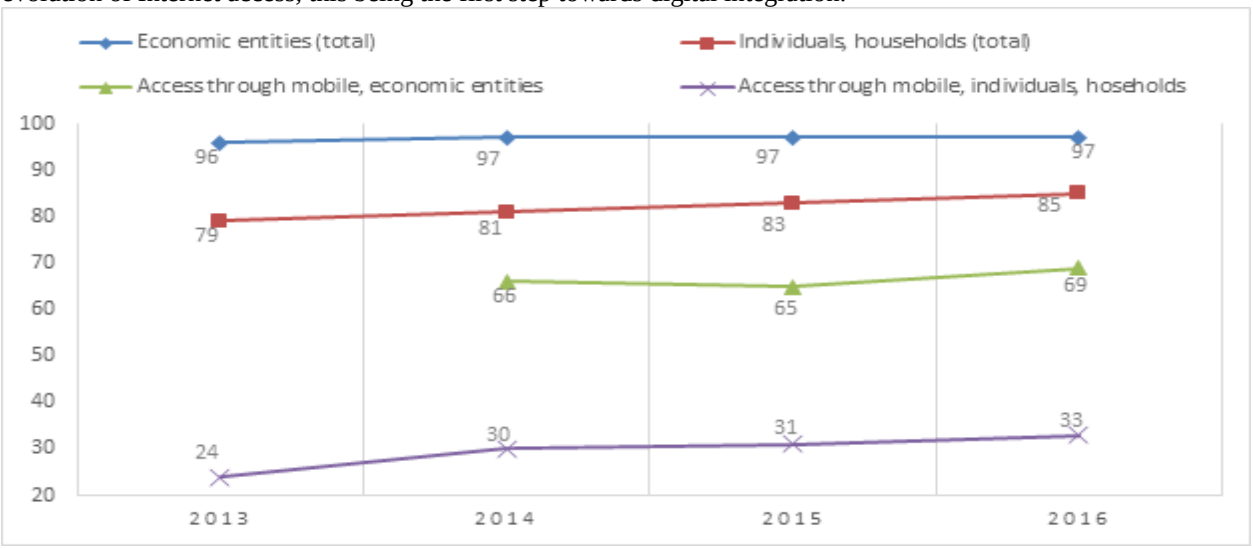

Figure no. 7 Access to Internet

Source: own elaboration with information from Eurostat, http://ec.europa.eu/eurostat/web/digital-economy-and-society/data/main-tables

It can be seen that the internet connection of companies is a natural aspect at present, the EU average is 97%, with many countries reaching 100% (Netherlands, Luxembourg, Finland, Lithuania); in the case of households the trend is upward, with the best values being in the Netherlands and Luxembourg (97%), Denmark and Sweden (94%); the opposite is Bulgaria with 64% and Greece with 69%. Also, a large number of businesses access the internet from their mobile phone; the leaders are Finland with 94% and Denmark with 92% of the registered companies. With the fewest companies accessing the internet on the mobile phone, is Bulgaria with 41% and Romania with 43% (in 2016) (European Commission, 2017).

From the point of view of internet access (through all available technologies), it can be said that the European Union is in a favorable position, both for companies and for persons, for which Fig. no. 7 indicates a further upward trend.

V. CONCLUSIONS

Industry 4.0 concept appeared in Europe and expanded rapidly, representing the upper stage in the evolution of production and business. From the study of some indicators available at Union level, it has been noticed that the EU has to recover a series of gaps compared to other developed countries for the fourth industrial revolution to be the current mode of production. From the analysis of all the indicators referring to the professional preparation of human resource, we can appreciate that the European Union is not yet ready to meet the requirements that will be imposed by the operation of the integrated systems from an Intelligent Factory. In this respect, closer collaboration with universities would be required to provide new study programs needed on tomorrow's labor market.

Within the EU, there are remarkable differences in the values of the same indicator among Member States, which makes it even more difficult to recover the gaps between EU and its main international competitors.

Industry Concept 4.0. enables the human resource to use better its creativity and innovation skills, and routine repetitive work to be taken over by robots and other technical systems. The envisaged transformations will fundamentally change the company concept, establish other forms of customer relationships, and promote new business models.

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