CHANGES IN THE ADDED VALUE CHAIN IN ECONOMY 4.0

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Abstract. For a few years, we can observe dynamic changes in the economy, which are also referred to as the fourth industrial revolution or economy 4.0. The main directions of the changes include progressive digitalisation, automation, and robotization with a view to improvement of the effectiveness and responsiveness to the consumers' needs. Concurrently, we are facing changes in the global added value chains. The purpose of this study is to show the changes leading to the growing importance of the pre- and postproduction and dilution of the significance of the central production services. As a consequence of the changes attributable to the fourth industrial revolution, also "intelligent" added value chains arise, which will self-organise, optimize and control themselves on the inter- and intracompany scale.

Key words: economy 4.0, added value chains and networks.

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Introduction

The western civilisation has already witnessed three industrial revolutions, which may be determined as erratic changes in the industrial processes resulting in a considerable improvement in the productivity. The first of them contributed to improved productivity owing to use of water energy, increased use of the steam energy and introduction of new machinery and equipment into production. The second industrial revolution was characterised by switching to the mass, serial production owing to use of electrical energy and intensification of work distribution. The third industrial revolution consisted in using the electronics and IT to continue automation of production. The fourth industrial revolution that we are facing now, is also referred to as "industry 4.0" or "economy 4.0". The concept of industry 4.0 proposes a completely new level of automation of production. On the one hand, it is related to the existing production concepts such as gradual establishing of data base networks and on the other hand it is aimed at generating automation of processes through highly flexible combination of the network data level with the actual factory processes which opens completely new forms of controlling and organizing production processes. These changes are primarily aimed at achieving a leap in the automation. The fourth industrial revolution also entails dynamic changes in the distribution of added value in the added value chains. The purpose of the study is to show the changes occurring in the economy which are generated by the fourth industrial revolution, with particular emphasis on the changes in the global value added chains.

Industry 4.0 in the light of economic theories

Transformations in the economy that every industrial revolution entails, are also reflected in the science. Consequently, the existing theories are modified and new ones are arising. With regard to changes in the economy, which are referred to as the first industrial revolution, A. Smith did not focus on the recent technological achievements such as invention of the steam machine, but generally referred to machines facilitating human life. He argued that the process of replacing humans by machines was underway, along with specialisation and distribution of work (Smith A., 2007). According to A. Smith, specialisation was a natural thing following from the human nature, and primarily from egoism. Consequently, specialisation sets the production process in order and makes it more effective and contributing to the wealth of nations (Olender-Skorek M., 2017).

The period of the second industrial revolution is preceded by the works of J. Schumpeter, who wrote about the process of creative destruction and new capitalism adopting dynamic

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characteristics. It is just the static model of capitalist economy getting more dynamic that is perceived as the greatest contribution by Schumpeter into the theory of economics (Stankiewicz W., 1998, p. 270). Schumpeter attributes a high role to the entrepreneurs, who in the process of creative destruction introduce innovations which are defined as new products, technologies or solutions. He also points out that innovations replace the hitherto obsolete solutions by being their more modern, more effective and more up-to-date versions, like the steam machine which was replaced with electricity (Schumpeter J. A., 2008).

The third revolution, which is referred to as the information revolution, is based on knowledge and its key role in the economic development. In the hitherto revolutions and concepts of the neoclassic economy (including Schumpeter), production was primarily based on work and earth. However, at this point, knowledge becomes important, which becomes an additional production factor of sorts. The third revolution is focused on information and it is information that creates the added value for the economy. This recalls the reflections of Friedrich von Hayek on the dispersed knowledge. This Austrian scholar has drawn attention to the problem of collecting and processing huge amounts of information, which, quite often, bring no valuable knowledge, and to the information noise surrounding people from which they have to extract the valuable information (Hayek F., 1998).

Nowadays, we are facing changes occurring in the economy which are referred to as the fourth industrial revolution or industry 4.0. It is based on the growing role of information, its collecting and transformation by modern technical solutions, including in particular any and all so-called co-existing application systems. The fourth industrial revolution differs from the preceding ones in that it is not only the collecting of information but rather about fast processing of large amounts of data and their skilful use. In discussing the nature of the fourth industrial revolution, we can also invoke the concept of the dispersed knowledge by Friedrich von Hayek. According to him, one of the main problems of the economic policy was to find the best method of using the dispersed knowledge, which, in turn will allow to design an efficient economic system. It seems that an important effect of the fourth industrial revolution will be a possibility of collecting and effectively using the dispersed knowledge.

Industry 4.0 as an element of economic development

Nowadays, we commonly recognize term: industry 4.0 (*German. Industrie 4.0*), which first appeared in the public domain during the 2011 Hannover fairs, as a name for the common initiative of the representatives of the business, political, and academic circles to promote the concept of reinforcement of the competitiveness of the German industry. The federal government of Germany made the *Industrie 4.0* an integral part of governmental initiative "*High-Tech Strategy 2020 for Germany*", which is aimed at promoting Germany as the global leader of the technological innovation (Czyzewski A., et al. 2017). The term was subsequently popularized by Klaus Schwab, Chairman of the World Economic Forum. According to Schwab, the most important thing that differs this revolution from the preceding ones is its speed. Big changes occurring in the industry and economy in the past had been slowly structured for decades. On the other hand, the technological breakthrough of our times is advancing at an extremely fast pace. Importantly, all the changes occur not only and exclusively in a single area; they apply not only to development of mobile networks or sensors, but also to nanotechnology, brain research, 3D print, or the science

about materials. The fourth industrial revolution is an innovation of the entire system (DzierzekA., 2015).

Industry 4.0 entails three phenomena (Gajewski J. Paprocki W. Pieriegud J., 2016):

- Universal digitalization and ensuring regular communication of people with each other, of people with devices and devices with each other;
- Increasingly often implemented disruptive innovations which allow rapid increase of the effectiveness and efficiency of the functioning of the social and economic system;
- Attaining such level of development of machines that they acquire the capability of autonomous behaviour thanks to employing the artificial intelligence in their control process.

According to Kevin Werbach, industry 4.0 develops in three dimensions. The first of them encompasses the so-called economy of sharing or the on-demand economy. This dimension is not only about the sharing of resources but primarily about services such as Uber and Airbnb, which facilitate on-demand access to resources. The other dimension is the internet of things as part of which devices of all types are connected within the network. Devices equipped with sensors communicate with each other more fast and efficiently than with the aid of humans. Consequently, this allows for automated factories using the artificial intelligence to anticipate customers' needs or autonomous cars driving passengers safely to their intended destinations (Werbach K., 2017). And finally, the third dimension, i.e. the *big data* and the analytics feeding the artificial intelligence, researching our consumer, communication or health behaviour and habits, guessing our needs, prompting solutions, steering production lines so that we get what we just need at the right time (Czyzewski A., et al. 2017).

Those three dimensions altogether bring the world to potentially become a single network, in which practically anything can become a data generator and all those data can be integrated, analysed and processed and skilfully used.

According to experts, success of industry 4.0 in Germany depends on introduction of the state-of-the-art. Technologies into six branches of the economy: the machine, electrical engineering, motor, chemical, agriculture and IT industries (Godlewski A., 2016).

Added value chain in economy 4.0

The term value chain means all the activities undertaken by companies and employees from the time of origination of product (goods or service) until its ultimate application which, taken together, decide about the value provided by the company to its surroundings. The global value chain is distributed among many companies and geographic locations. They include e.g. activities such as designing, production, marketing, distribution and end customer support (Kuzniar A., 2017). The model of value chain serves the purpose of making the strategic diagnosis of an organisation consisting in locating such activities at the enterprise which contribute most to the competitive advantage of the company, and consequently, translate into the profit generated by the company (Bochniarz P. et al., 2015).

Most frequently, an analysis of the global value chains applies to the production or service companies. However, in the agrifood sector, value chains are also developed. In the latter sector, the value chain links the agriculture, food processing and distribution which have a substantial effect on the level of economic well-being, and the social and ecological situation of citizens (Czyzewski A., 2001). The complex chain of the value of the agrifood sector includes companies generating means of production for the agriculture, farmers, traders, food businesses and retailers,

all of whom must ultimately satisfy diverse requirements of consumers. The agrifood sector covers a wide variety of entities at each phase of business activity. They include B&R businesses, farmers running their farms to satisfy their needs, technologically advanced big farms, ecological food stores, small and medium enterprises and cross-national corporations. According to KPMG, in 2012, the share of that value chain contributed to a total pool of profits of approx. USD 600 billion (The agricultural and food... 2013). Table 1. presents the level of profitability of the main sectors of the value chain.

Table 1

Profitability level in the links of the global chain of the added value of the agrifood sector

Sector	Input	Farmers	Traders	Food companies	Retailers
Sales: US \$bn	400	3.000	1.000	3.500	5.400
Number of players	100 s	450 million	Tens	Thousands	Millions
EBIT %	15 %	Variable	2–5 %	10–20 %	5 %
R&D % sales	<1 % - (fertilizers) 10 % - (seeds)	0 %	<1 %	1–2 %	<1 %
R&D spend: US\$bn	10	–	Low	8	Low
Composition/ Sub-sectors	<ul style="list-style-type: none"> • Seed • Fertilizer • Crop protection • Machinery • Animal health and nutrition • Crop insurance • Food ingredients 	<ul style="list-style-type: none"> • Grains • Fruit and vegetables • Meat • Dairy 	<ul style="list-style-type: none"> • Handling • Primary processing • Secondary processing 	<ul style="list-style-type: none"> • Bakery • Meat • Dairy • Snacks • Ready meals • Beverages 	<ul style="list-style-type: none"> • Multiples • Discounters • Wholesalers • Independents
Range	R&D-based majors to generic manufacturers	Smallholders to agroholdings	Global agribusinesses to local middlemen	SMEs to multinationals	Corner shops to hypermarkets

Source: The agricultural and food value chain: Entering a new era of cooperation, KPMG International 2013, p. 5.

The activity of Ferrero International, the producer of Nutella, is an example of the global added value chain in the agrifood sector. The Italy-based corporation has nine plants producing Nutella, five of which are in Europe, one in the North America, two in the South America and one in Australia. Certain components for production, such as skimmed milk, are supplied from the local markets, while other components are supplied globally. Hazelnuts come from Turkey, palm oil from Malaysia, cocoa from Nigeria, sugar mainly from Brazil and Europe, and the vanilla flavour from China. Vanillin is produced by a French company, so vanillin is also produced in France. Nutella is then sold in 75 countries through sale offices. Production plants are situated wherever there are outlets and high demand for Nutella (Europe, the North and South Americas, and Oceania). There is no Nutella factory in Asia, because the product is not very popular there (Mapping global... 2012).

In the recent years, high changes in the global value chains occur which are attributable to the transformations in the economy of the fourth industrial revolution. The contemporary added value chains use cyber-physical systems, the Internet, and cloud processing for their organisation. It is an implementation of an intelligent factory, in which cyber-physical systems steer the physical processes, and create the virtual (digital) copies of the real world, make centralized decisions, and things in the real time communicate and cooperate with each other and with humans through the Internet. The progressing economic globalisation process is the basic factor contributing to this

development. The globalization process offers new possibilities, in particular, thanks to a broadly understood technical and technological development, liberalization of trade, unification of legal regulations, standards and norms. In the course of subsequent negotiations rounds as part of GATT and WTO, the world trade was liberalized and the barriers to flow of capital were reduced. The increasing defragmentation of the production process, which quite often requires multiple cross-border shipping of semi-products would not be possible without development of an appropriate transport infrastructure and costs of transport remaining at the moderate level. Development of electronic application technologies is also important, in particular with regard to the *offshoring* of services. The technologies contributed to the drop in the costs of coordination of individual links of the service chain, which may be dispersed into many countries away from each other (Kraciuk J., 2014). Changes occurring in the last decades contributed to considerable growth of nearly all the phases of the process of value adding cycle, but for one: the production phase. This means that companies which focus only and exclusively on manufacturing are exposed to pressure to reduce prices. In addition, they will be eliminated from the supply chain if they do not automate fast or build new added value in the form of the R&D processes and designing (Backer K. De., 2013).

Distribution of the added value along the value chain may be presented in the form of so-called "smile curve." The smile curve was first formulated by Stan Shih, the founder of the ACER company, in 1992. This presentation proves to be particularly valuable upon analysis of the generating activities of the global corporations and network, multi-stakeholder, international business production undertakings.

Currently, the smile curve comes in many variations and mutations. It is also used for the business analyses concerning the fourth industrial revolution. The "smile" we can see becomes increasingly deeper in the process of development of the global economy, since the added value of pre-, and post-production services is growing, while the value of the centrally placed production services is diminishing. The process is accelerating in the course of industrial revolutions, in particular during the most recent, fourth industrial revolution (Fig. 1).

Source: K. De Backer, *Global value chains and trade in value added*, OECD, Paris 2013, s. 14.

Fig. 1. Distribution of the added value in the added value chain – the U curve (the „smile curve”)

The current changes in the added value chain are predominantly attributable to the digital transformation. A two-dimensional integration occurs here (Mychlewicz C., 2017, s. 14):

- vertical – thanks to availability of the data on economic processes, they can be better integrated within the organisation, starting from R&D, purchases, through production to logistics and marketing. Comprehensive management of product lifecycle and assets becomes possible.
- horizontal – intelligent delivery and logistics systems, tracking the flow of raw materials and products and their management allow optimisation of the logistics and production processes and improvement in the planning quality. On the other hand, availability of digital data and “visibility” of production allows easier sharing of information between the organisation and its counterparties and suppliers on the one hand and clients and companies in the distribution network on the other hand.

In pace with transformation of the economy into industry 4.0, operation processes such as subcontracting, production, service, delivery and customer service will be combined by highly flexible information networks.

As a consequence of the fourth industrial revolution, the paradigm changes from the “centralised” into “decentralized” production. The decentralization paradigm means departure from the centralized management and control to creation of autonomous networks, intelligent process units, which exchange information and configure for the optimum performance of the production process and achieving the effective result while basing on product-related data. Functioning within the network imposes on a company the need of becoming oriented into its own key competencies and shifting of any other activities to cooperating parties. Owing to this business models change their orientation from products to services, i.e. to the offering within the network, of a service that is the best in their specialisation for the implementation of the given fragment of the production process. With regard to the value chain in M. Porter’s recognition, in which a product or service moves one-dimensionally to another organisational unit (with each of them adding value thereto), in the new industrial reality, value networks, which are multi-dimensional, are spoken of. Here, the source of the value is a combination of network links which is based on cooperation (Soldaty A., 2016).

As a consequence of the changes, “intelligent” value added chains arise which will organize, optimise, and control themselves, both on the intra- and intercompany basis. The optimization criteria will primarily include costs, the availability of resources and their consumption level. On the other hand, the optimization process will be possible thanks to combination of all the systems participating in the creation of the added value into a network, thanks to the possibility of obtaining information about each object participating in the process in the real time, and also as a consequence of commitment of all the resources and the possibility of determining the optimum flow of the added value from the data.

Conclusion

- 1) The economic growth and improvement in the competitiveness are strongly determined by development of science, origination of new technologies, introduction of innovations and their implementation into the real sphere of economy.
- 2) New technologies are materialized in the concept of the new model of industry under the name of industry 4.0. In this model, the area of changes encompasses the entire product life cycle and associated added value chain, i.e. the preproduction, production and postproduction phases jointly. Particular emphasis is put on the pre- and postproduction areas since they create the highest added value.

- 3) Customers' needs will be setting the direction of changes subject to strong integration processes in the value chains, products and services. All of them will be increasingly better adjusted to the individual needs of the customers. It will be possible thanks to data analytics. Leaders who can effectively use the industry platforms will gain significant advantage of the competition. A thesis may be put forth that only in such circumstances a sufficiently strong effect of complementarity and synergy will arise which is necessary for economic development.
- 4) The outcomes of the research conducted by PricewaterhouseCoopers show that in the next five years, enterprises that have been effectively implementing the solutions that economy 4.0 entails may count on increase in the annual proceeds by 2.9 % on average with concurrent reduction of costs at the level of 3.6 % (Industry 4.0 or challenges ..., 2015). Moreover, the leaders who already have performed the digital transformation will most likely achieve even more spectacular results.

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