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THE IMPACT OF „INDUSTRIAL REVOLUTION 4.0" ON THE DEVELOPMENT OF PORT TRANSPORT HUBS

... "People want progress but do not want changes" ...
(Søren Kirkegaard 1813-1855)

Abstract: The contemporary world is faced with many complex and interrelated phenomena and trends, defined as globally significant changes or as trends transforming society and posing challenges for all spheres of economic and social activity. The accumulation of such phenomena is seen as the turning point of a civilization, i.e. the replacement of a shrinking industrial civilization by another one, even if still undefined in the absence of intellectual concepts pertaining to solve significant structural problems. Such social attitude towards the past is a reaction of people to rapid and profound changes that they are unable to understand, and consequently they return to old, known and proven behaviour[1]. In these conditions, the process of shaping a new reality begins. It is referred to as the 4th industrial revolution, which aims to combine qualitatively different material and digital resources in a way that will allow us to understand the new technological revolution and properly direct its course[2]. Economic activity is particularly susceptible to these type of changes, including the transport sector, which is already undergoing radical quantitative and qualitative changes. In addition, this sector has to face several fundamental challenges resulting from the crisis of globalization and from the future concept of sustainable and environmentally friendly development of a globally managed economy.

Keywords: globalization, 4th industrial revolution, port transport hubs, challenges.

1 See: Z. Bauman, *Retropia. Jak rządzi nami przeszłość,* Wydawnictwo Naukowe PWN, Warszawa 2018, pp. 18-19.

2 See: K. Schwab, *Czwarta rewolucja przemysłowa*, Wydawnictwo Studio EMKA, Warszawa 2018, pp. 22-25.

1. THE ESSENCE AND CONDITIONS OF THE FOURTH INDUSTRIAL REVOLUTION

Revolution equals sudden and radical change. The most dynamic drivers of economic and social changes in the past centuries were inventions related to tools and methods of production[3]. New technologies are also new ways of perceiving the world that represent a fundamental change in economic systems and social structures. The fourth industrial revolution is the latest phase of the development of globalisation, most often understood as the process of establishing, tightening and multiplying economy-wide economic, political and socio-cultural ties[4]. This development is dominated by continuous, and occasionally accelerating, technical progress. Within the development of globalisation, we can distinguish four stages, referred to as successive types of industrial revolution.

The first industrial revolution began around mid of 18th century and lasted until the mid of 19th century. Its basis was the Promethean innovation in the form of a steam engine capable of converting the energy contained in coal into useful work. In addition, thanks to the telegraph, international trade, capital and labor flows significantly accelerated. The use of steam engine revolutionised transport, enabling mass transport of goods and people by rail and ship, and created an international market for raw materials. It also enabled the transformation of manual handcraft into industrial activity.

The second industrial revolution was based on the use of electricity, resulting in the creation of the electric motor, light bulb, tram and metro, radio, the development of the internal combustion engine and the application of an assembly line and serial production in factories. This contributed to a significant increase in the welfare of many social groups in economically developed countries, as well as to the expansion of the scope of consumption and the emergence of a market for perishable food products. It happened thanks to the introduction of cold storage. Due to the pro-consumer nature of this stage of the industrial revolution, it is often referred to as the time of satisfaction and prosperity. It lasted from the end of the 19th century to the beginning of 20th century (First World War).

The third industrial revolution took place in the period 1945-1980. This period saw great progress in the field of information technology and telecommunications. The development of computers and the wide use of television, including satellite and mobile phones, was also of key importance. It is popularly called the computer or digital revolution, as the catalysts of progress were semiconduc-

[3] See: R. Cameron, *Historia gospodarcza świata. Od paleolitu do czasów najnowszych*, Wydawnictwo Książka i Wiedza, Warszawa 1996, p. 16.

[4] See: H.R. Nau, *Perspective in international relations. Power, institutions and ideas*, Washington 2007, pp. 9-27.

tors and large computer systems, personal computers and the Internet. In addition, three significant innovations in transport were applied: containers, jet airliners and tankers.

While previous industrial revolutions were characterised by a relatively slow introduction of breakthrough technical innovations, allowing man to adapt to the new reality, the 4th industrial revolution constitutes a qualitatively and mentally new challenge to human adaptation. The 4th industrial revolution is in fact the unification of the world of real production machines, with the virtual world of the boarding school and information technologies. It is a specific integration of man and machine or machines.

There is no clear cut-off between the 3rd and 4th industrial revolution. The economic essence of the fourth industrial revolution can be interpreted as a fusion of products and services, as well as individualisation of production by integrating the customer's expectations within the manufacturer's offer. The fourth industrial revolution is associated with the digitization and networking of value-added chains, from design and research, through production, management and logistics, to the distribution of final goods. The essence of this revolution "…is the transfer of most decisions from the hands of people to the competence of machines and the blurring of the boundaries between what is biological and what is digital…"[5].

The concept of the "Revolution 4.0" will permanently change how we manage the economy and will have a fundamental impact on international socio-political relations. It will touch on every aspect of human existence – work, health, interpersonal relations or the culture of everyday life. The fourth industrial revolution is based on the application of intelligent and inclusive technology, within any organisation but also, more and more pervasively, in everyday life. The main driving forces behind these changes are: artificial intelligence and learning machines, Internet of Things, blockchain, autonomous vehicles, 3D printing and advanced robotization.

Huge amounts of systematically growing data generated by control systems, currently used mainly to monitor technological processes, will in the future make it possible to predict behavior and enable effective management on a global scale. Communication technologies between machines, business entities and consumers based on the industrial use of the Internet, as well as advanced methods of information processing, are a key factor of transformation from "Revolution 3.0" (introduction to the computer industry and automation of manufacturing processes) to "Revolution 4.0". The main feature in this case is not the transition to higher and higher stages of development, but the shape, pace, nature, intensity and direction of these transformations. It is based on human innovation as a resource that cannot be exhausted, and thus allows us to reject defeatist thin-

[5] K. Schwab, *Czwarta rewolucja przemysłowa*, Wydawnictwo Studio EMKA, Warszawa 20118, p.14.

king about the existence of limits to development. Revolution 4.0 offers new Promethean technologies, i.e. those that represent a civilization leap in the way of producing and using energy that is the basis for the functioning of any complex system, including the economy and civilization. Transport plays an important role in the fast and successful course of this process, as each industrial revolution requires changes in four basic areas of the economy: technology, energy, transport of goods and communication.

2. CONTROVERSIAL GLOBALISATION

Globalisation is a multifaceted mega-trend of world development. Its driving forces are primarily technical and economic progress, and its consequences in the socio-political sphere. It is long-lasting and spontaneous, and its appearance is not a product of the 20th century[6]. The first clear manifestations of this process can be observed already from the era of great geographical discoveries, and then as the effects of the industrial revolution of the nineteenth century and, more recently, the information technology revolution. What all these eras have in common is technological progress advancing in waves, raising productive forces and social relations to a significantly higher and qualitatively different level.

Generally speaking, globalisation is a set of processes that co-organise a common world. Today, globalisation is understood as the process of liberalisation of relations and the accompanying integration of previously largely isolated national economies, into one interconnected world market. As a result, the importance of national borders is gradually fading, while integration covers the spheres of national economies, trade and international investment, production, technology and technology management, cultures and socio-political relations. The consequences of this are increasingly complex relations and growing interdependencies between states[7].

The globalisation process, viewed in a perspective, began to play a key role in the shaping of the world economy from the mid-1980s. The effect of rapidly advancing globalisation over the next quarter century were mainly positive and they covered the following areas:

- systematic development of world production,
- increase in international economic cooperation manifested in the growth of the volume of international trade and a marked acceleration in direct foreign investments,
- globalisation of financial markets,

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6 See: G. Kołodko, *Globalizacja, kryzys i co dalej*, Wydawnictwo POLTEXT, Warszawa 2010, pp. 7-14.

7 E. Skawińska, P. Kułyk, A. Niewiadomska, *Międzynarodowe stosunki gospodarcze. Poszukiwanie równowagi*, Wydawnictwo CeDeWu, Warszawa 2018, pp. 19-51.

- the progressive internationalisation of production and development of global value chains,
- rapid and creative scientific and technical progress,
- intensification of international migrations,
- other emerging forms of economic ties.

It seemed that globalisation was an objective, self-contained and continuously progressing process. It will continue to create primarily positive effects, as the networks of international economic ties have exceeded their critical mass. This will cause further progress of globalisation, and stimulate the formation of new ties.

Since the beginning of the second decade of the 21st century, the world economy has faced complex challenges to its developments that need resolving. These mutually dependent challenges are not yet direct threats, but they do require analysis and constructive assessment and then pre-emptive action to solve them[8]. The most important challenges are:

- decline in the rate of economic growth,
- pressure of growing public debt,
- demographic changes and aging populations,
- depletion of resources,
- deepening economic and social inequalities,
- global migrations,
- mitigating the impact of technical progress,
- digitization of economies and societies
- climate and environmental changes,
- strong increase in international competition,
- shifting the center of world economic power,

This was also clearly revealed by the COVID-19 pandemic[9]. Breaking down these complex barriers to development is critical to the future development of the global economy. Its sudden collapse in 2008 started a wide and protracted recession, with impacts beyond the area of economic relations. Consequently, since then globalisation has decelerated and this stage is often referred to as „slowbalisation"[10]. In addition, there is evidence of the deglobalisation of the world economy. Deglobalisation is a reaction to the current form globalisation, which on the one hand is synonymous with the dynamic development of international trade, and on the other hand, corporate globalism motivated by profit above equality, justice, natural environment, solidarity and social welfare[11]. Deglobali-

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8 E. Bendyk, *W Polsce, czyli wszędzie, Rzecz o upadku i przyszłości świata*, Wydawca 'Polityka" Sp. Z o.o, Warszawa 2020, pp. 52-66.

9 A.J. Ali, *Global challenges: the pressing and visible issues*, „Competitiveness Review" Nr 3/2014, p.192-198.

10 P. Falfas, A. Odrobina, *Syndromy spowolnienia globalizacji (slowbalisation*, [w] Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk 2020, p.107-131.

11 G. Ziewiec, *Trzy fale globalizacji. Rozwój, nadzieje i rozczarowania*, Instytut Nauk Politycznych PAN, Warszawa 2012, p. 192-206.

sation will mainly alter the functioning of value chains, causing excessive fragmentation of international production. Fragmentation of production is also seen as a significant cause for the collapse of world trade, as evidenced recently by the COVID-19 pandemic.

The decline in the importance of nation-states, the growing importance of international corporations and the current state of globalisation create the problem of financing the revolution 4.0. Up to now, it has usually been the state that had an interest in the development of new technologies, both for military and industrial-political reasons. This state financed basic research, where commercial interests were not the main priority. As a consequence, the research results were often transferred "for free" to international corporations. The crisis of the global economy itself changes the relationship between the creators of technological progress, its financing and progress itself. As a result, although the development and implementation of new technical innovations is necessary, it becomes more and more unpredictable.

3. PORTS AS TRANSPORT HUBS UNDER THE CONDITIONS OF "REVOLUTION 4.0"

The "4.0 revolution" is irrevocably linked with growing production and expanding range of locations for entities that make up the production value chain. As a result, there is a strong increase in the demand for the transport of cargo of decreasing size. This, combined with the increase in quality requirements for supply and distribution systems, requires reliance on time-effective and cost--effective and flexible logistics and transport. This is commonly referred to as "Transport 4.0" and represents the direct impact of the fourth industrial revolution on international freight and passenger transport.

The "4.0 Revolution" is increasingly dependent on safe, ecological and efficient transport. When holistically managing transport, transport infrastructure and cooperation economic entities must adapt fixed assets, develop innovative transport technologies and prepare new management models.

"Transport System 4.0" includes all elements directly and indirectly related to the movement of cargo and passengers. It is characterised by a specific structure and constitutes a logically ordered whole, allowing for a strong connection and coordination between all components that are part of this system and its environment. The condition for successful cooperation is openness to change and willingness to improve skills.

The focal point, where development challenges are concentrated, is the seaport, being the key link in the international transport network. It is a particularly convenient location for a wide variety of economic activities, especially transport, trade, logistics and other complementary activities. All these activities comple-

ment each other and stimulate each other's development, providing opportunities for significant added value related to the efficient and comprehensive management of cargo, passengers and the means of transport that carry them. This results from the implementation of the basic task of each seaport, which performs a leading role. Such activities are carried out through the function integrating various activities arising in connection with the development of individual types of economic activity occurring in ports, and the functioning of these ports, and between ports and their hinterland. The integrating function of a port consists of specific activities covering:

- transport and reloading function,
- commercial function,
- passenger traffic service function,
- logistics and distribution function,
- industrial function,
- city and region-forming function,
- social and civilisation function,
- administrative and political function[12].

Functions fulfilled by a particular port, its scope and size, depends on the geographical location of the port, its role in the international transport system, road, rail and inland waterway connections with the rest of the country/ market, public transport policy, the port's competitive position, as well as other relevant factors[13]. The activity of ports is influenced by both domestic and international, as well as internal factors. This will determine the future operation of the port in the conditions of the 4.0 revolution. Ports must face the problems of the future related to their sustainable development, i.e. climate change, changes to modern shipping, expectations of stakeholders, as well as the need to improve cooperation between ports, government agencies and local communities[14].

In the era of globalisation, a seaport is not only the area where land meets the sea, but a place where both ships and land transport deliver cargo. The rapidly growing volume and variety of goods handled in ports, their varied geographical origins, means that a modern seaport should not be perceived only in economic, but also in technical, social and cultural terms. It is an area of application of modern management methods. It is the basic element of the land-sea transport chain, within which the following can be distinguished:

- technical and functional transport chain,
- organisational and administrative transport chain,
- communication transport chain.

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12 See: A. Grzelakowski, M. Matczak, *Współczesne porty morskie. Funkcjonowanie i rozwój*, Wydawnictwo Akademii Morskiej, Gdynia 2012, pp. 30-32.

13 See: E. Gostomski, T. Nowosielski, *Ewolucja i znaczenie portów morskich w krajach Unii Europejskiej*, Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk 2021, pp.146-184.

14 As above, p.219.

The land-maritime transport chain is the highest form of complexity and integration of maritime transport with related diverse economic activities. The management of this extensive system in the face of globalization is possible thanks to logistics, understood as a purposefully organized and IT-supported set of activities such as supply, production, storage, transport and distribution, as well as supporting services, along with the relations between them, their properties and the constant efforts to achieve a higher degree of organisation and efficiency[15].

From the perspective of the port's development, the logistics approach to the land-sea transport chain is not limited only to the coordination and synchronization of the different phases of the transport process. It is also the technical adaptation to each other of the transport infrastructure and means of transport, handling and storage facilities, organisational integration of the coordination of activities of all participants on the surface of the sea and the interests of their internal and international environment. Significant help in this area is offered by the achievements of revolution 4.0 implemented as part of sustainable development.

It is in the seaport that most of the changes related to the 4th industrial revolution seem to concentrate, which is also commonly identified with the blended technologies of "Industry 4.0". These technologies are closely related and cooperating within the cyber-physical system. It is this system of interdependent and cooperating information technologies that generates new value for people, including economic value. Both the speed and the extent of the changes taking place, coupled with the increase in complexity, make the task of developing and implementing strategies, that promote productivity and inclusive growth, inherently difficult. It is important to build awareness of the qualitatively new factors and conditions required for the transformation of economic systems, such as a seaport, to assess their readiness to face the future challenges of the civilization crisis and the implementation of the "Industrial Revolution 4.0".

4. THE STATE OF READINESS OF THE ECONOMY TO THE CHALLENGES OF THE "4.0 REVOLUTION"

The implementation of the idea of the fourth industrial revolution creates the need for new comparative and diagnostic tools facilitating dialogue between stakeholders, shaping joint activities, informing about the development of new ideas of strategies, taking into account that what is new and unknown often creates uncertainty. Nevertheless, the fourth industrial revolution has already begun and it is impossible to ignore it. Future changes cannot be limited to

[15] See: E. Gołembska, *Logistyka,* Wydawnictwo C. H. Beck, Warszawa 2012, pp. 43-73.

technological changes, but must also take into account such fundamental issues as: changes in the ways of thinking, education, work, health, running a business, organisation, society, or the functioning of states and their economic and social potential. It is the state of economic potential and innovation of each country that determine the scope and speed of implementation of the achievements of the 4.0 revolution. A novel attempt to assess the ability of countries to adapt the economy to the requirements of the fourth industrial revolution was made for the first time in 2018 by the World Economic Forum together with the international consulting company A.T. Kearney[16]. This took the form of a country's permanent readiness index to implement the concept of industry 4.0. This index is the result of the impact of the country's economic potential represented by its complexity and size, and the impact of the state of six production development stimulators, such as:

- the potential of technology and innovation,
- the state of human capital,
- global trade and investment,
- institutional structure of the economy,
- balancing the raw material potential,
- demand potential,
- production factor potential.

This index is forward-looking and its authors have tried to combine on the one hand the size of the impact of fixed factors defined as the structure of production (complexity and size) and on the other hand six relatively permanent factors defined as production development stimulators. From the perspective of the structural aspects, the ranking of the ten leading countries in the world in terms of readiness to implement the concept of "Revolution 4.0" is as follows:

1. Japan 8.99;
2. South Korea 8.85;
3. Germany 8.68;
4. Switzerland 8.39;
5. China 8.25;
6. Czech Republic 7.94
7. USA 7.78;
8. Sweden 7.46;
9. Austria 7.46;
10. Ireland 7.34;
11. **Poland** **6.83.**

From the perspective of production development stimulators, the ranking is as follows:

[16] See: *Readiness for the future of production report 2018*, World Economic Forum and A.T. Kearney, Coloque-Geneva 2018, pp. 1-12.

1. USA 8.16;
2. Singapore 7.96;
3. Switzerland 7.92;
4. Great Britain 7.84;
5. Netherlands 7.75;
6. Germany 7.56;
7. Canada 7.54;
8. Sweden 7.40;
9. Denmark 7.20;
10. Finland 7.16;
11. **Poland** **5.83.**

The ranking covers 100 countries around the world, and the maximum possible value of the index is 10.0. Attention is drawn by the fact that the values of the indices for the structural readiness ranking are closer to maximum value than the case is for the production stimulus readiness ranking. Only four countries (USA, Switzerland, Germany and Sweden) are included in both rankings, and the composition of the lead countries confirms the intuition of the international community. The above two rankings are a point of reference and inspiration to diagnose readiness and work out an optimal method of implementing the fourth industrial revolution to national economies[17].

The fourth industrial revolution will have a fundamental and irreversible impact on economic, social and political systems. Even the slowdown or the reversal of the globalization process will not change it. It should be kept in mind that the impact of the "4.0 Revolution" on the economy is also manifested in the transition from the concept of global management to the concept of global governance. To rule is to decide by all about their common affairs by the method of continuous consensus building[18]. This is a particularly difficult task, because in the new conditions man will not be an operator, but only a supervisor of autonomous systems of devices controlled by artificial intelligence. Working with artificial intelligence, humans will need to demonstrate different thinking and reasoning skills in order to be able to oversee autonomous decisions made by independent systems controlled by artificial intelligence[19].

CONCLUSIONS

The remedy for the civilisation turning point that we are experiencing, and the further development of the world economy, is seen in the positive effects of implementing the "Revolution 4.0". This change has been made evident by the

[17] See: *Singapore smart industry readiness index. Catalysing the transformation of manufacturing*, Singapore Economic Development Board, Singapore 2017, pp. 6-38.

[18] A.M. Kjaer, *Rządzenie*, Wydawnictwo SIC, Warszawa 2009, p. 29-117.

[19] See: W. Cellary, *Przemysł 4,0 i gospodarka 4,0*, Biuletyn PTE, Nr 3/2019 p. 48-51.

current economic and financial crisis, which has its deeper source in the cultural crisis, and, in fact, in the crisis of values. This forces us to look at the world economic and social system anew, in the light of the relationship between its economic value and values important in the social and cultural dimension. This also applies to port transport hubs. Their main determinants of development lie beyond them and concern the modernity and frequency and regularity of the operation of land-sea connections, costs and quality of service, competitiveness of the offered land-sea transport services and a wide range of complementary services. In this light, it is necessary to constantly improve the infrastructure of ports leading to an increase in their capacity to handle goods and passengers, by encompassing the maritime and terrestrial environment, supported by IT and telecommunications of the 4.0 generation and artificial intelligence.

The modern economy develops in correspondence with profound social changes and is transformed by the digital technological revolution and global openness to international cooperation. As a result, it has become a space for confronting various value systems. It is this confrontation that determines the future shape of the world economy and the use of innovation as the final resource that allows us to optimistically perceive the future of world development, taking into account the political aspect of this development[20].

The future of the fourth industrial revolution on the socio-economic level requires courage, imagination, new approaches and new institutions. They must in a credible and at the same time appealing way express the meaning of the changes taking place and help regain faith in the future – a future free from fear of the unknown and rebuilding social trust.

SUMMARY

IMPACT OF „INDUSTRIAL REVOLUTION 4,0" ON THE DEVELOPMENT OF PORT TRANSPORT HUBS

The whole world is undergoing increasingly faster changes. The initial analysis indicates technological advances as a key factor. Not only are they the driving force of change in many areas of life, but they have also introduced revolutionary changes in the concepts of the operation of the modern global economy and, at the same time, maritime industry. There have been a number of new concepts, predictions and the individual actions together with the question about the directions, scope and pace of transformations in maritime industry.

One of such new considerations is the concept of „Industrial Revolution 4.0". Professor Klaus Schwab, founder and executive chairman of the World

[20] See: I. Wallerstein, *Koniec świata jaki znamy*, Wydawnictwo Naukowe SCHOLAR, Warszawa 2004, pp. 231-261.

Economic Forum, defines the 4th industrial revolution as "…new technologies that are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human. Previous industrial revolutions liberated humankind from animal power, made mass production possible and brought digital capabilities to billions of people…". Despite how fast the technology in our interconnected world evolves and how fast we adopt it, the „Industry 4.0" is ultimately about people.

Therefore, it is worth examining the assumptions if this concept and the consequences of its implementation in order not only to prepare to this new reality, but also take rational measures to adjust Polish maritime industry to the new needs and challenges.

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