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The Characteristics of the Fourth Industrial Revolution: Buzzword, Hype or a Radical Change?

The usage of the terms the 'Fourth Industrial Revolution' and its predominantly used synonym 'Industry 4.0' has curved upwards at a higher rate than the number of underlying interconnected production units. The concept of Industry 4.0 originates from a project on the high-tech strategy of the German government in 2011. This project promoted the computerization of manufacturing and it was a logical suggestion for the long-term competitiveness of the German economy. The fundamentals of an export-oriented economy need system-level development not to be disadvantaged in the global competition. Building all this on the most modern technologies can be defined as a traditional step. The umbrella term 'Industry 4.0' has outgrown this step and in 2016 it became an independent agenda item of the World Economic Forum. In this study, with the help of a literature review, we examine which factors of this so-called fourth industrial revolution are similar and which factors are different compared to the previous industrial revolutions. Can the characteristics of industrial revolutions be identified? Is the impact complex and does it influence not only the technology but also the society, the politics, etc.? Whether the use of the term is substantiated or is it only an advanced, fashionable buzzer hanging all today's forward-looking innovations on the same peg?

Keywords: Industry 4.0, fourth industrial revolution, critics, innovation
JEL Codes: O14, O30

A negyedik ipari forradalom jellegzetességei: hívószó, hype vagy radikális változás?

A 4. ipari forradalom, illetve a túlnyomórészt szinonimájaként használt ipar 4.0 kifejezés használata nagyobb sebességgel ívelt felfelé, mint az alapjául szolgáló, hálózatba szervezett termelőegységek száma. Az ipar 4.0 fogalma 2011-re, a német kormány gyártás-digitalizációt promótáló high-tech stratégiájának egy projektjére vezethető visszsza. A német gazdaság hosszú távú versenyképességéhez ez egy logikus javaslat volt, az exportorientált gazdaság fundamentális alapjait rendszerszinten kell fejleszteni ahhoz, hogy ne kerüljön hátrányba a globális versenyben. Mindezt a legmodernebb technológiákra építeni tulajdonképpen egy tradicionálisnak mondható lépés. Az ezt összefogó ipar 4.0 kifejezés viszont olyannyira túlnőtte ezt, hogy 2016-ban már a World Economic Forum önálló napirendi pontja lett. A tanulmányban azt vizsgáljuk szakirodalmi feltárás segítségével, hogy ennek az úgynevezett negyedik ipari forradalomnak melyek az előző ipari forradalmakkal egyező tényezői és melyek az eltérőek. Azonosíthatóak-e az ipari forradalmak jellegzetességei, megjelenik-e a komplex, a technológián kívül a társadalmat, politikai stb. rendszereket átformáló hatás. Megalapozott-e a kifejezés használata, vagy megelőlegezésről, napjaink előremutató innovációit egy kalapba emelő divatos hívószóról beszélhetünk csak jelenleg.

Kulcsszavak: Ipar 4.0, 4. ipari forradalom, kritika, innováció
JEL-kódok: O14, O30

Industrial revolutions

On the one hand, the Industrial Revolution can be explained as a period when the formerly used technologies are widely, fastly and radically replaced by new ones. On the other hand, the Industrial Revolution also has significant and complex effects on the transformation of the society.

The (first) industrial revolution lasted approx. from 1760 to 1840. The invention of the steam engine, the mechanization based on the possibilities of coal and steam especially in the textile industry and in the iron production, and later also in transportation provided the technological background.

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The second industrial revolution or technical revolution was approx. between 1870–1920. This era was characterized by the production of steel, the construction of railway and transport networks, the exploitation of electricity, the emergence of internal combustion engines, turbines and chemical products and the development of telecommunication. Due to the significant expansion of scientific achievements in various fields (e.g. medicine, mathematics, chemistry, physics), we can also speak of a scientific revolution (which also meant a paradigm shift in the sense of Kuhn (1962; 2012)).

The period of the Third Industrial Revolution (also known as the Digital Revolution) is dated approximately from 1970 to 2000. Transistors, integrated circuits and connected technologies, e.g. processors and computers meant this era. Based on them, the Internet, mobile phones, and many other digital devices and technologies were born.

The Fourth Industrial Revolution is a relatively new terminology. The concept of Industry 4.0 originates from a project on the high-tech strategy of the German government in 2011. This project promoted the computerization of manufacturing. The phrase Fourth Industrial Revolution was first introduced by the World Economic Forum, which has a so-called independent agenda item at its World Economic Forum Annual Meeting 2016 in Davos. The fourth industrial revolution brings the rise of so-called Cyber-physical Production Systems (CP [P] S).

'Industry 4.0 describes the organization of production processes based on technology and devices autonomously communicating with each other along the value chain: a model of the 'smart' factory of the future where computer-driven systems monitor physical processes, create a virtual copy of the physical world and make decentralized decisions based on self-organizational mechanisms.' (Smit et al., 2016)

Some sources already envision the fifth industrial revolution, approximately from 2030, as a complete digital ecosystem (see on *Figure 1*). The term industry 4.0 expresses the current trend even more plastically, using the numbering of the IT developments to provide the basis of its usage in the common language. Thus, this numbering, for example in the Figure (1) below, also crawled back to the naming of former industrial revolutions.

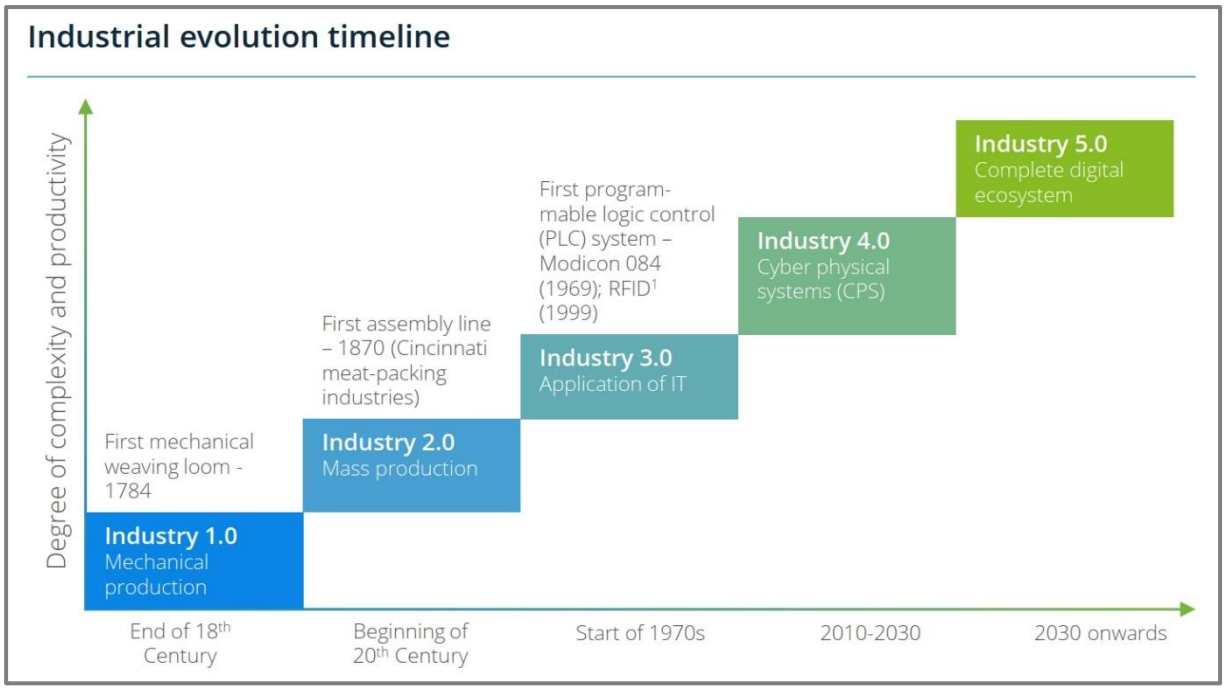

Figure 1: Industrial revolutions
Source: Mehta & Hamke (2019)

The key technologies of the 4th Industrial Revolution are shown in Figure 2. These can be further expanded. For example, the robotics, the internet of things, the industrial internet of things (IIoT), big data, cloud computing, augmented reality, additive manufacturing (such as 3D printing) and cybersecurity, as well as the foundation providing fifth-generation wireless technologies (5G), the artificial intelligence, nanotechnology, quantum computing, biotechnology and fully autonomous vehicles could be mentioned. These technologies have typically emerged, but have not yet become widespread nowadays.

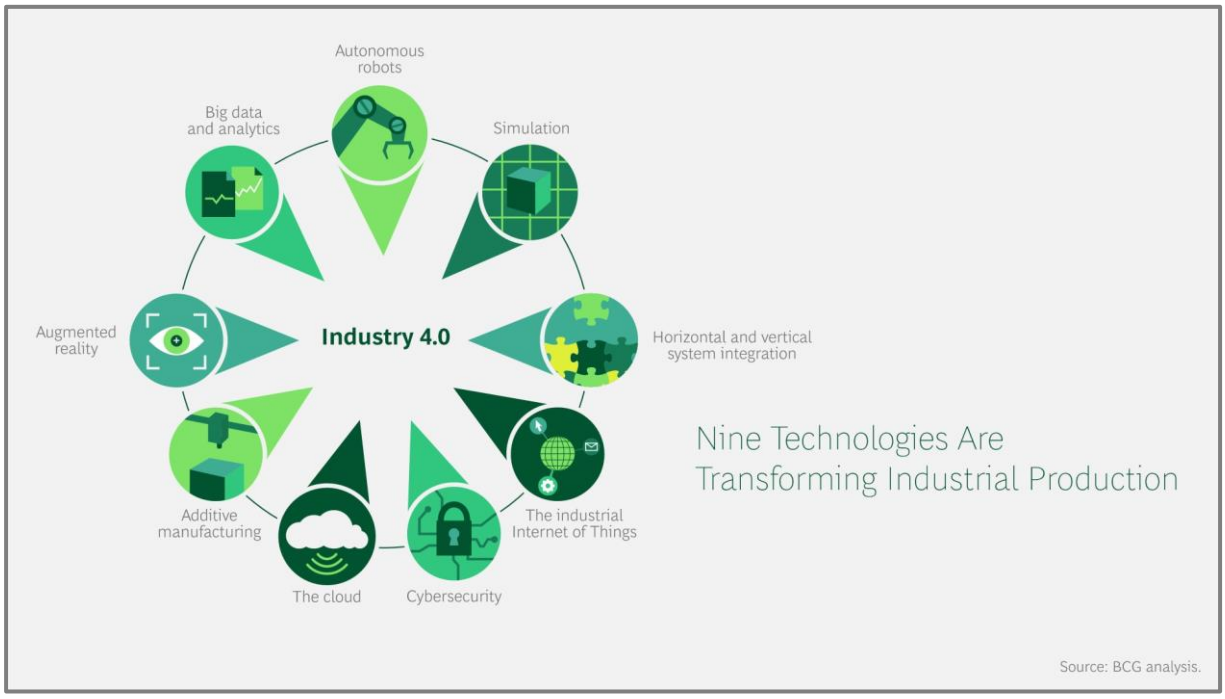

Figure 2: Industry 4.0 technologies
Source: Boston Consulting Group (s.a.)

Industrial revolutions and social changes

First industrial revolution

The first industrial revolution took place mostly in Britain and related areas. Several social antecedents can be drawn. Enclosures served as the basis to design latifundiums where the need for improving efficiency could have emerged. They also meant the base for urbanization and the liberated labor force could work in the industry. The Protestant work ethic (Weber, 1904| 2001), which emphasizes hard work, discipline, and frugality, formed the whole of worldly life and therefore provided a good basis for the prominence of self-interest and entrepreneurial spirit, which also significantly increased the social wealth.

An important basis was the social network of populations scattered due to religious persecution (e.g., Sephardi Jews / Hispanic Jews or French Protestants / Huguenots), which developed commercial networks across Europe (Beaudreau, 2017). This was accompanied by the Enlightenment, which redefined the relationship between the man, the state and the Church, and by the European, cross-border intellectual construction of the philosophers and scientists, such as the Republic of Letters. Meanwhile, the staple rights granted to medieval, smaller areas, with which they imposed tolls and tariffs on goods traded among them, were abolished, creating a larger internal market. Also, the colonial empire formed after great geographical discoveries was an important basis, which provided resources and also a huge – demand – market. At the

same time it also demanded for more efficient production as well as for more and more affordable products. The stable political and legal system also contributed to the Industrial Revolution. If James Watt had not been able to patent his invention, free copying could not only have undermined his motivations and ambitions, but could also have undermined the general pursuit of continuous innovation (emphasizing that the patent system could also hinder the introduction of innovations). Focusing on profit, self-regulating market, and the liberal state behind them, has upset the relationship between the economy and society (Polányi, 1944|2004).

The industrial revolution and the increase in the rate of industrial production also increased urbanization. Manufacturing has shifted from small-scale companies serving small communities and based on labour force to larger organizations. Joint-stock companies appeared in larger numbers. Industrial labor (the proletariat) also appeared and swelled to a considerable size, gradually gaining rights (e.g., electoral reforms from 1832, which, of course, was still far from suffrage in today's sense). Workers' organizations, trade unions were organised. Large-scale social inequalities also provided a basis for the emergence of new theories. Marx and Engels formulated the Communist Manifesto in 1848.

Second industrial revolution

The second industrial revolution emerged new countries. The two most important foundations were the major social changes that provided an opportunity for social transformation (e.g. Japan: Meiji Reforms, 1868) and the completion of the single market (e.g., the unification of Germany in 1871). The engine of the second industrial revolution was the United States. According to the widespread view of the Manifesto destiny, it is the moral duty of the United States to populate and civilize the West. With the annexation of the areas, the huge – demand – market that required mass production was available. All of this was accompanied by outstanding immigration during the Industrial Revolution, at more than 20 million people.[2] Typically they came from Europe, most of them from Italy. Industrial workers came from England and Germany, farmers from the Scandinavian areas, and oppressed Jews from Eastern Europe. The industry has also been able to expand rapidly thanks to millions of European immigrants offering cheap labor.

Mass production appeared in production, production lines and assembly line production were established, but the roots of the lean production system connected to Toyota in Japan can also be traced back to this period (Koloszár–Pankotay, 2017).[3] With the complexity, the size of plant and the required capital have also increased. Large joint stock companies became widespread, and monopolies appeared (again, but in a different form) in greater numbers. The monopolistic extraprofit became typical, which was strengthened by syndicates, holding companies and trusts in addition to weak regulations. Certain phenomena of the industrial revolution (eg expansion of business activities, increased investor risk) also made auditing important and started the development and wide application of control methods (Kovács, 2016).

In addition to coal, crude oil has become a key raw material. Significant scientific breakthroughs have shaped not only the technical progress but also society, e.g. Darwin's theory of evolution. Significant achievements enriched mathematics and natural sciences. The results, which can be called basic research in today's terminology, may have had an impact beyond the era of the Second Industrial Revolution.

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[2] https://www.history.com/topics/immigration/u-s-immigration-before-1965#section_4
https://www.libertyellisfoundation.org/immigration-timeline#1880

[3] http://www.toyota.com.cn/company/vision_philosophy/toyota_production_system/origin_of_the_toyota_production_system.html

Common feature of the first two industrial revolutions, returning from history books, is the significant demand market, which required the increase in production efficiency that the technological and, at the same time, social renewal of the industrial revolution could provide (Beaudreau, 2018). Also common characteristics are the universally used cheap raw materials (coal and oil, respectively) and the measurable jumps in productivity and production. Furthermore, both industrial revolutions reshaped society and created new world economic centers. The question may be, do the periods in our lives show similar features?

Third industrial revolution

The Third Industrial Revolution has been largely recorded since 1970. The first microprocessor computers appeared those years, which also marked the appearance of personal computers, creating the widespread use of informatics. By the end of this era, the digital revolution had extended to communication. The Internet had evolved from a computer network between American scientific institutes (ARPANET) to a globally and widely used digital connection. Digitilization has been able to shift uniform mass production towards (cost-effective) mass customization of products. Incidentally, these solutions seeking uniqueness brought back the peculiarities of the previous eras (in response to consumer demand).

However, questions may also arise. Where should the beginning of this era be drawn? The first computers were made in the ’40s. Atanasoff–Berry Computer, ENIAC, and the British Colossus are competing for the title of the first computer, interestingly even involving the court (Koloszár, 2013). The first commercially available computer, the UNIVAC (Universal Automatic Computer) was handed over to the U.S. Census Bureau in 1951. During this period, a number of non-IT-related technological steps also took place. The nuclear age provided a new source of energy. Man stepped out into the cosmos. As a result of industrial fertilizers and pesticides, the yield of agricultural production has increased significantly. The world’s population has also skyrocketed thanks to mass vaccinations and significant advances in medicine. The emerging possibility of birth control has had an important impact on the traditional roles of society. These are not addressed in the concept of the 3rd Industrial Revolution outlined today.

At the same time, digitalisation also induces several wide range of social changes (Kollár, 2017). Information monopolies are a new type of social challenges, while, in parallel, as a contradiction, actors organized into decentralized networks can play an increasing role in the distribution of information. Furthermore, digitalisation greatly contributes to the creation of a larger range of global capital, global companies. Economic systems are formed which take over the nations that defined the Second Industrial Revolution.

The question may be whether the central, cheap raw material for the era can be determined. In connection with digitalization there are some statements, e.g. the number of transistor, according to Moore's law doubles every two years in integrated circuits. It is a more exciting idea to move to an intangible level and focus on information. The study of the information society began to unfold in this era, which supports this suggestion. However, the cheapness of the information is debatable. On the one hand, the availability of information through the digital network is significantly expanding, on the other hand, searching in a very accumulating unstructured data set and the technology required for access are also costly, while the acquired knowledge is becoming more and more rapidly obsolete. Therefore, lifelong learning is becoming a requirement, which increasingly requires employees to develop the competencies needed for mobility between knowledge areas.

It is also a question whether productivity increases. Linked to this era there is the so-called productivity paradox, expressed very clearly in a quote from Robert Solow (Winner of the Noble Prize in Economics in 1987): “We see computers everywhere except in the productivity statistics.” Emphasizing that this has been completed by subsequent research, e.g. with

lags, measurement errors, redistribution and mismanagement (Brynjolfsson, 1993). In his article, IT Doesn't Matter, Carr (2003) argued that IT investments no longer provide a competitive advantage, but rather a barrier to enter the market. He argues, therefore, that effective participation in a given industry requires an IT investment appropriate to the industry level, to which sufficient capital is necessary, but at the same time this investment must not bring a strategic advantage. The key to competitiveness must be sought elsewhere.

Following these, researches showed that there is a significant positive relationship between the IT investments and the organisational structure in increasing the company's performance. This investments are considered innovative and being able to change the business processes. In this view, innovation means eliminating an old structure and creating a new one (Koloszár, 2013). This is in line with Schumpeter's approach of creative destruction, that is, "the process of industrial mutation – if I may use that biological term – that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one." (Schumpeter, 1942) So IT development can only bring satisfactory results along with rethinking the business side. Kurucz and Potháczky Rácz (2018) point out that for the effective application of modern technologies, the learning process must be an integrated part of the corporate organization, i.e. those companies are good at adaptation where teamwork and learning are self-evident in the organizational culture. See also e.g. the concept of the Learning Factory (Szóka, 2018). Keresztes et al. (2019) also highlights that the development of an innovative organizational culture, including the values of people-oriented leadership, teamwork and continuous learning, is necessary to achieve better performance.

The concept of the 3rd Industrial Revolution outlined today disregards all of this. It focuses exclusively on digitization, ignoring all the factors that did not affect society in this way, and also not looking for comprehensive development patterns that have brought outstanding technological and societal changes. It basically focuses on grounding the 4th Industrial Revolution placed today. At the same time, we can also see that several signs can be identified by the third industrial revolution in an extended time horizon and focus, that are similar to features of the first and second industrial revolutions.

Fourth industrial revolution

The concept of Industry 4.0 originates from a project on the high-tech strategy of the German government in 2011. This project promoted the computerization of manufacturing and it was a logical suggestion for the long-term competitiveness of the German economy.

Among the German medium-sized companies, the so-called Mittelstand, there is a group of around a thousand of companies called hidden champions, which have outstanding innovation potential and their market share makes them the top three companies in their niche markets, also providing a solid foundation for the German economy as the world's third largest exporter (GTAI, 2019).

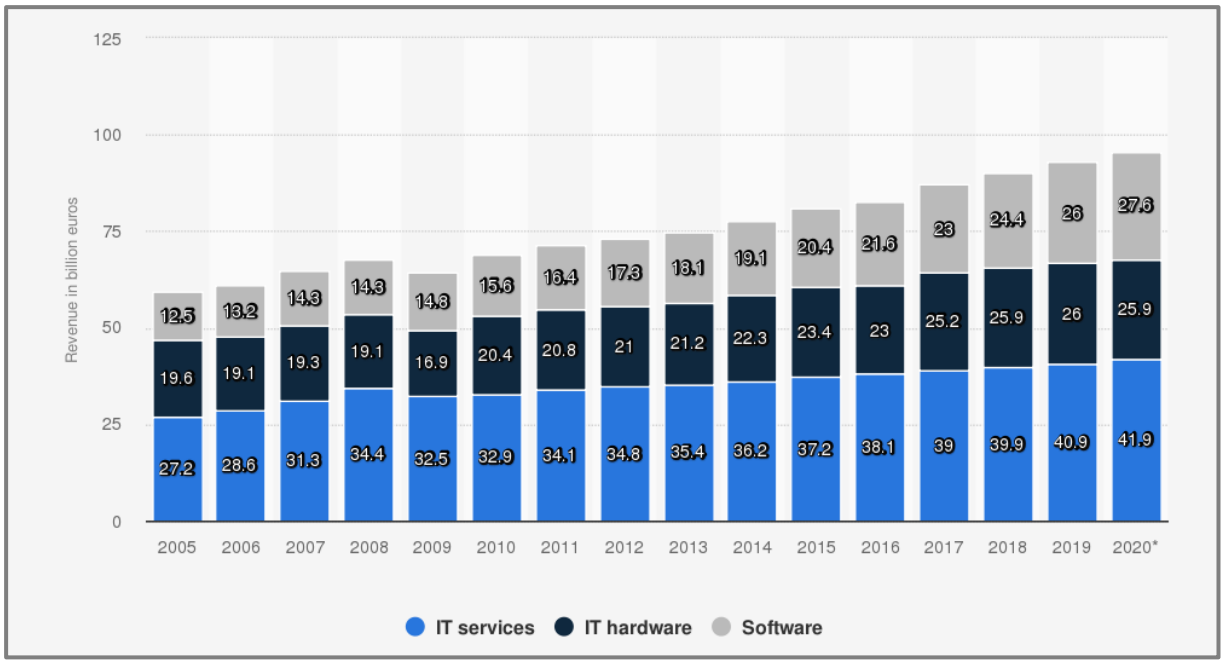

Figure 3: Revenue of the IT industry in Germany from 2005 to 2020, by segment
Source: https://www.statista.com/statistics/460482/it-industry-revenue-by-segment-germany/

However, 16% of German industrial exports were only high-tech products in 2017, which lags behind the similar value of competitors (e.g. USA, China, UK, Japan),[4] adding that high-tech product and industry 4.0 technologies are only partially overlap.[5] The revenue of the German IT industry is currently not decisive (see Figure 3), and the infrastructural background, such as the speed of the Internet and the proportion of companies with high-speed Internet, would require significant development.[6]

The reason for the German strategy is therefore clear. If they want to remain competitive nowadays, it is advisable to support separately new technologies that seem to be a potential as future today. It is also important to coordinate the use of resources in this way in order to be efficient, so to achieve the greatest result from a given input. The name of the strategy that brings this together captures the goal very clearly, the name Industry 4.0 is ideal for this.

Based on a 2016 survey of German companies, most companies expect improved processes and capacity utilization from industry 4.0 applications, followed by a faster service to individual needs and low production costs (Riemensperger, 2016). In contrast, the biggest hurdle is the high investment cost (see *Figure 4*).

[4] https://www.theglobaleconomy.com/compare-countries/ (Innovation measures: High tech exports, percent of manufactured exports)

[5] High-tech products are divided into nine groups: 'aerospace', 'armament', 'chemistry', 'computers-office machines', 'electrical machinery', 'electronics-telecommunications', 'non-electrical machinery', 'pharmacy' and 'scientific instruments'.

[6] https://www.statista.com/statistics/896772/countries-fastest-average-fixed-broadband-internet-speeds/

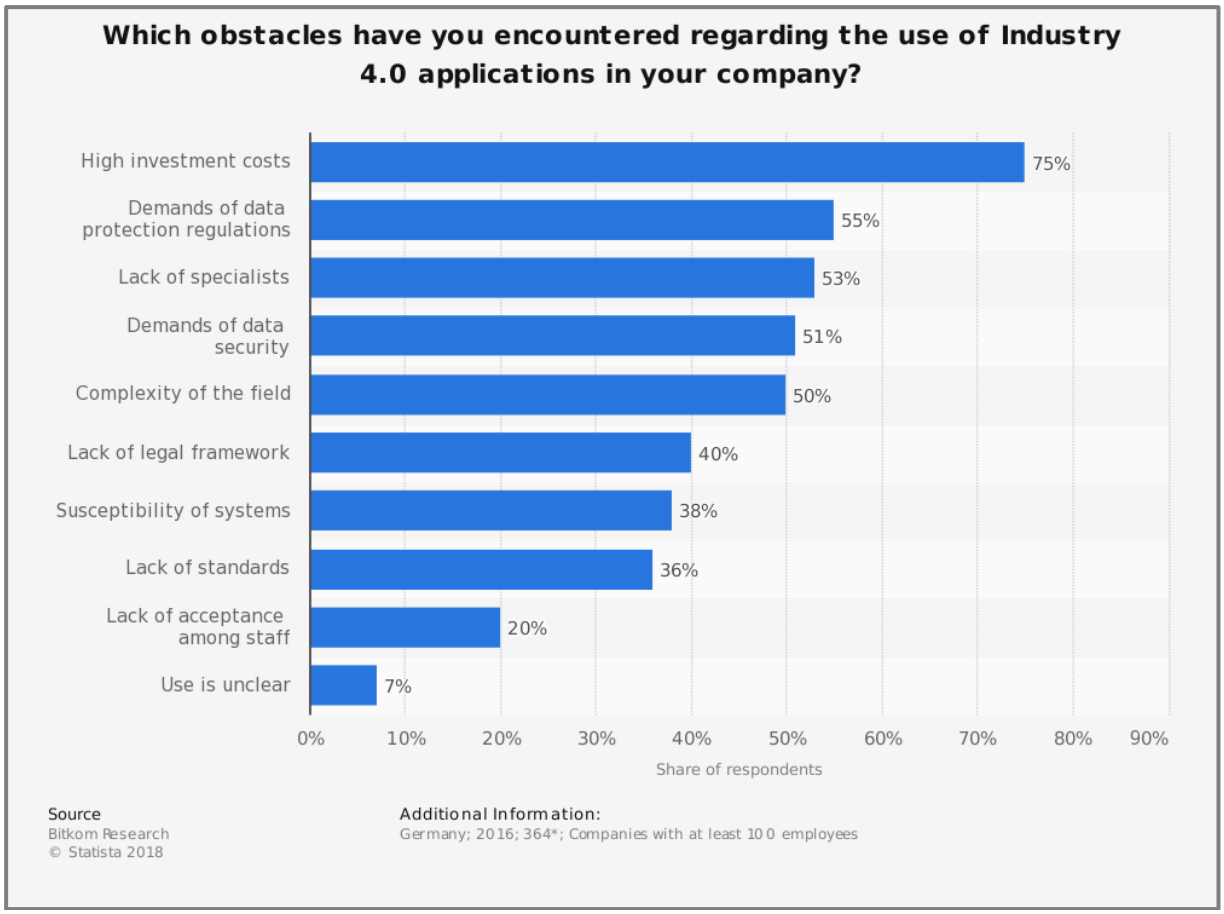

Figure 4: Obstacles related to the use of Industry 4.0

Source: https://www.statista.com/statistics/668849/industry-40-obstacles-regarding-application-in-german-companies/

Let us examine whether the characteristics that were typical by the previous industrial revolutions can be named.

Is it possible to identify a new, cheap raw material on which the Fourth Industrial Revolution is based? The era continues to put information at the center. Have the expectations for information been met? The social use of information shows a mixed picture. Information that is becoming more accessible to all appears as a kind of tsunami, against which a significant proportion of people close. Previously, there were costs to obtaining information. Today, a more intensive wave of information is practically knocking on the gate, in exchange for the costs of filtering, sorting and organizing (for example, in the form of effort). A significant part of society does not want to bear this cost, it closes off from information dumping, but the admitted parts are not selected on a rational basis, see e.g. spread of fake news. Have we reached the information society? It can be seen that the existence or some level of use of the technology is not enough for this. A truly obvious example is the digital education introduced worldwide as an answer for covid-19. The technology was available, but at the same time an unavoidable need was necessary for a sudden breakthrough in the walls of decades of resistance, after which a rapid reorganization is expected. The example of education also shows that today it is still a question how we can integrate technology into determining social processes. This does not mean that there are no existing uses, but that they are currently not dominant and have only a complementary role to the whole education sector.

Can a new center be identified? No clear rearrangement has yet been announced, although there is a forward fracture of China, partly due to industry 4.0 technologies, as also the US-China opposition (e.g. Huawei boycott) is due to it.

Technology is constantly evolving, but the question is whether there is a leap that would mean an industrial revolution. “We are on the verge of the fourth industrial revolution” (Abonyi–Miszlivetz, 2016) – can be read in several studies. So this is a kind of advance. The truly inspiring new technologies and the potential they show are impressive, but it could be felt by former societies about that time introduced technologies. The DotCom fever of the ’90s may be a typical example. With the emerging potential of the Internet, the stock price of the newly formed, unprofitable listed companies dealing with it has also extremely risen, and then the sobering was brought about by the bursting of the DotCom bubble at the end of the millennium. As Figure 4 shows, currently high investment costs are the most deterrent. These may decrease parallel with the spread of developments, but we are not yet here. In connection with covid-19, many companies have developed a face protection plexiglass mask with 3D printing. In Hungary, after rapidly rising demand, production has been redesigned to traditional production lines due to lower costs.

For the time being, no (completed) broader social processes can be identified. Many forecasts deal with expected changes in the labor market (Szóka, 2019), the possible positive and/or negative effects of employment (Fülöp, 2018),[7] or expected trends, e.g. with the reversal of globalization, as the cost of labour does not matter in an automated factory, so relocated production can be placed back (and this affect significantly the developing countries), but these have not yet occurred or we can rarely see examples. This does not mean that forecasts would be useless, the expected processes need to be prepared at both individual and social levels. However, it is not advisable to name an era in advance. As a counterexample, we can cite the already functioning Chinese state surveillance system, which operates social scoring using new technologies, realizing the level of total state that has never existed before.

Artner (2019) points out that the effects on work cannot be studied by attributing only to the technology, because in this social conditions are decisive. The profit interest that determines socio-economic conditions also clearly defines the technologies used in the transnational corporations organizing world market. The effects of changing labour to technology should only be considered in the profit interest of capital owners, but these interests do not obviously lead to mechanization. In the private ownership-based economy, similar regularities appeared in the individual industrial revolutions at the turn of 18th and 19th centuries as today. So the primary result of this is not the loss of jobs, but the fact that precarious conditions became the main feature of employment.

The concept of the Fourth Industrial Revolution is not new. Edgerton (2010) cited Barnest, who wrote in 1948 about the beginning of the Fourth Industrial Revolution: ’the world had gone through three industrial revolutions, the first of iron, steam, and textiles, the second of chemistry and large industries, steel, and new communications, and the third, still occurring in 1948, was ’the age of electrification, automatic machinery, electric control over manufacturing processes, air transport, radio and so on’. A fourth was on the way: ’with the coming of intra- atomic energy and supersonic stratospheric aviation we face an even more staggering fourth Industrial Revolution’.’

The actuality, the new things perceived as revolutionary can paint an excessive picture of the present compared to previous ages we have not lived. In the introduction of The Hitchhiker's Guide to the Galaxy, Douglas Adams (Adams, 1995) describes with gentle irony but appositely: ’Far out in the uncharted backwaters of the unfashionable end of the western spiral arm of the Galaxy lies the small unregarded yellow sun. Orbiting this at a distance of roughly ninety-two million miles is an utterly insignificant little blue green planet whose ape-descended life forms are so amazingly primitive that they still think digital watches are a pretty neat idea.’

[7] https://www.weforum.org/agenda/2020/01/future-of-work/
https://www.weforum.org/about/jobs-and-the-fourth-industrial-revolution
https://www.weforum.org/agenda/2019/09/fourth-industrial-revolution-jobs/

Conclusions

In the discussion of the Third Industrial Revolution, we found that the purpose of its current definition is mainly to establish the recently experienced trends identified as the Fourth Industrial Revolution. However, most of the characteristics of previous Industrial Revolutions can be identified with a broader time horizon and interpretation. For the fourth industrial revolution, this may be only an advance for the time being. It is not clear which characteristics make us highlight this as an independent era, why 4.0 and not Industry 3.1. A significant proportion of events is a forecast, unrealized process, and a 'techno-optimistic' perspective of developments, not dealing with impediments (e.g., especially people, who significantly influence corporate spread).

The worldwide spending on information technology (IT) was around 3,800 billion U.S. dollars in 2019, [8] while the gross production value of pistachios reached $ 8,100 billion worldwide in 2015. [9] This comparison also shows that we can talk about emerging technologies now, with future promises.

For the time being, the construction of the infrastructure ensuring the operation of the new technology is being prepared (5G) and this is also surrounded by a sufficient mystique. It may be worth comparing this with the fact that when the railway appeared, during the First Industrial Revolution, there was a serious fear that trains running fast (at about 30km/h) would cause eye damage, so a wall should be built next to the railway tracks. Some elements of smart technologies are already available, but the vision they tune in has not yet materialized. Simultanously marketing is also working, which could affect the sense of real progress. It is difficult to determine the real content behind the markers, some words are hackneyed, e.g. 20 years ago washing powders have been provided with 'smart' markers by advertising professionals.

On the other hand, the consulting profession, from time to time, needs hot topics on which consulting marketing can raise the need for renewal – and so the importance of the use of consulting services. Figure 5 shows the most characteristic consulting trends last years. Adding together the proportions of Digital tranformation, Artifical intelligence, Smart tech, Cyper security and Industry 4.0 / IoT, we get that the topics related to the concept of the Fourth Industrial Revolution represent 60%.

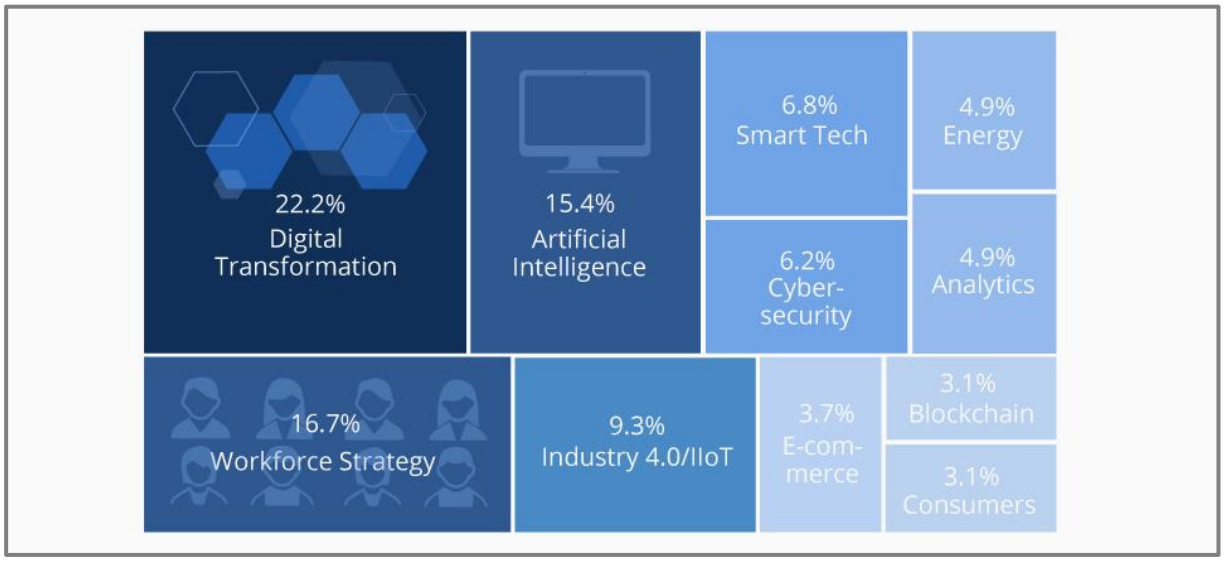

Figure 5: Trending topics in the consulting industry, 2016-2018
Source: https://www.statista.com/chart/16882/trending-topics-consulting/

[8] https://www.statista.com/statistics/203935/overall-it-spending-worldwide/
[9] https://www.statista.com/statistics/964028/production-value-of-pistachios-worldwide/

Edgerton's (2007) 'use-centered' history as history 'from below' approach focuses on things used in a given space and time. Instead of innovations and years, he describes society and technology by use of things typical of the given period. Thus, a more accurate picture can be outlined of the extent of an invention. For example, although the steam engine was tied to the First Industrial Revolution, its use was much more widespread during the Second Industrial Revolution as one of its important base. If we look at it today, we can say that the Fourth Industrial Revolution – at least with breakthrough force – certainly did not appear. See a short summing-up in *Table 1.*

Table 1: Characteristics of the Industrial Revolutions

Characteristics	First Industrial Revolution	Second Industrial Revolution	Third Industrial Revolution	Fourth Industrial Revolution
Era	1760–1840	1870–1920	1970–2000 (?)	2010–?
Type of revolution	technical	scientific	digital (?)	
Main resources (universally used, relatively cheap)	coal	coal and oil	information	information?
Geographical centres	Britain	US	US	US and China?
Market pull	YES	YES	?	?
Main industrial influence	mechanical production, joint-stock companies, larger organisations	mass production, production and assembly lines, increasing plant size, widepreading large joint-stock companies, monopolies	application of IT and cost effective mass customization of products, globalization	Cxber physical systems (CPS), mass personalization?
Measurable jump in productivity and production	YES	YES	NO	?
Industrial inventions and new technologies	steam engine used in textile and iron industry, transportation	steel production, combustion engines, turbines, chemical products, transportation, electricity, telecommunication	Computers; the Internet, digital devices, wireless technologies (nuclear power, industrial fertilizers and pesticides, vaccinations)	Computerisation of manufacturing, 'smart' factory
Widespread and common use of inventions	YES	YES	YES	NO (yet)
Some social effects	Urbanisation, industrial labor and workers' organisations – trade unions	social transformation (descent of nobles), Darwin's theory of evolution	growing global populations, change in status of women, information monopolies	information society?, LLL, mobility

Source: own edition

In summary, on the one hand, it is useful for the development of technology to have supportive strategies that concentrates on specific development directions and focus resources on areas that are considered to be priority ones. Understanding and accepting discoveries that go beyond existing knowledge and are out of the system at a given time – accidental or ingenious – are essential for social progress. The developed environment must be able to accept this as well. History also teaches us this. Think of Semmelweis, who came up with something, 20 years before the discoveries of the system – the microscope and the identification of microorganisms. Today we celebrate him as the savior of mothers, even if at his own time almost the entire medical community opposed him.

On the other hand, the contemporary judgment of the given ages is burdened with emotions and attitudes. This is very well captured by a quote from Douglas Adams (2012) in 'The Salmon of Doubt': 'I've come up with a set of rules that describe our reactions to technologies: 1. Anything that is in the world when you're born is normal and ordinary and is just a natural part of the way the world works. 2. Anything that's invented between when fifteen and thirty-five is new and exciting and revolutionary and you can probably get a career in it. 3. Anything invented after you're thirty-five is against the natural order of things.'

Therefore, names are more lasting if they are given by posterity, after the end of an era. This is true from streets named after people to the era of industrial revolutions.

For now on, we see the Fourth Industrial Revolution as a forecast rather than a real process. The industry 4.0 concept is surrounded by a kind of hype. It can also be useful, help to adopt new technologies that can accelerate their diffusion, and also strengthen the urge in the minds of managers of smaller companies not to fall in, but to move into the future in a planned way.

However, it is important that the technological optimism of industry 4.0 does not distract the attention from real issues. Looking to the future, it is also significant to articulate the issues that will determine the society of the future. This is in line with the definition of the Industrial Revolution as having significant and complex effects on the transformation of society as well. If we are just at the beginning of a revolution, why not try to solve also current social problems by using it.

More efficient implementation of resources is also socially determining. In addition, what else needs to be addressed? Is it important to have more / better things? Or do we have to find answers in connection to population explosion? Should we deal with the related environmental sustainability, too? How will technology affect social inequality, the social and economic order? Can capitalism remain in its current form? These may already be questions of other studies.

References

Abonyi, J. – Miszlivetz, F. (2016): *Hálózatok metszéspontjain: A negyedik ipari forradalom társadalmi kihívásai (At the intersection of networks: The Social Challenges of the Fourth Industrial Revolution).* Savaria University Press.

Adams, D. (1995): *The Hitchhiker's Guide to the Galaxy*. Random House Publishing Group. 224 p.

Adams, D. (2012): *The Salmon of Doubt*. Pan Macmillan, 320 p.

Artner, A. (2019): A technológiai változások és a munka (Technological Change and Work). *Munkaügyi szemle,* 62(4), pp. 6–13. https://www.munkaugyiszemle.hu/technologiai-valtozasok-es-munka

Beaudreau, B. C. (2017): *Calvinism, Huguenots and the industrial revolution*. 84th International Atlantic Economic Conference, October 05-08, 2017 Montreal, Canada

Beaudreau, B. C. (2018): *A Pull-Push Theory of Industrial Revolutions*. In: Proceedings of International Academic Conferences, International Institute of Social and Economic Sciences.

Boston Consulting Group (s.a.): Embracing Industry 4.0 and Rediscovering Growth. https://www.bcg.com/capabilities/operations/embracing-industry-4.0-rediscovering-growth.aspx

Brynjolfsson, E. (1993): The Productivity Paradox of Information Technology: Review and Assessment. *Communications of the ACM*, December, 1993. DOI: 10.1145/163298.163309

Carr, N. G. (2003): IT Doesn't Matter. *Harvard Business Review*, May 2003 https://hbr.org/2003/05/it-doesnt-matter

Edgerton, D. (2007): The Shock of the Old: Technology and Global History since 1900. Oxford University Press, 270 p.

Edgerton, D. (2010): Innovation, Technology, or History What is the Historiography of Technology About? *Technology and Culture*, 51(3), July 2010, pp. 680–697. DOI: 10.1353/tech.2010.0007

Fülöp, Z. (2018): Az ipar 4.0 foglalkoztatásra gyakorolt hatása (Impact of Industry 4.0 on Employment). *Munkaügyi szemle*, 61(6), pp. 58–64. https://www.munkaugyiszemle.hu/az-ipar-40-foglalkoztatasra-gyakorolt-hatasa

GTAI (2019): Economic Overview Germany: Market, Productivity, Innovation. Germany Trade & Invest. https://www.gtai.de/resource/blob/63824/b43c3f08a45892076323cf4c40f3b4a7/economic-overview-germany-market-productivity-innovation-en-data.pdf

Keresztes, G. – Paár, D. – Pirger, T. (2019): *Az innovációmenedzsment és a szervezeti kultúra összefüggései (Relationships between Innovation Management and Organizational Culture).* In: Mohácsi, M. (ed.): Menedzsment tendenciák. Debreceni Egyetemi Kiadó, pp. 93–108.

Kollár, D. (2017): *Értékrendszer az információs társadalomban (Values in the Information Society).* TEAM Társadalmi Elemzések Alkalmazott Műhelye, BCE. 38 p.

Koloszár, L. (2013): *Vállalati információs rendszerek (Business Information Systems)*. University of West Hungary Press, Sopron, 183 p.

Koloszár, L. – Pankotay, F. M. (2017): Lean eszközök a KKV-k fejlesztésében (Lean tools and SME development). *Gazdaság & Társadalom / Journal of Economy & Society*, 2017/3–4, pp. 67–98. DOI: 10.21637/GT.2017.3-4.05

Kovács, T. (2016): *Belső kontroll funkciók a pénzügyi intézményekben – nemzetközi történeti és fogalmi kitekintés (Internal Control Functions in Financial Institutions – International Historical and Conceptual Outlook)*. In: Kulcsár, L. – Resperger, R. (eds.): Europe: Economy and Culture International Scientific Conference. Proceedings. University of West Hungary Press, pp. 132–137.

Kuhn, T. (1962|2012): *The Structure of Scientific Revolutions*. The University of Chicago Press. 288 p.

Kurucz, A. – Potháczky Rácz, I. (2018): *The Role of Group Work and Group Learning in Corporate Culture in Hungarian SMEs.* In: Löster, T. – Langhamrová, J. – Vrabcová, J. (eds): Conference Proceedings: RELIK 2018: Reproduction of Human Capital – links and context. Oeconomica Publishing House, pp. 184–194.

Mehta, D. – Hamke, A-K (2019): In-depth: Industry 4.0 2019 – Statista Digital Market Outlook. August 2019. https://www.statista.com/study/66974/in-depth-industry-40/

Polányi, K. (1944|2001): *The Great Transformation: the Political and Economic Origins of Our Time*. Beacon Press, 317 p.

Riemensperger, F. (2016): Industrie 4.0 – wie Sensoren, Big Data und 3D-Druck die Produktion und die Arbeit in der Fabrik verändern. Bitkom. April 2016 https://www.bitkom.org/sites/default/files/file/import/Bitkom-Pressekonferenz-Industrie-40-21-04-2016-Praesentation-final.pdf

Schumpeter, J. A. (1942): *Capitalism, Socialism and Democracy*. New York: Harper & Row, 431 p.

Smit, J. – Kreutzer, S. – Moeller, C. – Carlberg, M. (2016): Industry 4.0. Study. European Parliament. Directorate General for Internal Policies Policy Department A: Economic and Scientific Policy. February 2016. https://www.europarl.europa.eu/RegData/etudes/STUD/2016/570007/IPOL_STU(2016)570007_EN.pdf

Szóka, K. (2018): *Az új üzleti modell kialakításának feladatai a kontroller számára (Tasks of Developing New Business Model for Controllers).* In: Resperger, R. (ed.): Demographic Changes Changing Economic Challenges International Scientific Conference. Proceedings. University of West Hungary Press, pp. 343–352.

Szóka, K. (2019): *Process Orientation in the Modern Controlling*. In: Rotschedl, J. – Holman, M. (eds): Proceedings of the 47th International Academic Conference, Prague, International Institute of Social and Economic Sciences (IISES), pp. 101–108. DOI: 10.20472/IAC.2019.047.026
Weber, M. (1904|2001): *The Protestant Ethic and the Spirit of Capitalism*. Taylor & Francis Ltd, 320 p.

Databases & Links:

https://www.statista.com/chart/16882/trending-topics-consulting/
https://www.statista.com/statistics/203935/overall-it-spending-worldwide/
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https://www.statista.com/study/66974/in-depth-industry-40/
https://data.oecd.org/germany.htm
https://ec.europa.eu/eurostat/data/database
https://www.theglobaleconomy.com/compare-countries/ (Innovation measures: High tech exports, percent of manufactured exports)
https://tradingeconomics.com

https://www.history.com/topics/immigration/u-s-immigration-before-1965#section_4
https://www.libertyellisfoundation.org/immigration-timeline#1880
http://www.toyota.com.cn/company/vision_philosophy/toyota_production_system/origin_of_the_toyota_production_system.html
https://www.weforum.org/agenda/2020/01/future-of-work/
https://www.weforum.org/about/jobs-and-the-fourth-industrial-revolution
https://www.weforum.org/agenda/2019/09/fourth-industrial-revolution-jobs/

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