Industry 4.0 and Serbia: Modern Technologies and the Impact on the Economy of Modern Society

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INDUSTRY 4.0 AND SERBIA: MODERN TECHNOLOGIES AND THE IMPACT ON THE ECONOMY OF MODERN SOCIETY

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Abstract: The fourth technological (industrial) revolution is based primarily on digital technologies, but also on their synthesis with other technologies, both traditional and conventional, as well as advanced, such as nanotechnologies and biotechnologies. The emergence of disruptive technologies causes changes in markets, which can sometimes be revolutionary. Economic as well as other sciences have not yet given the ultimate judgment - will the Fourth Technological Revolution and disruptive technologies contribute to the creation of a welfare society, reduce poverty and facilitate work, or increase material inequality, make distribution of goods more unfair and cause mass unemployment.

Keywords: modern technologies, disruptive innovations, biotechnology, nanotechnology, market, (in)equality, poverty, welfare

1. Introduction

As we have noted and emphasized [11], modern macroeconomic theory considers all economic activities as equal, neutral. This is, obviously, based on microeconomic approach, and was accepted from macroeconomic theory, with many and far-reaching consequences. Today's, mainstream theory forgot the old economic truth, known more than few centuries: economic activities are qualitatively different. This truth was recognized from the economic life of first European states-cities in early centuries of modern economy's appearance and described in first economic works of Renaissance and mercantilist economists. As they emphasized, economic structure of the state is of great importance, and the industry is moving force of technological progress, an engine to economic growth and creator of synergetic effects in all economy, as it was described in 1613 by Italian mercantilist Antonio Serra [16]. Serra was the first that emphasized the manufacturing and agriculture are subdued to different principles [16, p. 118-120]. He was the first to describe increasing returns, named after him "Law of Increasing Returns" (Senior), in contrary to diminishing returns, characterizing agriculture (Turgot).
Over the next centuries, the development of today's developed part of the world was precisely the industry, which generated the innovations and technological changes, and in which the productivity of labor, in contrast to agriculture, was growing dynamically, which, in Zombart's sense, was beyond capitalism. From this development, colonies were excluded, which, despite all the stories about the metropolitan civilization role, were not allowed to build their own industry. Excluding several short periods of prevalence of the so-called laissez-faire ideology (and practical economic policies), which always ended with dire and sad consequences, the state had a very active economic role throughout this period. In addition, it is important to emphasize that the antagonism between state and market, which has characterized the twentieth and the beginning of the twenty-first century, is a relatively new phenomenon [14].
As a result of such development, the strongest economies of the world naturally have strong industries. On the other hand, they practically make it harder or impossible to develop small and poor countries' industries. Therefore, it is not surprising that one of the key effects of the transition process in the former socialist countries and underdeveloped countries has been deindustrialization, carried out by abiding by the guidelines of the Washington Consensus embedded in the economic policies promoted by the IMF. The deindustrialization process in the last decades of the twentieth century also affected developed western countries, in whose economic structure continues to decline in the share of

employees in the primary and secondary sectors, and increases in a tertiary one, while within it also included is a quaternary, which includes research, science, development projects. Nevertheless, the deindustrialization process significantly affected the underdeveloped countries and countries in transition, and by a coincidence of different circumstances (international sanctions during the 1990s and the NATO Pact's 1999 aggression), Serbia was more affected than others (Figure 1).
Since the countries of the West, headed by Germany, at the beginning of this decade promoted Industry 4.0, that is, the new (fourth) industrial revolution, our country is undergoing a bigger and more difficult task of (re)industrialization and inclusion in this technological revolution. Whether we as a society are up to this task and challenge will be shown by not so far future, but in any case - it should be prepared for it.

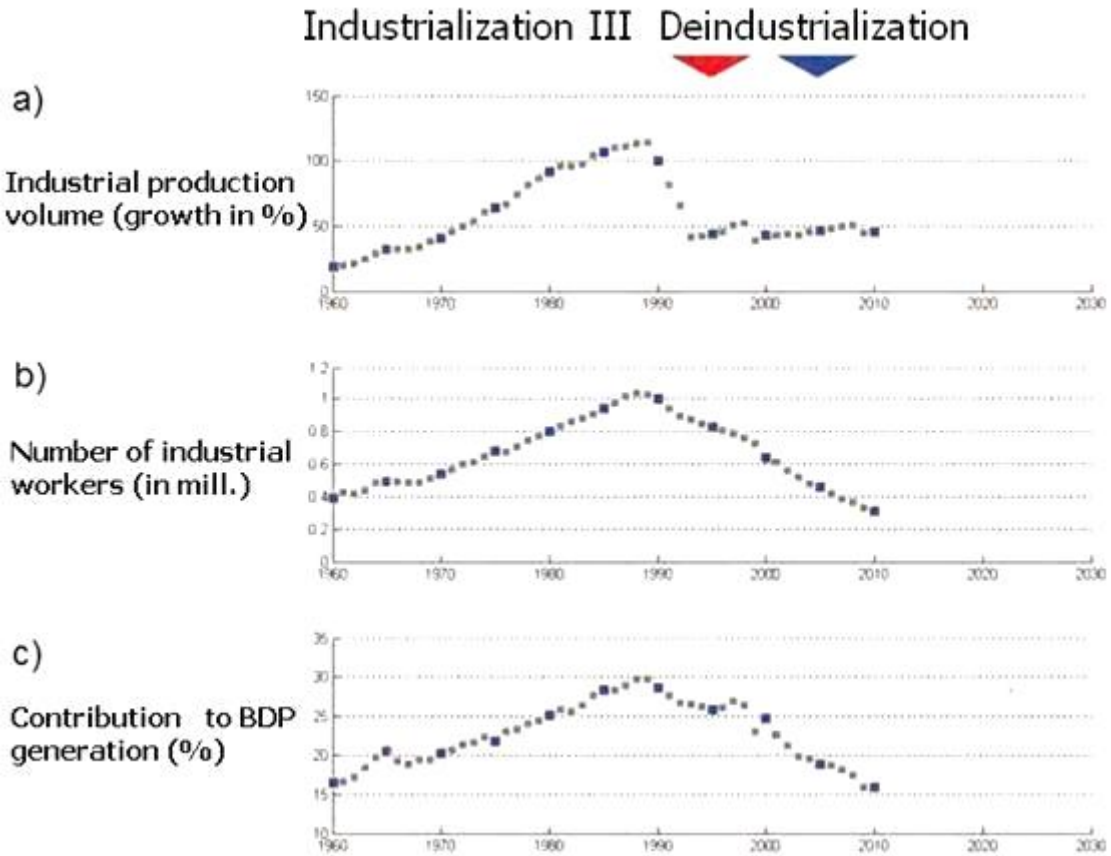

Fig. 1: Performance indicators of industrial development of Serbia in the period 1960-2010 [12, p. 184]

The fourth industrial revolution is a continuation of the technicalistic, but also wider civilization progress of the new-century and modern history of the world. It is primarily associated with the emergence and development of the industry since the second half of the 18th century, but also the means of traffic, then communication, and in the modern times of information technology and related technologies. Within the Industry 4.0, the term promoted at the CeBIT exhibition (Centrum für Büroautomation, Information Technology and Telecommunications) in Hannover 2011, it is aimed at linking elements of the design, manufacturing and logistics process to the cyber-physical system, in which parts of the system (machines and products) become "smart", that is, they get the opportunity of self-learning and communicate.

2. Four industrial revolutions: Some historical remarks

Unlike Adam Smith, who threw them out of his economic system, innovations, starting from Francis Bacon and his *Essay on Innovation* [1] from the beginning of the 17th century, had a significant place

in social life, and since the 18th century especially in economic science. Smith attempted to show and prove that all economic activities are the same, and therefore rightly lie at the heart of contemporary, mainstream economic theory. Together with innovations, as exogenous factors in Smith and his followers, all other factors that lead to unequal growth are treated: investments in new knowledge, economies of scale, declining yields, synergies, and institutions. As a result, the economy has become learning about a harmony, a system in which the market creates a harmony of itself [14, p. 102].
In contrast, economic history shows a very dynamic and uneven development, even within the developed countries, and as one of its main drivers, innovations and technological changes have been introduced. Although possible, and indeed existing, different classifications of technoeconomic or long waves of technological changes, today's usual and almost universally accepted is the following one presented in Figure 2.

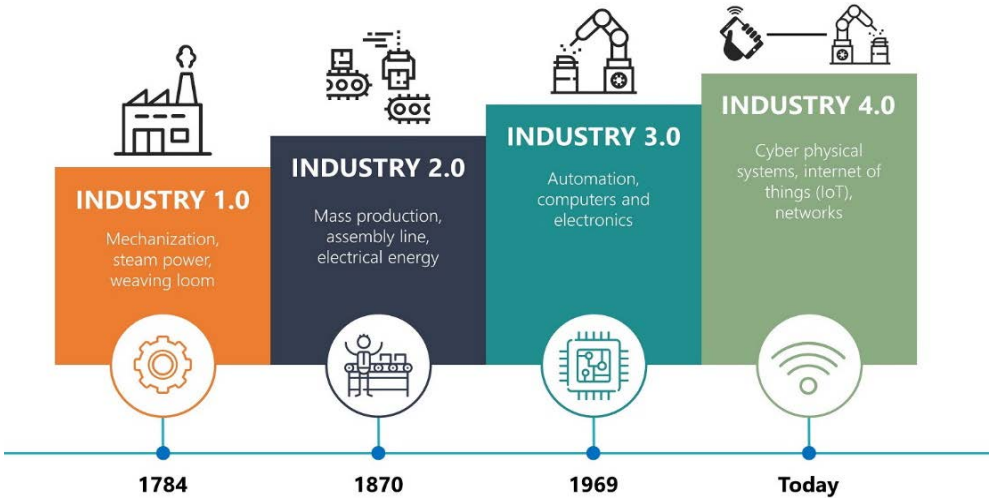

Fig. 2: Four industrial revolutions [https://yandex.com/images/]

The first industrial revolution was the invention and application of the steam engine, that is, the transition from manual to mechanical production. In terms of fuel there comes to the transition from wood and other bio fuel to coal. New chemical substances introduced into the production and process of metal processing, especially iron, improving the effectiveness of water and water vapor and the development of machine tools. Especially the textile industry gained its significance. The first industrial revolution was slowly shifting to the Second in the period from 1840 to 1870, primarily by increasing the use of steam transport (rail and ships), and developing the steam-powered industry. The development of standards, especially in countries that were suddenly affected by the rapid development of the first industrial revolution, was evident and the largest in the history of the past.
The second industrial revolution is based on the invention of electric current, first of all, followed by its perfecting, and it developed during the second half of the 19th century, and there is a fundamental use of oil and oil derivatives. The invention and using of phones, turntables, radio, aircraft, film, train improvement are some of the most important inventions of this era until the beginning of the 20th century. The second industrial revolution led to a sudden increase in the density of population, urbanization and created large modern cities, megalopolises. The creation of a large working class is associated with this epoch.
The third industrial revolution developed in the mid-20th century by the creation of electronics and information technology, telecommunications. By perfecting mass production, which had its forerunner at the beginning of the century with conveyor belts in factories, it is developing strongly in this period until the beginning of the 21st century.
Digital technology, which has been improving since the last decades of the 20th century, could serve as the tie of the Third and Fourth Industrial Revolutions. Model Industry 4.0 precisely on the digital basis is developing and implementing information and communication technologies (ICT), which integrate all the stages of the product from generation to usage. By merging of technologies, the difference between the digital, physical, and biological spheres is reduced, and thus also annihilates. In addition to the similarity with the previous, Third Industrial Revolution, there are also important,

qualitative differences, reflected in the speed, scope and impact on the systems. The current decade has passed in a massive acceleration in the field of information and communication technologies. At the beginning of the decade, in one platform, called "force Nexus “, four components were interflown: mobile devices, clouds, large data analytics and social networks, and later joined the construction of new digital models and the constitution of digital business.

The fourth industrial revolution is based on the project of total automation and digitization of production. The high-tech project of the German government, which has been encouraged since 2013, is aimed at making the industry as independent as possible from human beings. Automation develops from cyber-physical systems that are enabled by the Internet of Things (IoT) and Cloud Computing (CC). The goal is to create the so-called "smart factory", which will have their own smart networks capable of self-learning and controlling themselves. It is about a significant profit for the world economy, aimed at opening millions of jobs in the most industrialized countries, which would, of course, lead in the realization of this vision. Of course, such optimistic predictions are a major question, and even if it was realized, it would be the major issue of their repercussions on demand for adequate labor in regional and local markets, and consequently on population and migration movements on a global scale. All this, along with other elements, will have a reflection in the geopolitical sense, where countries (especially BRICS) that have colossal elements of the so-called "claim of power" (size and quality of territory, demographic force, natural resources, power of the economy and military power) count on that in time they will gain significance due to gross indicators. It is clear, however, that those countries that will be able to draw the maximum benefit from the Fourth Industrial Revolution will be able to keep at least some leverage of progress and influence, even in the case of smaller countries.

The key changes brought by the Fourth Industrial Revolution, in addition to digitization and automation, were in the field of artificial intelligence, nanotechnology, biotechnology, blocking, development of the energy storage and storage system, genomics, advanced materials, drones, 3D printers. Particularly highlighted is the exponential growth of computer power and the ability to handle huge amounts of data, with enormous importance in the field of artificial intelligence development. Digital production and the development of 3D printing enable many changes in production processes, in business models and in interaction with each other. Printing of the products allows not only manipulation of materials (seizure or addition of materials in various phases), but also leads to a revolutionary concept of supply and supply chain management. At the same time, 3D printing makes it possible to eliminate defects "on the site", not in the place of production. In the field of biotechnology, there is great expectation not only of the discovery of new types of drugs, given that the next generation genomics can revolutionize the way of diagnosis and treatment of today's incurable or hardly curable diseases. The completion of the project of the human genome sequencing has opened up unimaginable opportunities, not excluding, of course, those completely undesirable, as indicated by recently disclosed experiments on human embryos (Chinese scientist He Jiankui recently reported about the "creation" of two genetically modified girls, who by reprogramming of the genomes are allegedly naturally resistant to HIV virus). Visions, of course, do not end on everything mentioned above. Thus, engineers integrating computer design, engineering material and synthetic biology will develop, interacting with digital technology in production with the biological world, a kind of symbiosis of microorganisms, human bodies, products that people consume and, say, the environment in which they live.

Technological leap relying primarily on the advancement of information and digital technologies has influenced the transformation of mankind perhaps more than any previous technological advancement in history. The emergence of new technologies has always significantly influenced changes in society throughout history, and this is particularly sensitive in the layers of the urban population. Since the percentage of the city population has steadily increased over the course of the previous century, the influence of technology on society has also grown. It is precisely that during the 20th century, social relations have changed significantly. It may not be too hard to say that today technology is a factor from which practically society as a whole depends.

The specificity of the Fourth Industrial Revolution, in addition to the rapid pace of development and a great deal of business branches and the fields of social life, is also reflected in the harmonization and integration of a large number of various scientific disciplines and discoveries. Today's advancement of technology is not one-way and uniform. It combines the capabilities of electronic, physical, technical

and biological systems of technology and promotes multidisciplinarity in the field of science. The essential characteristic of the Fourth Technological Revolution is that it will not change only what man does, but will substantially change the very person himself.
There is a widespread fear that major changes based on digital technologies can cause the emergence of uncontrolled "artificial intelligence", which in the future can in some ways endanger human existence. There are also doubts that digital technologies will diminish the freedom of man, his privacy, and enable absolute control over the individual, his movement and action.

3. Disruptive technologies

Looking from the point of view of new technologies, the biggest impact on markets have the so-called disruptive innovations. They, according to Clayton Christensen [3], should be defined in this manner:
"Disruptive innovation is a process by which a product or service begins as a simple application at the bottom of the market and grows until it destroys competition."
Disruptive technologies are those technological innovations that change common business methods and processes, even the entire industry, that is, introduce new forms of business relying on new technologies. These technologies have as their basis several simple principles: to make the process easy for the user, to convert monotonic methods of application into attractive, to make use simple, to shorten the time of reaching the goal and to enable competitiveness in the market. If they want to achieve these principles and survive on the market, innovation is a priority for companies. However, the complexity of innovation and their great dynamics make it impossible for small firms to invest in them, so they are usually forced to cooperate with big companies or to follow trends.

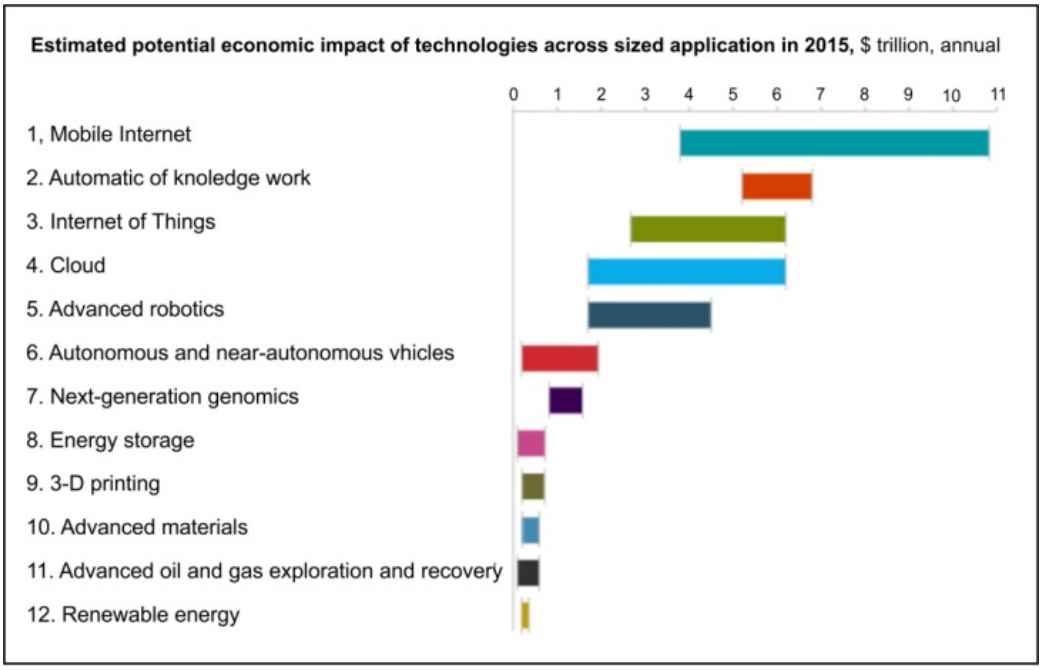

Fig. 3: Expectations of potential impacts of technologies from 2013 [8]

Disruptive technologies are most often characterized by high rate of change and ability and lead to accelerated rates of change or discontinuous improvements. The technology of sequencing of genes, then advanced materials development technologies, such as graphene from which the first artificial production in 2004 to the creation of the first integral circuit on its base in IBM in 2011 not even a decade has passed. Such technologies can, in principle, come from any field, that is, scientific discipline, but of course this does not mean that the chances of their appearance are the same.
However, not all disruptive technologies are generally also successful in the market, as is not every market breakthrough caused by disruptive technologies. On the road to market success, managers can mix strategies that may or may not involve disruptive technologies. In order to be economically

successful, technology has to satisfy some special conditions, above all, it should have a wide range of impacts, to "reach" companies and activities that influence (or can influence) a sufficiently wide range of machines, products or services.
The expectations of the potential impact of technologies from 2013 proved to be true in 2015 (Fig. 3).
Disruptive innovations directly influence the creation of new business models; striking on established traditional and conventional models of business, change the system of production, consumption, transportation and delivery from the roots. These changes also affect the social sphere: they affect the behavior of people, their work and communication, the manner of expression, the obtaining of information, and the forms of entertainment and the use of leisure time.
The impact is similar at the level of state institutions and public administration, education, health care and traffic. The spread of advanced technologies creates a new world in which virtual business and physical production are intertwined, at a global level. This ensures complete product adaptation and creation of new operating models.

4. Impact of technological changes on economic sphere

In the field of economic science, there are claims that this revolution will bring not only some kind of material growth, but a better and more just distribution of goods to all people on earth, that is, maximization of well-being. Also, the expectations of reducing the dependence of growth and development on the consumption of natural exhausted resources are also significant. However, there are also contradictory opinions.
New technologies are not only related to smart machines and systems. The spectrum of their action is much broader. At the same time, there are waves of new discoveries in the most diverse areas: from deciphering human genes to nanotechnology, from renewable energy resources to quantum physics. It is precisely the synthesis of these technologies and their mutual collaboration in the physical, electronic and biological domain that represents the fundamental difference between the Fourth Industrial Revolution and all the previous revolutions. It is now normal for electronic technologies to be incorporated into the biosphere. Some designers and architects already combine automated design, advanced technology, material engineering and synthetic biology to innovate a system of interactions between microorganisms, our bodies, life-essentials and even the buildings in for living. Almost all branches of the digital technology industry have been influenced by the new treatment of goods and services, which completely demolished the previous order and removed the boundaries among the branches. The best example of this is the automotive industry: today's car has become a computer on wheels, in which electronics make up about 40% of the price of the car itself.
Although technological advance brings great benefits, it is considered that it brings (or can bring) major problems. A major concern in scientific community, especially among economists, causes an increase in material inequality. Since all people at the same time are both consumers and producers, innovation at the same time impacts both favorably and unfavorably to the standard of living and total well-being. These problems are difficult to determine by quantifiers. Advanced technologies can, in principle, be useful for capital rather than work, and can also exert pressure on earnings, that is, affect its reduction, and consequently the reduction in demand on the market. The negative impact on the labor market needs to be borne in mind, in the short term perspective. It is known that the appearance of computers has affected the disappearance of a whole lot of occupations, and this tendency continues even today. In any case, modern technologies radically change the character of work in all branches of economy and occupations, and the fundamental reason for this is the replacement of work by automation. The disruptive effect of automation deprives workers the wage and requires them to seek income elsewhere. There is fear that technology advances will trigger a mass unemployment crisis. However, the same disruptive effect can cause an increase in demand for new goods and services, which leads to the creation of new jobs, companies and even entire branches of the economy.
According to the World Economic Forum [17], changes in demand for basic occupations and forecasts for the period after 2020 are shown in the following figure (Figure 4). In the Report, the chief human resources officers of today's largest employers in 10 industries and 15 economies were asked to imagine the impact on employment, jobs and skills up to 2020. As Fig. 4 shows, survey respondents

believe that complex problem solving, social and systems skills will be far more in demand in 2020 when compared to physical abilities or content skills.
According to Schwab, we can say the next. In tomorrow's world, many new positions and professions will emerge, driven not only by the fourth industrial revolution, but also by non-technological factors such as demographic pressures, geopolitical shifts and new social and cultural norms. Today, we cannot foresee exactly what these will be but I am convinced that talent, more than capital, will represent the critical production factor. For this reason, scarcity of a skilled workforce rather the availability of capital is more likely to be the crippling limit to innovation, competiveness and growth. [15, p. 47]

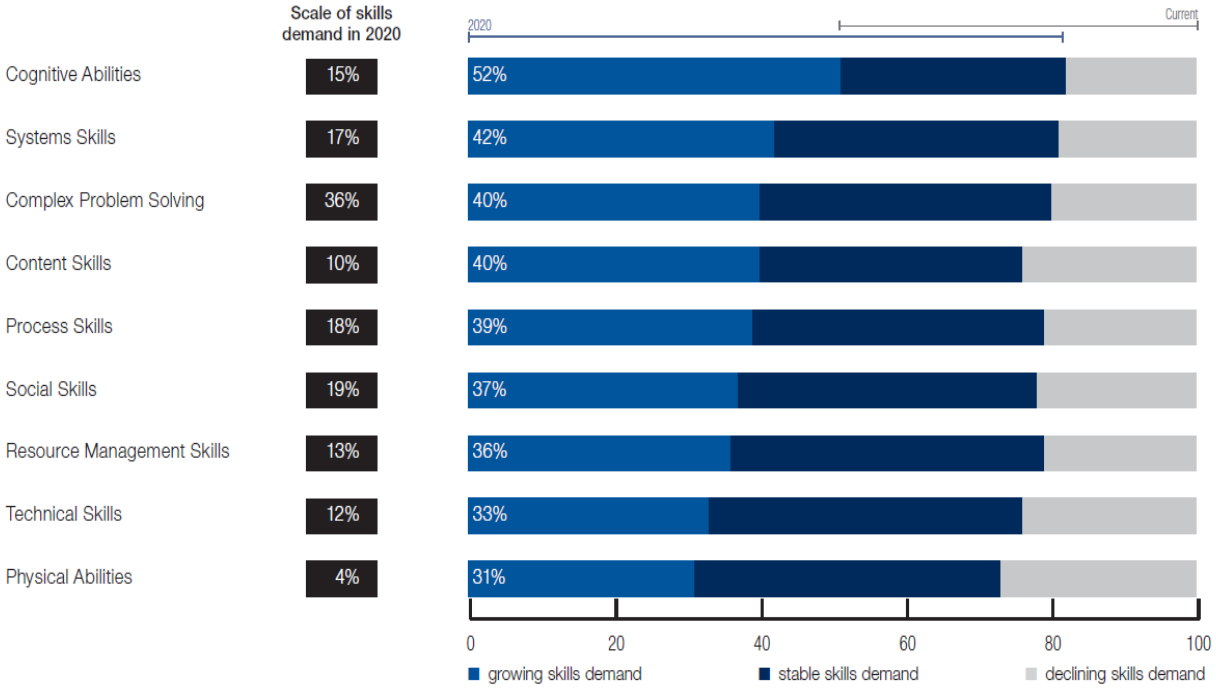

Fig. 4: Change in demand for core-related skills, 2015-2020, all industries [17, pp. 22]

It is believed that the main economic winners of the Fourth Industrial Revolution are or will be the owners of intellectual and material capital: innovators, investors, shareholders and the main losers will be the workers, due to the automation and robotization of labor. This also explains the growing material split between those who live from their own work and those who manage capital. On the other hand, important changes took place in the final phases of the third industrial revolution in the governing and sociological sphere of the structure of companies. According to the economist-sociologist Peter Drucker [5], in the post-industrial society of the end of the XX century, there comes to an increasingly widespread and more often separation of the ownership and management function of the company, a phenomenon characterized by the so-called managerial revolution [2]. This is a consequence of the further strengthening of the role of share capital, where a greater number of owners lead to the need of a layer of professional managers and administrators of managing and operation of industrial enterprises. Individual owners are all the more rare, who at the same time would be both efficient and quality managers.
Technologies can make goods available at lower prices and in that way impact on the increase of general well-being. Until the beginning of the economic crisis in 2008, the growth of the global economy was around 5% per year. If such a pace of growth is to be maintained, this will ensure that global GDP is doubled every fifteen years, and billions of people will then free themselves from poverty.
However, one paradox is also noticeable. In the last ten years, global economic efficiency (measuring either efficiency of work or overall efficiency of production factors) has shown a standstill, despite the exponential growth of technological progress, investment and innovation.

Technological progress creates problems primarily on the supply side, in the field of labor and production. Over the past few years, the vast majority of developed countries, as well as emerging countries, such as China, have experienced a significant percentage decline of labor share in GDP. Such a fall was mainly due to the fall in the relative cost of production, which was caused by the development of innovations [7].
The impact of technological progress on economic growth is a question in which economists differ in their thinking. On the one hand, there are claims that the possibilities of electronic technologies have already been exhausted and can no longer affect the efficiency of production. On the other hand, there are opposing assertions: that technologies and innovations are in a state of great expansion and in the near future can cause additional rapid economic growth.
As a result of technological advances, there are four phenomena: 1) consumer demands change; 2) the quality of goods increases; 3) new forms of business partnerships are being formed; 4) operational models are adapted to new digital models.
Modern advancements in technology are characterized by unmanned vehicles, 3-D printing, advanced robotics and advanced materials in the most visible, physical form. New materials are emerging in markets that have such properties, which could not be imagined just a few years earlier. The materials are becoming lighter, firmer, more resistant, more adaptive, and more suitable for secondary processing. Self-renewable materials are being produced, metals that "remember" the form and are flexibly returned to their previous form, ceramics that is resistant to high temperature or that converts pressure into energy.

5. Conclusion

The fourth industrial revolution began at a time when a significant part of the world was affected by the deindustrialization process. Of course, it has manifested itself differently in the developed countries and in the rest of the world, and accordingly, it has had and will have different consequences. One of the processes that have partially mitigated the effects of deindustrialization in the countries in transition and underdeveloped countries and led to a slowdown in the industrial growth in developed countries was the relocation of industrial plants from developed to developing countries, including former socialist ones. The motives are above all economic, since the semi-periphery and periphery countries (former socialist countries in transition and Third World countries) have considerably cheaper labor force, as well as loose environmental standards both on paper and in effect. Besides that, a number of Third World countries and those in transition offer subsidies for the relocation of industrial plants from developed countries or are prone to applying pressure and corruption in order to achieve the goal. Essentially, the low-qualified jobs industry and the direct foreign investment ideology are unable to reverse the negative effects in industries and societies of the Third World and countries in transition. Instead, it is vital to design a strategy of industrial development with the aim of empowering large enterprises, achieving permanent economic growth and as high as possible employment rate, all of which will stop and reverse negative demographic indicators [10]. Having the aforesaid in mind, the possibilities of engaging in a new technological revolution vary from country to country. Considering the unenviable state of our economy, especially the industry, Serbia will have significant constraints in these processes.
The Fourth Technological Revolution has an impact on man, his way of life and his environment much more than the three previous ones. These revolutionary changes bring changes in the sphere of economics. However, economic science has not given a final and unanimous judgment on the consequences it will bring in the economic sphere. There are claims that this revolution will bring not only (some kind of) material growth, but a better and more just distribution of goods to all people on earth, that is, maximization of well-being. Also, the expectations of reducing the dependence of growth and development on the consumption of natural exhausted resources are also significant. However, there are also contradictory opinions: that the distribution of goods will become more inequitable, that the gap between the rich and the poor will deepen further and that the automation of labor will cause mass unemployment. The greatest benefit of the Fourth Industrial Revolution today have the owners of intellectual and material capital, while the main losers are workers, whose work is

replaced by automation and robotics. For this reason, a material split grows between those who live from their own work and those who manage capital.

A near future will show which of these assumptions is correct, and on what way will the future economic and social development move. As previous experiences with previous technological revolutions have shown - the result will most likely be somewhere in the middle between these two extreme assumptions. In any case - ahead of us are times of great opportunities and great dangers.

It should be borne in mind that there are huge differences and contradictions in the world at large today. Their manifestations are very diverse and are involved in almost all spheres of economics and society. As Schwab says, in this, fourth industrial revolution, emerging technologies and broad-based innovations are diffusing much faster and more widely than in previous ones, which continue to unfold in some parts of the world. The second industrial revolution has yet to be fully experienced by 17% of the world as nearly 1.3 billion people still lack access to electricity. This is also true for the third industrial revolution, with more than half of the world's population, 4 billion people, most of who live in the developing world, lacking internet access. The spindle (the hallmark of the first industrial revolution) took almost 120 years to spread outside of Europe. By contrast, the internet permeated across the globe in less than a decade [15, p. 12-13].

It is obvious that different countries enter into new industrial and technological revolution with different positions. Certainly, this will partially reflect on their population characteristics, that is, on the situation on the labor markets. Not a small number of jobs, especially manual and lower qualified, will be practically eliminated, while the importance of trained and educated engineers and specialists of other professions will be able to manage and coordinate new mass production systems. Such movements will, of course, set new demands also to the educational systems, which are particularly sensitive especially in smaller and underdeveloped countries, which are already characterized by large emigration and depopulation processes. Their otherwise modest educational and scientific potentials will be faced with great temptations, as evidenced by the fact that the rich European Union, recognizing that it has no capacity to finance all scientific research, has chosen for excellence, i.e. it has selected 38 scientific-technological platforms (STPs), in whose framework problems are defined, research directed and tasks are designed [9, p. 124].

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