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OVERVIEW OF CURRENT ISSUES IN INDUSTRY 4.0 IMPLEMENTATION

Peter Poór, Josef Basl

University of West Bohemia, Czech Republic

Corresponding author:
Peter Poór
University of West Bohemia
Univerzitní 8, 306 14 Plzeň, Czech Republic
phone: +420 37763 8004
e-mail: poorpeter@gmail.com

Abstract

The main purpose of this article is to deal with the situation and implementation of Industry 4.0. The first part of the article is informative – it guides the reader with the evolution of industry (first – fourth industrial revolutions). The following part deals directly with Industry 4.0 and its characteristics. This concept focuses on digitization of all physical assets and integration into the digital ecosystem, including business partners within the value chain. Also, "pillars" on which Industry 4.0 relies, are presented here. The next part deals with Industry 4.0 initiative implementation. Eight crucial issues were selected here. The final part of the article proposes some solutions and suggestions for future implementation.

Keywords

Industry 4.0, implementation, issues, Czech Republic.

1. Introduction

Nowadays, Industry 4.0, the fourth industrial revolution, and similar concepts are becoming more and more often mentioned and addressed in connection with social changes. First of all, they are most visible in industry, therefore these changes are referred to as the Industrial Revolution.

If you say Industry 4.0, some know exactly what this is all about, but many do not know what they are supposed to imagine. According to many claims and expressions of a wide range of experts, 4th industrial revolution is currently on the way. The very word "Revolution", whose definition should express something that suddenly changes society in a revolutionary manner with all its particulars [22].

Interestingly, the three previous industrial revolutions took place first, or the world reached them, and were only named afterwards. With the fourth revolution that is going on now, it's just the opposite. It seems to have been introduced by force. This is because in the past people lived in a different reality and technological changes took place sequentially. After a certain invention, it always took many years for its influence to manifest itself in the structure of factories and the labor market. Today, the situation is different. The pace of life is faster, thanks to the global interconnectedness. Changes around happen instantly, and often in parallel.

The first industrial revolution is a concept everyone knows as the only industrial revolution and is already taught about in primary schools. It could be compared to the Neolithic Revolution, when the society profile changed from hunters and collectors into farmers. It burst at the end of the 18th century in England and can be characterized by changes in the use of energy sources, means of transport and information flow, as well as production industrialization. At the same time, this was a crucial period of social, cultural and political changes in individual countries. The symbol of the first Industrial Revolution is a steam engine invented by James Watt in 1765.

A rapid increase in labor productivity was brought about by the implementation of new methods used in agriculture - alternating field cultivation and introducing machinery into agriculture. An important concept of this period is industrialization, which means transforming the agrarian country into an industrial one.

The revolution also had a huge impact on society. The population of England doubled while reducing mortality due to better hygiene, less hunger, and better medical care. High urbanization took place – large urban industrial centers emerged as a result of migration from rural areas. Typical factories with high chimneys were typical symbol of that period. Thanks to that development new business routes – roads, railroads, bridges and canals were built. The most advanced cities at that time were Manchester, Liverpool, Birmingham and Glasgow.

At the end of the 18th century, the machines were broken by workers. They were afraid they would be without the machines work and the machines seemed to be the cause of their misery. This working class was called luddism. At the beginning of the 20th centu-

ry, workers' self-consciousness began to grow when the workforce became a special social class, and soon the first trade unions were created to defend workers' interests. The unions were negotiating, for example, the length of working hours and the amount of wages. In 1960s, political parties began to emerge of the working class which tried to gain parliamentary representation.

The Second Industrial Revolution began one hundred years later, in 1870, and was linked to electrification and the emergence of assembly lines. It also resulted in mass production based on division of work on electricity-fueled lines. One of the first such lines was built in factories of an American car manufacturer, Henry Ford. It basically starts the next industrial revolution. A great invention was the bulb by T.A Edison in 1879, and the transformer designed by Nicole Tesla, which is used until today.

Organization of work was dealt by Frederick Taylor, who managed to increase factory productivity by up to a hundred times. His principles of work organization, which are still in use today, consisted in a precisely determined work process and the task wage. In 1870, the first assembly line was established and it began the division of labor in Cincinnati. Other inventions of this time include dynamite, telephone, airship, etc.

Sometimes the Second Industrial Revolution is called the Revolution of the Technical Science. Darwin came with his theory of evolution. In the area of physics, Newton enforced the mechanical conception of nature, whereas the discovery of the microscope made it possible to notice what one does not see with the naked eye. Max Planck introduced the quantum theory, and Albert Einstein developed the theory of relativity. Sigmund Freud looked into the human mind through the theory of unconsciousness, the so-called psychoanalysis.

The new inventions changed people's lifestyle and life priorities. There is a connection between science and technology, therefore the results of the natural science were applied to industry. This created new materials which replaced natural fertilizers, dyes, therapeutic substances. After the invention of the combustion engine, diesel started to be applied. Electric motors were produced. Electricity began to be used to illuminate cities, develop urban transport (trams), and communications (telephones). Natural sciences and humanities were developed, scientific institutions, associations and foundations were founded. In 1901, Nobel Prizes began to be awarded. Individuals did not have the means to introduce electricity and the new technologies, and therefore they had to associate themselves with monopolies. A monopoly is an association of businesses from one industry or relative industries, thereby acquiring the exclusive right to produce, price and market a particular product or service.

Due to large concentration of banks and production, financial capital was created. Banks were co-owners of businesses, and entrepreneurs were co-owners of banks. On the top of businesses and banks stood the financial oligarchy, which was the privileged social class. The supply of goods began to grow, but. on the contrary, demand fell. Free capital was created, which was necessary for export. The USA exported capital to their industry-building colonies.

Colonies meant cheap labor and raw materials. Alternatively, the capital was lent to the backward countries for high interest (usury). There was a struggle between the Great Powers and the Territorial Colonies. This problem started the First World War.

The beginning of the Third Industrial Revolution dates back to 1969, when first programmable logic controller, i.e. PLC, was made. This period is accompanied by the introduction of automation and a boom in electronics and information technology. Technology was subsequently introduced into production to drive machines and automate them [7].

The next era of the Industrial Revolution is the expansion of the Internet. The Internet has essentially existed since 1962, but in 1987 the term "Internet" was created. Its commercialization took place only in the year 1994. From then on, it can be said that the Internet has penetrated into all areas of human activity. Since the late 1990s, there has been a huge increase in Internet users, who can now be counted in billions [15].

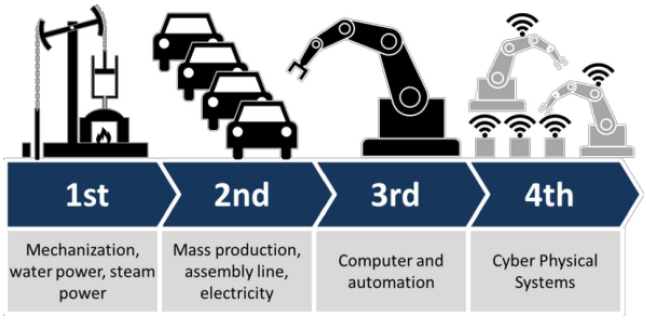

Fig. 1. Four industrial revolutions [1].

2. Industry 4.0 concept characteristics

Thanks to the rapid development of new technologies, a new philosophy is created that brings a whole society a change affecting a whole range of areas – from industry, through technical standardization, security, education, law, science and research, to the labor market and the social system [30].

The concept of Industry 4.0 is considered to be the key to ensuring greater efficiency and flexibility for manufacturing companies in the future [12]. It has become an integral part of human life and served as an accelerator of production processes and with concepts, such as a digital factory towards which production engineering and related branches will go [5].

There are relative terms for Industry 4.0, such as "Industrial Internet" or "Digital Factory". None of these terms provides a complete view of the situation. The Industry 4.0, the concept focuses on digitization of all physical assets and integration into the digital ecosystem, including business partners within the value chain.

Industry 4.0 is based on the following "pillars":

1. Digitalization and integration of horizontal and vertical value chains

Digitization and integration of vertical processes takes place across the organization, from product development, purchasing, management, manufacturing, logistics and services. Vertical processes will be linked with horizontal ones within corporate systems that will be able to respond to changing demand for products and services on time. Horizontal integration is connected with suppliers, customers and other key partners. All data on operations and process planning can be performed in real time, and using the support of expanded reality is perhaps the constant optimization of production processes.

2. Digitization of products and services offered

There will be so-called smart products that will be uniquely identifiable and localizable. The digitization of products is based on developing the existing products, for example, by adding smart sensors or communication devices that can be used with analytics data tools, and on creating new digitized products that are targeted to a fully integrated solution [17, 25].

By integrating new methods to collect and analyze data, companies are able to obtain information about the use of the product, which will not only know its history and current status, but also alternative ways to improve the product to meet the growing needs of target customers. This way, companies will put pressure on consumers to be flexible and produce tailored products in a relatively short time. It will help (SW), where virtual prototyping will be possible – i.e. virtual designs not only of products, but also of production means and processes [4, 11].

3. Digitization of businesses and access to customers

These technologies are being used already today. This pillar is closely related to the Internet of Things (hereinafter referred to as IoT), and the Internet of Services (IoS). In the customer segment, for example Customer Relationship Management (CRM) systems are used that integrate social networks and data analysis, especially in e-commerce. Social networks and available information on the Internet have increased customer demand for delivery speed and product quality.

Customers on social networks evaluate, among others, company products and provide reviews. Offered services through Internet marketing offers a wide variety of products, including clothing, cars, travel, financial services, employment, electronics, etc. If companies do not catch up with this trend and do not use the opportunity to communicate with customers in this way, there is a great risk from the point of view of the relationship with the public or outdated marketing [31].

2.1. Industry 4.0 Initiative implementation

From the point of view of implementing individual elements of Industry 4.0 in industrial enterprises, it is advisable to follow a different approach for companies, which is, of course, influenced by various factors.

The very implementation of Industry 4.0 principles makes it hard to tell what its target status will be, because this concept is very diverse and constantly evolving over time. It is necessary to dedicate our attention to transformation of the method of creating and distributing value, with the main medium of this transformation being digital space. In this space, the main processes will take place and there will be also created, integrated and controlled the value-creating model of the enterprise. Primarily thanks to digitization and much more intensive use of knowledge in business will be overcome local political boundaries will be overcame and a change in economic architecture will take place at a global level.

In this new economic architecture, the following economic types will play key roles:

- Innovator/expert on a particular issue,
- The platform that provides services in a particular domain,
- Infrastructure Service Provider.

2.2. Overview of current Industry 4.0 implementation issues

A recent international survey among small and medium-sized businesses in Central Europe has shown that businesses do not yet engage in digital connectivity with other businesses and customers, which is probably thought to be CRM systems [6]. "They still have the impression that if they are not manufacturers, Industry 4.0 does not concern them because it is still mainly related to industry. The fastest, however, is to adapt to 4.0 just in terms of trade and services" – says the head of the Association of small and medium-sized enterprises, Karel Havlíček. Smaller businesses are aware that they need to invest in the 4.0 concept, but do it only when they are pressured by the market, large multinationals with which the supply chain is involved [10]. Businesses also need to clarify whether it is worth investing in the technology they have to put on the existing machines data devices or purchase new machines. Large companies are introducing new digital technologies and processes to its production primarily to save costs, increase capacities, etc.

The analytical study of the Czech industry from CEEC for the year 2017 is very beneficial, as it maps selected aspects of the Industry 4.0 deployment rate in collaboration with leading personalities of the Czech industry, science and research [20]. These personalities comment briefly and clearly in the document on the current state and, of course, provide their own opinions or recommendations for further action in certain areas. The results of this study are based on interviews with more than two hundred representatives of selected industrial enterprises [1].

According to the CEEC survey, most companies would appreciate its continued activity and support of Industry 4.0 mainly for simplifying administration,

introducing standardization, simplifying legislation, as well as more advanced support for R&D, improved infrastructure, and more targeted and efficient use of funds [29]. It is also important, according to experts deepening cooperation between government, science and practice [21].

According to the survey, technical education is not bad, but better graduates' readiness would contribute to deepening the link between the composition of study fields and their content to the needs of practice and more intensive collaboration between schools and businesses. Theoretical knowledge is better, the ability to implement in practice lags behind. University graduates appear to be the best, according to the survey, but also the largest difference in the ability to implement this knowledge in practice. In terms of values, education reflects Industry 4.0 requirements only partially [13].

According to the CEEC survey, Industry 4.0 is currently implemented in only one third of companies (29 percent), and another 56 percent of companies plan to introduce it in the 5-year horizon. At the same time, there is a huge difference between the big and the small companies. When it comes to small businesses, Industry 4.0 is actively launched only by 2 percent of them, and the survey only confirms the aforementioned fact that small businesses will probably be implementing "pushed" by their partners in the market.

Most enterprises are equipped with well-established information systems that ensure collaboration or even automation of processes such as invoice approvals, contract preparation, calculations, project documentation, etc. [14]. This is at least a positive finding for the future deployment of other solutions in the framework of the Industry 4.0 implementation, and thus, more efficient use of already established processes [9, 24, 26].

A question what to do with little qualified workers is closely connected with the implementation of the Industry 4.0 principles These people are likely to be much less employable in a few years, as opposed to specialists, who will be highly demanded by the market [8].

Finally, it should be noted that public awareness also has its weight in Industry 4.0 implementation.

2.3. Eight issues in implementing idea-based principles of Industry 4.0.

Based on previous findings, seven critical issues were presented:

1. Lack of Industry Awareness 4.0

This aspect is ranked among the issues because Industry 4.0 is still a concept is not known to the general public. At present, there is none Czech official document that would instruct the implementation of Industry 4.0. Most large companies, in which Industry 4.0 has been introduced, have most of their own internal documentation, often including an implementation plan. It must be added that a large number of these companies are of multinational corporation type, such as Bosch, Siemens, or deal with car manufacturing, like Volkswagen. Such companies share their knowledge also with foreign branches. In my personal opinion, therefore lack of information can be a major threat to Industry 4.0 development among Czech companies [2].

2. Insufficient support for Industry 4.0 by the state

State support can be of two kinds, first of which is financial support. It can be directly in the form of a financial subsidy for different operational programs, or it can constitute a tax benefit that the company can write off. The other option is legislative support, which is in the form of administrative simplification, introduction of standards, a better and more efficient way of communication between businesses and authorities and the like. Both parts are crucial for implementation, the financial difficulty of introducing new technologies does not need to be mentioned and unnecessary paperwork and administration is clearly complicated and prolongs all processes within the implementation of each change.

3. Insufficient state of digitalization in the Czech Republic

The current state of digitalization in the Czech Republic is not quite bad, but especially in terms of digitization of state administration, the Czech Republic ranks among one of the worst in Europe. In this industry, there is a lot to catch up and for the full start of the Industry 4.0 it is a barrier. As far as industry is concerned, digitization should not be an industry that businesses pose a major threat. However, this factor is also important be included in potential problems [3].

4. Lack of industry experts supporting Industry 4.0

Education as such will certainly be on Industry 4.0 to respond. It is must be the first in this field before it is actually produced by experts to identify people who will teach these issues. In my opinion, it will take education about 5–10 years to reach this condition. This problem is defined as a current issue in terms of the needs of industry specialists 4.0, as far as education issues are concerned, and the readiness to produce these specialists is another problem that the companies will have to deal with [27, 28].

5. Technologically low level of environment in industry

In some businesses this factor could be a problem due to old technologies that will not be able to communicate with each other on defined infrastructures. In such cases, it will be necessary for companies to invest in new ones or modify the existing ones. This factor is not so critical to seriously threaten industry implementation 4.0.

6. Insufficient cyber security

Cybernetic security is the term often referred to recently, with the onset new technologies and generating an increasing amount of data, which will become more and more valuable, with more cybernetic attacks possible to occur. Companies do not address this area so far, but will certainly have their own importance in the

future. However, at present there is not too much risk for the implementation of the Industry 4.0 [23].

7. Insufficient support for Research and Development

This factor is the most important one that could be the whole thing of implementation, such as research and development of cooperation with industrial practice. Unfortunately, the Czech Republic is still in the ratio of funding between basic and applied research a bit behind the other mature ones [7].

3. Conclusions and suggestion of Industry 4.0 further implementation

The next procedure for the implementation of Industry 4.0 should correspond with the above mentioned Industry 4.0 Initiative. These suggestions lead to the conclusion that the focus should be on the areas in which they are at a weaker level than is appropriate to create an enabling and supportive environment introducing the idea of Industry 4.0 [18].

This is primarily about supporting science, research and innovation, that is, focusing more on funding innovation centers, the emergence of new centers with a focus on innovative technology, better interdependence with universities, support for emerging companies – start-ups, etc. Another benefit would be to inspire, for example, the German Fraunhofer Institute, which, is concerned with projects focusing on innovation and new technologies. An integral part to aid Industry 4.0 is to spread its ideas to a wider community, and also to include it into educational institute programs. It is precisely because of changes in education that there should be another approach to the transition to Industry 4.0. These changes mean a change in methods, content and extent of teaching [19]. Consideration should be given to future developments and associated fact that quite a few jobs will be lost and, on the contrary, new ones will emerge, and also that's why education change should also be addressed. At the same time, students are educated too narrowly focused on the given area. In the future, they should be educated in a more general way and then narrow their focus later into practice. A key role is played by support for the digital economy and information and communication technologies thanks to which the industry operates and is directly subject to these technologies.

Of course, the previous steps must be the simultaneous creation of information documents and strategic materials that will be used to act and through which Industry 4.0 concept will be further expanded [16].

Of course, the Industry Initiative 4.0 Document contains many other terms and conditions, technological, legislative, ethical and others, which are very important for further development of the industry and the future functioning of the society.

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