

AKADÉMIAI KIADÓ

International Review of
Applied Sciences and
Engineering

11 (2020) 2, 140–146

DOI:

[10.1556/1848.2020.20020](https://doi.org/10.1556/1848.2020.20020)
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ORIGINAL RESEARCH
PAPER



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Industry 4.0 from a few aspects, in particular in respect of the decision making of the management /Will the new industrial revolution change the traditional management functions?/

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Received: July 29, 2019 • Accepted: August 23, 2019

Published online: July 2, 2020

ABSTRACT

The fourth industrial revolution, often identified as the terminology of Industry 4.0, more and more enforces changes and modifications from each participant of the socio-economic ecosystem. These enforced corrections concern the households, the governmental areas in different degrees, but the operation of the company sectors is rearranged most strongly by them. The study analyses this latter structure in the following respect: which are the most important supports of Industry 4.0 and what kind of competency elements are required from the employees and the management? According to the research data to be introduced, the domestic companies lag behind in preparations for the challenges raised by Industry 4.0; the international experiences are more favourable in this field. After—partial—review of the professional literature, the author concludes that the business sphere is in a condition before paradigm shift due to Industry 4.0. As per the analysis of decision-making based on digitalization, the question in the subtitle is answered—Industry 4.0 does not change fundamentally the traditional management functions of the company sector, but the decision-supporting applications based on digitalization must be learnt and applied. That statement seems to be founded that only company management, being able to live with decision making based on digitalization, can win competitive advantage.

KEYWORDS

Industry 4.0, management, digitization, competencies, decision-making

1. INTRODUCTION

In my opinion, as a result of the new industrial revolution, the global economic sector [1] is characterized by a situation before paradigm shift on the bases of scientific-historical approach. This will be explained in detail in the Conclusions section. The definition of Industry 4.0 is well known among the researchers and the experts, and researching of the topic is more and more popular in the mainstream economic science, too. Concerning its definition, the standpoints are different, but the most accepted one is what was approved by the German Industrial–Scientific Research Association according to the definition of Buhr [2]. In the definition of Industry 4.0, the author outlines the concept of the intelligent factory through all of the manufacturing parts and the full process. Further real time inspection through ITC and more increased use of the robots which control themselves. It includes the development through the implementation of which and by the improvement of resource efficiency they contribute to greater productivity. Others, such as [3] consider that Industry 4.0 refers to the integration of the communication technology into the industrial environment. Investigating the determinant components of the process [4], five key elements of

Industry 4.0 were identified, they are: 1. digitalization, optimization and customizing of the production, 2. automation and adaptation, 3. man-machine cooperation, 4. value-added services and storage and 5. automatic exchange of data and communication. In another approach [5], the concept of the fourth industrial revolution refers to ever increasing digitalization of the full supply chain through the application of cyber-physical systems. As a result, the individual players, objects and systems are connected on the basis of real time data exchange. Thanks to this cooperation, the machines and processes equipped with artificial intelligence become capable of independently adapting to the spontaneously changing environmental factors. During discussion of the topic, this latter definition is considered as the basis of analysis by the study. In the study, Industry 4.0 and the new industrial revolution are used as synonyms.

In order to detect the effects of Industry 4.0 on the traditional management functions, it is relevant to determine what is fundamentally the task of the company management. Based on the concept of system theory, the business organizations, the management must deal, in the course of solving of the tasks, with two necessarily interconnected fields of different approach: with people and their groups and with the tools and technologies. The management functions outline the frameworks of performing this activity. In order to be able to detect the changes occurring in the management tasks, first of all, it must be defined what we mean by the traditional management functions approved today. These manager's roles and their contents—based on [6]—are the following. Planning: the process of setting of the performance to be achieved and of the activities leading to it. The management determines in the draft what results are expected of the working processes, it outlines the tools which enable reaching of the given targets. The next one is the process of organization, it includes determination of the concrete tasks, appointment of the executors, assignment of the resources as well as synchronization of the activities of the groups and of the individuals. During this the management prepares, the approved plans for implementation: it determines the tasks to be performed and establishes the required technological background, the human and other resources. Then follows leading, in the course of which the management guides the endeavours of the employees in the direction of achieving implementation of the plans and reaching of the targets. In the course of leading, the management works on making the employees committed to the organization and the possible best work of the employees is stimulated in order to reach the targets. Finally follows checking, being the process of performance measurement, comparison of the set targets and results and making of the appropriate corrective steps. Information gained during checking contribute to preparations and planning of the required changes by the management. The following Fig. 1 shows the relation between company output and feedback:

2. METHODOLOGY OF RESEARCH

For answering the set sphere of questions, I have used the methodology of the review of the professional literature.

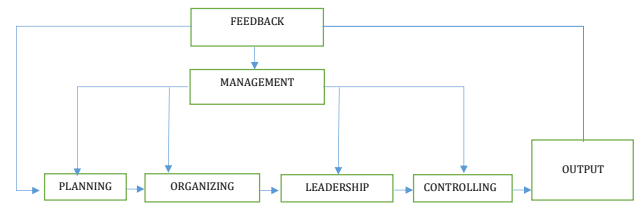


Fig. 1. Management functions and feedback

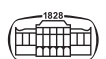
Helped with the review of the professional literature applied for summarizing, the topic of Industry 4.0 I could define further research issues through revealing relevant and closely related sources. By applying the key words related to the review of the professional literature of the new industrial revolution, querying of the scientific data bases and retrospective or prospective searching of further publications based on the relevant articles were involved. According to ref. [7], while retrospective search means review of the articles found on the basis of key word research, the prospective search refers to the analysis of further sources referred to in the reviewed articles in this methodology.

For examination of the company preparedness for the challenges of Industry 4.0, I have used the results of several domestic and international empiric researches.

3. PHYSICAL AND TECHNOLOGICAL SUPPORTS OF INDUSTRY 4.0 AND COMPETITIVE ADVANTAGES OF THEIR APPLICATION

As I have already mentioned in the introduction, Industry 4.0 fundamentally refers to the increasing digitalization of the full supply chain through the cyber-physical systems. The combination of the physical and technological supports offers the possibility for developing truly digital companies. These companies can bring decisions being aware of much more and more accurate information than those known now. Examination of the topic requires a brief introduction of the most important physical and technological elements. Reference [8] describes the support of Industry 4.0; these are the following:

- M2M (Machine to Machine): Data flow and communication between machines (computers) without human participation. The intelligent machines of the future must learn to communicate with each other compatibly in order to be able to take over management of the more complex tasks, too. Communication in a common language between the intelligent machines is inevitable for this purpose.
- AI (Artificial Intelligence): AI usually means the capacity of the machines for logical thinking and learning. It is important that actual artificial intelligence will be in a future when the more complicated tasks will be solved by the machines not because of the complex



pre-programming, but independently, even by the development of own methods.

- Robotics: Behaviour trees, that is far-reaching behaviour patterns will determine the development of robotics in the future. The machines using behaviour trees will be behaviour-based robots, from which behaviour-based work groups and behaviour-based factories can be created. They should not be programmed to everything; they will function as intelligent and efficient workers.
- Quantum computers: Now, they exist only in theory and the difference from the traditional ones is that while the operation basis of these latter ones is the bit, with the value of 1 or 0, the basis of quantum computing is qubit. This can include 1 or 0 or their superposition meaning indefinitely more conditions, so consequently it makes parallel fulfilment of indefinitely more operations possible. This multiplied computing capacity will be used in Industry 4.0 to operate much more diverse and complex Internet and the above-mentioned behaviour-based robots.
- IoT (Internet of Things): It means a large number of interconnected intelligent devices which are capable of recognizing some essential information and to communicate it to another means through the internet-based network. Practical application of IoT is already existing today: software and sensors embedded in objects and devices being in connection with each other and the operating personnel monitor anything they are set for.
- IoS (Internet of Services): The key point of the IoS is that the companies sell not simple products anymore, but services embedded in objects, since the purchased goods can be continuously developed.
- 5G: The system will play an enormous role in the connection of mobile devices. 5G service providers require the demands of the consumers and based on them they can adjust the technology to these demands. For example, it is an expectation that data transmission be quick enough to allow for extended solutions based on virtual reality. However, these high-demand, global tasks need locally specialized mobile networks, too.
- Cloud-based services: Almost indefinite volume of data can be stored in these clouds, which are this way not on a local media but on the devices of a service provider company. The cloud-based services help collection and centralization of the business information and offer at the same time a platform for the open cooperation between the users.
- Big Data: It is not a concrete technology, rather the synthesis of the old, approved and the new technologies: it means interpretation and processing of large volume of data changing at a high rate. The key point is to produce from plenty pieces of unnecessary information only a few useful ones. Big data will be mainly used for forecasts in industry 4.0, e.g. forecasting the consumers' demands from the feedbacks on which basis then certain products can be pre-fabricated or different modifications can be performed.
- Edge Computing: The main point is that the system can transmit—in the shortest time—useful data wherever it is relevant. The companies dealing with this pre-filter huge

data volumes (big data) at the source, at the edge of the process; the name comes from here. They immediately get rid of the unnecessary information and only the data requested by the professionals are transmitted.

Depending on the companies' level of technological preparation for Industry 4.0, they can realize different competitive advantages. The study of ref. [9] gives details of it.

There are differences in the exact determination of the physical and technological elements of Industry 4.0 among the researchers, however, they are not so relevant differences that would prevent further discussion of the topic. It is possible because the concrete technical elements of Industry 4.0 will not have a great role in explaining the subject. See works [10] and [11] about the different determination of the physical and technological elements.

The individual means of Industry 4.0 learnt and applied so far influence the profits and the efficiency of the companies, differently. Application of some of them generate extra revenue for the given company. Other means show their positive effect by resulting in lower costs. These lower costs improve operational efficiency of the company. The mentioned relations are shown in publication [12].

4. COMPANIES' COMPULSION TO LEARN AND THEIR READINESS FOR PHYSICAL AND TECHNOLOGICAL CHANGES

The technologies and their application change the ecosystem of the business sphere known so far. Man, as the designer, the producer and the consumer, changes. Different vertical and horizontal integration will be needed in the production process of the company than before. So called 'smart products' appear at the end of the production process. The below Fig. 2 shows the levels of the ecosystem of Industry 4.0, in the above enlisted order:

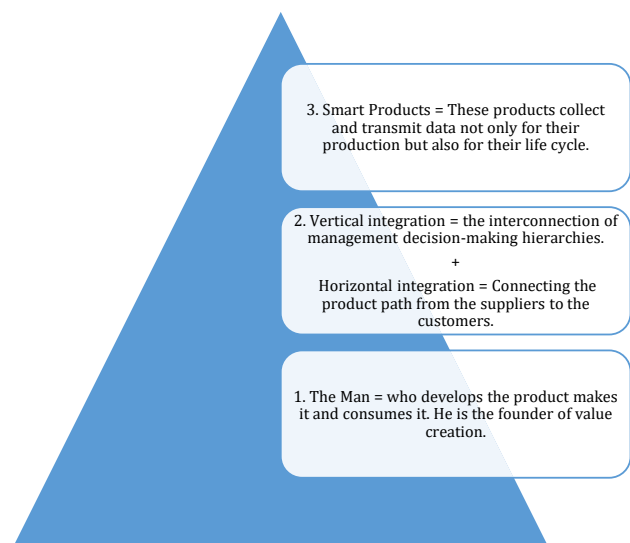


Fig. 2. Pyramid of the ecosystem of Industry 4.0

The companies must prepare for these changes. It is evident that the new industrial revolution will enforce the players of the business sphere, as well as their management and other employees to learn new types of processes and methods. The companies need it because Industry 4.0 will fundamentally change the adaptation expectations for the producing-servicing sectors. Consequently, the usual individual and company competencies must necessarily change, too. First, it is relevant to show what will be the key competencies expected by Industry 4.0 from the management and the employees. The researches have different opinions in this issue. We certainly have to wait for the exact, scientifically and uniformly acceptable definition of competencies for a long time. According to ref. [13], the key competencies that will become necessary in the near future are the following: complex problem-solving, critical thinking, creativity, human management, cooperation, emotional intelligence, decision-making, service centricity, negotiations and cognitive flexibility. Contrary to the previous determination, the studies of others, e.g. [14], distinguish technical, personal, methodological, social competencies, and those related to acting and the professional field. However, there is no difference between the researchers of the topic as regards the fact that the new competencies can only be acquired by learning of the managers and employees of the concerned companies. For the development of these competencies and efficient training of the colleagues, the companies must apply such innovative and practical learning technics that promote the employees to adapt to the changed environment by means of solving real working tasks [7]. Continuing the above thread [15], it outlines that the newest/digital/industrial revolution in the company sector will fundamentally change the consumers' habits and improve the products and the services. Consequently, completely new business models, not known so far, will be enforced in this section. In the fourth industrial revolution, the managements of the companies are faced with several socio-technological challenges. The traditional forms of learning do not give appropriate response to these challenges, since these are created within the borders of the organizations, so the limits of organizational learning must be extended.

I show preparedness of the companies for Industry 4.0 in domestic and European relation. A European survey enlists the Hungarian companies, as to their preparedness for the challenges of Industry 4.0 to the second half of the European hierarchy. Berger index (distinguishing four categories on the basis of preparedness) classifies Hungary to the group of the so called 'traditional' countries together with the Czech Republic, Lithuania, Slovenia and Slovakia. The countries classified to this category, mainly the countries of Central and Eastern Europe, have strong industrial basis, however, they have only a few initiatives that would push the industry into a new era. According to the research data described in study [15], the level of preparedness of the domestic companies is rather low than high as to the challenges of Industry 4.0. The researcher examined quantitatively and qualitatively the preparedness of the Hungarian companies for the challenges of the new industrial revolution. Because the present network relations of the companies are not

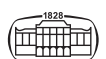
capable of serving the demand for the new knowledge related to Industry 4.0, new type of network cooperation and learning is needed. Study [16] shows a bit better picture about the preparedness of the domestic companies for Industry 4.0, as compared to the results of the previous survey, but lagging behind the international leading group is evident. The empiric part of the study is based on four company interviews. The domestic economic policy recognized that the government must support the companies in widely using the digital tools of the new industrial revolution. 2016 brought a visible breakthrough in the industrial policy of the Hungarian government, when a support program was announced. The government launches non-refundable tenders or establishes a venture capital fund with the explicit purpose of supporting the industry 4.0 [17].

The survey made in the sphere of the international companies about preparedness for the new digital industrial revolution shows a slightly more favourable picture; they are better prepared. Survey of ref. [18] confirms it. This organization performed a survey in 19 countries involving 1600 top managers. They searched the answer to the question of how the companies are ready for utilizing the possibilities offered by Industry 4.0. The survey studied the opinion of the top managers focussing on four fields—society, strategy, capacities and technology. The majority—87%—of the managers participating in the research found that Industry 4.0 will bring greater equality and stability in the economy. Although the positive effects are clear, it is doubtful how the companies will be able to use these possibilities. Only 14% of the questioned managers answered that they think that their company is prepared for utilizing of the possibilities offered by the new industrial revolution. However, it is also seen that the companies are determined to develop in intra-company training. 84% of the respondents stated that they do their utmost in their company to have the appropriate labour force available for managing the challenges of Industry 4.0.

In the survey [19], preparedness index for Industry 4.0 was drawn up with Europe in the focus. They have considered many aspects during their examination, for instance the degree of openness of the economy, the capacity of adapting to the convergent industrial sectors. Excellence of the innovation networks, qualification and flexibility of the employees and interdisciplinary levels of the knowledge were surveyed. Based on the so called Berger index, the leaders are: Switzerland, Germany, Ireland, Sweden, Finland and Austria. These countries are characterized by great industrial basis, very modern technologies and perspective business thinking. The enlisted states are such capital-intensive countries that are capable of the development and application of the new technologies.

5. THE EFFECTS OF INDUSTRY 4.0 ON THE COMPANY MANAGEMENT FUNCTIONS, CHARACTERISTICALLY ON DECISION-MAKING

The decisions needed for the operation of a company are taken by the management. We can also say that the



management activity is the same as decision-making. Here and now, I do not wish to deal with the semantic differences between the definition of the leader and the manager. In the interpretation of the study, the manager is the person who makes decisions needed for the operation of the company, while the management is the activity performed by one or more persons in order to coordinate and harmonize the activity of the organization. Decision-making appears in the four management functions described in the introduction, since planning, organization, management and control all need definite decisions. I think that the statements of ref. [20] can be considered as the starting point in respect of the discussion of decision-making of the management. In respect of digitalization, it outlined (among other characteristics) the importance of the manager style allowing for delegating decision-making. Now, I wish to point out the practical aspects of the delegation.

In the period of the new industrial revolution, the basis of decision-making by the management is identification of the data and processes influencing the company conditions. First of all, it must be stated what information is needed for the management in order to make its decision. However, the available data are appropriately structured only in the rarest of cases. The relevant step of the preparation of decision-making by the management is appropriate selection, grouping and interpretation in the same way of the data and the information.

Decision-making makes a determinant part of the activity of the management in business life. Based on the content of the previous sections, it can be stated that in the company activity within the framework of Industry 4.0 it is not possible to make decisions without digitalization. However, the management is not alone in the decision-making process today, since a part of it can be delegated, that is, others can be entrusted with, namely computers, smart devices of some kind of an algorithm. Just Industry 4.0. has strengthened the debate about delegation of the management's decision rights, due to the fact that it is no longer to be assigned only to people. A frequently debated question of our days is not delegation itself, but its depth. Delegation may concern implementation of the management tasks, making of smaller or bigger decisions and execution of the supervisions. In the age of digitalization, the decisions can be assigned not only to the employees, but also to the machines and the algorithms by the management. However, mistrust is founded: since several questions related to responsibility arise regarding the involvement of the machines and algorithms into decision-making. However, the process of decision-making becomes easier by the work of the computers and other smart devices because it appears as a series of making several smaller decisions. However, it should be emphasized that only automated, objective decisions with known output capabilities should be left to the management of machines and other decision support tools. Only foreseeable, easily considerable and later reliably revisable decisions. The smart devices and machines, robots and algorithms are excellently suitable for efficient planning and allocation of the resources, but they can reliably do it on

the basis of objective aspects. This means, e.g., the forecasting of the time demand of a producing-servicing task, calculation of the required machine hours or allocation of the employees within the plant/factory/company, etc. may be delegated to the above-mentioned devices by the management.

In the age of Industry 4.0, several informatic tools and digitalization solutions promote the decision-making of the management. Much more plentiful data are available than before. However, data redundancy, seeming to be indefinite, causes difficulty in decision-making for the management only seemingly. This is possible because the management is supported in synthetization of the much larger volume of data by much more effective and efficient means of digitalization than before. Industry 4.0. relies heavily on the help of artificial intelligence, through the application of which the management can automatically execute algorithmized decisions. This way the time for decision-making can be reduced in the production and production management, thus utilization of the tools and efficiency increases. Digitalization comprising each segment of the full company supply chain made data processing and data structuring easier. The automatically generated graphs and reports and displaying of their extreme values are functions which promote more thorough understanding of the production process. Thus, they can call the attention of the management to the necessary interventions. However, it is important for well-founded decision-making that the management should consider not only the automatically generated statements, but itself must process the produced information. In the framework of Industry 4.0, the systems organizing and evaluating the data of the products and the parameters gathered from the production offer efficient help for the management in decision-making. Due to the fact that each data and process characteristic can be found in the same place, or perhaps it is accessible in the previously processed condition the time demand of the decision-preparation process can be well reduced. Under the conditions given by Industry 4.0, the greatest benefit of digitalization in the decision-making of the management is that it can establish the same decision environment for each decision-maker. It is possible because a computer, a controller or another intelligent device can offer the same data and information (even in the same environment). So, in such a situation, the role of the manager entrusted with decision-making does not have to do anything but make his decision on the basis of the data and information provided by the system for him.

6. CONCLUSIONS

It seems from the content of the introduction that Industry 4.0 is one of the most relevant research topics of our days. There is no uniform standpoint among the researchers about the basic definitions of the newest industrial revolution and not even about the business-technological content of the process. I think it quite natural because nothing else happens



than before, when a new scientific discipline appeared. We can perhaps declare that we experience paradigm shift of the business processes now, and the reason is the phenomenon of Industry 4.0. Paradigm of the new industrial revolution does not exist yet but forming and strengthening of the processes is going on now. Perhaps the statement that the phenomenon of Industry 4.0 today is in a ‘Pre-paradigm’ condition, as interpreted by Kuhn, is not an exaggeration. In his theory, the lack of accepting the uniform theoretical pre-assumption is characteristic for the ‘pre-paradigm’ period in a given field of science. This plurality ceases because acceptance of the paradigm leads to unification of the scientific theorems approved by the scientific society. However, in connection with the phenomenon of Industry 4.0, the elaboration and unification of the science theorem still has to wait. Being a new field of science, the examination of the organizational and management aspects of Industry 4.0 cannot be considered as finished. Several research issues are still waiting for answers.

From the examination of the expected competencies, it is clear that there is no agreement in the present phase of Industry 4.0 among the researchers, e.g. on the issue of what key competencies this brand-new business model requires from the employees and the management of the company. If consent could be reached in this, and some other fundamental issues, that would greatly promote elaboration and spreading of the standardized methods of the new industrial revolution.

Based on some domestic and international empirical researches, I have investigated how much the companies are prepared for the challenges of Industry 4.0. The consequence can be drawn that the preparedness of the domestic companies is insufficient. According to their own opinion, the existing knowledge and the traditional relations of the Hungarian companies are not enough for meeting the challenges of Industry 4.0. The domestic subsidiaries of the companies in foreign ownership are better prepared, which is due, decisively, to the financial support of the mother companies and the more up-to-date concept represented by them. Based on the international investigations (as per the so-called Berger index), the countries of the German language speaking area and the Scandinavian countries can be qualified as the most prepared for the challenges of Industry 4.0.

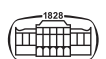
Finally, I have studied whether the emergence of Industry 4.0 would change the decision-making of the company management in the ecosystem. This examination became necessary because by now the bases of decision-making by the management relying on digitalization have been developed. However, the decision-making and controlling role of the management still exists. And this is not different for the other management functions. In the course of exercising the functions of planning, organization and leading the management can rely on the fundamentals of Industry 4.0. But they still are not exempt from the responsibilities of the consequences of their decisions. Finally, the smart devices and the softwares collect data and prepare decisions with the help of the algorithms in a data base, but

the concrete decision must be made by the management even in the future.

Namely, the contents of the traditional functions of management will not be changed by Industry 4.0. But the tools and procedures used for performing these management functions will be different, as compared to those used before. However, the new industrial revolution will significantly facilitate the most important task of the management—top level decision-making—with its more innovative tools, based on digitalization.

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