

INDUSTRY 5.0 – THE EXPECTED IMPACT OF NEXT INDUSTRIAL REVOLUTION

Daniel Paschek
Politehnica University Timisoara, Management Faculty, Romania
daniel.paschek@student.upt.ro

Anca Mocan
Politehnica University Timisoara, Romania
ancamocan2003@yahoo.com

Anca Draghici
Politehnica University Timisoara, Romania
anca.draghici@upt.ro

Abstract:

While the most companies are still struggling with the digitalization of their business through the integration of artificial intelligence (AI), Internet of Things (IoT), cloud technologies and further developed technology the next step of Industrial Revolution appears in the nearest future. Industry 5.0 will step into the future daily business due to the velocity of further technological development and changing human process integration. In this context, the paper analyses and evaluate the business impact of the next Industrial Revolution, so call Industry 5.0. Therefore, the actual Industry 4.0 business transformation record of accomplishment as well as weakness and threats are analysed by interviews with experts and business representatives. The first result is the business situation analysis to identify existing gabs with the derivation of opportunities and threats as well as suggestions for the business how to transform best in times of the next Industrial Revolution. Furthermore, the approach of integrate human workers back into the supply chain next to automated processes is debated. This paper underlines the assumption that companies did not recognize, yet the next Industrial Revolution because of the lack of entrepreneurship and transformation capacity related to Industry 4.0.

Keywords: Industry 5.0; Fifth Industrial Revolution, Artificial Intelligence; Business Change; Industry 4.0; Digitalization

1. INTRODUCTION

“We are on the cusp of the Fourth Industrial Revolution, or Industry 4.0” mentioned Bernhard Marr, a strategic business and technology advisor to governments and companies (Marr, 2018). Although many companies are still hard working on the digitalization of their business to achieve the competitive advantages of the Industry 4.0 like: scalability, process automation and thereby improved productivity, improved efficiency, support of flexibility and agility to generate a better customer experience, higher revenues and an increased profitability (Moran, 2018). Despite the continuing transformation process by digitalization within Industry 4.0 there are some entrepreneurs who are looking into the future and do not see the business processes and the organizations as they are but as they could be with the future industry (Industry 5.0). In addition, the technological developments grow with high speed, so fast that Industry 5.0 is already becoming part of the business landscape (Atwell, 2017).

Nevertheless, digitalization, globalization, agilization, customer centricity and many more business parameters ensure the ongoing development, transition and transformation of companies. The enterprise, who will find and anticipate future trends and the related changes need are defined as innovative and will succeed in the next step of Industrial Revolution. Companies should consider this opportunity.

In the context of this article, the research analysis the existing transformation status of Industry 4.0 within different industries (over small, medium and large companies) in Europe. Furthermore, the scientific knowledge base and occurred business values of the Industry 4.0 are analysed. The research recorded the existing transformation issues to get in mind as lessons learned for the transformational approach to Industry 5.0. The research mythology consists of a survey based on questionnaire developed with the support of managers on C-Level (high-ranking executive of a company in charge of making company-wide decisions as: chief executive officer (CEO), chief operating officer (COO) and chief information officer (CIO)). Clear definitions of core terms generate the scientific basis of this paper to facilitate an equal understanding of the economic context dynamics. To support the positive business evolution to Industry 5.0, the analysed issues and existing opportunities are considered.

2. Literature review

2.1. Industry 4.0 characterization

Industry 4.0 Revolution was announced (recognized) first in 2011 by the German Government at the Hannover Fair and describes the fourth step of Industrial Revolution by improvement of communication and information technology for manufacturing (Ustundag, 2018). The fourth step of Industrial Revolution is characterized by a high level of automation by automated govern machines (defining Cyber Physical Systems) as well as high use of cloud technology and big data (Lewis, 2017). Industry 4.0 encompassed a wide range of concepts as the digitalization, automation, standardization, dynamic and secure networks, miniaturization as well as incremental in mechanization and general innovation (Ustundag, 2018). Cyber Physical Systems monitor physical processes over the whole supply chain using real time communication and Internet of Things (IoT) (Ustundag, 2018).

The fundamental changes by the transformation of Industry 4.0 are based on technology developments like application of AI, Data Analytics, IoT, Cloud technology, Robotics, Blockchain technology, 3D printing, cryptocurrencies and more (Ustundag, 2018). Synthetizing by (Lewis, 2017), four design principles characterize Industry 4.0:

- Interoperability – integration of industrial machines, tools via IoT and supporting machine-to-machine communication;
- Information transparency – computer system can generate virtual copies of real-world objects;
- Technical assistance – computerized machines with AI to support human workers efficiency and effectiveness;
- Decentralization – implementation of technical systems that can act and execute tasks on their own.

These principles support enterprises' transformation into the Industry 4.0 scenario. For the successful transformation, three dimension should be consider (Ustundag, 2018):

- a) Horizontal integration - value creation between organizations and businesses for elevating product lifecycle and efficient financial management as well as material flow by real time data sharing and accurate planning;
- b) Vertical integration - collaboration within different hierarchical level of organization via cross-linking and digitalization of business units. This enables the company's transformation into a Smart Factory with a high flexibility by real time data sharing and accurate planning;
- c) End to end engineering - product and service design and development process considering customer demands and requirements with digital technology integration.

Currently, customers' acquisition decision is based on searching the best product or services (output for companies) satisfying their needs. This is associated with continuous improvement processes of the companies, by considering low-cost, high quality and their output immediate availability. Obviously, the multi-criteria processes optimization is difficult to realize. Industry 4.0 try to change the trade-off challenge and provide benefits in six specific categories like depict in Table1. Adding even more technologies that are new can drive benefits to the next level (e.g. using Big Data and AI) will detect patterns to predict and avoid future problems (Almada-Labo, 2017).

Table 1: Six benefits of Industry 4.0 for businesses

Benefit	Description
Efficiency	Less people and more automation drive the decision-making process more rapidly and keep efficiency high. Automation also tends to keep quality high and keep low manual production issues.
Agility	With a focus on high standardization and small lots, Industry 4.0 generates a high flexibility within the manufacturing process.
Innovation	Since Industry 4.0 production lines are made to accommodate high mix and low volumes, they are ideally suited to new product introduction and experimentation in design.
Customer experience	The responsiveness and deep information availability of customer requirements and existing issues can give customers suited products and services, sometimes in real time.
Costs reduction	After initial investments for the transformation, the costs will drop. Fewer quality problems lead to less material waste, lower personnel and operating costs.
Revenues	Better quality, lower costs and the ability to serve customers well, Industry 4.0 puts manufacturers on a path to be a preferred supplier to current customers. It also opens ways to serve larger markets, offer customized and thus higher-margin products and service to all customers.

Source: Almada-Labo, 2017

Next to the technical and cyber-physical system integration, an appropriate organizational structure is required to benefit from the advantages of Industry 4. Therefore, a strategic workforce planning, partner management as well as the sharing and participating / using of technological standards are essential basics for companies (Ustundag, 2018).

Discussing the fourth step of Industrial Revolution, the most studies debate technical aspects, but do not pay attention to managerial approaches and organizational culture, which are a major influencing factor of success for Industry 4.0 (Mohelska, 2018). This obstacle can be defined as one key complication in transforming a business (Mohelska, 2018). Next to this, an insufficient skill-set and less knowledge for implementation of Industry 4.0 technologies (Lewis, 2017). Another obstacle is the fear of workers of losing their jobs by introducing automatization and robotization (Lewis, 2017). In addition, security concerns, reliability issues as well as fear of IoT glitches lead to misunderstandings and an outstanding transformation in organizations (Lewis, 2017).

2.2. Definition of Digitalization

The term digitalization is used inflationary and in many different interpretations like the following examples: digital transformation, digital change, digital business processes, digital society or digital revolution. In the literature, the original term digitalization describes the transfer of analogue information into digital data and the effect, which is triggered by it. Digitalization helps to transform all the information that arrives in organizations into a uniform digital format, to process them electronically in the processes with the electronic documents and thus to increase the efficiency, flexibility, save process cost and run a faster time to market (Köhler-Schute, 2016).

Regarding the business transformation digitalization describes the implementation of digital technologies in society, business and the related changes in the connectivity of organizations and individuals. Urbach (2018) describes the faster time to market as well as commoditization of technology as key driver of digitalization (Urbach, 2018). Furthermore, digital technology includes on the one hand site established technologies like SMAC (social media, mobile computing, advanced analytics, cloud

computing) (Paschek, 2017) and on the other hand emerging technologies like Artificial Intelligence, Blockchain or IoT (Gartner, 2017).

Time and location independent availability of data are the advantages of digitalization. This enables an unprecedented speed of change and level of connectedness over the whole supply chain which enclose the customer dominant role (Urbach, 2018). Forbes describes the digitalization as the driving force for Industry 4.0 by several trends like connected consumers, empowered employees, optimized production and transformed products (Newman, 2018). These underline the connection of digitalization with Industry 4.0.

2.3. Characterization of Industry 5.0

The analysis of Industry 5.0 shows a lot of uncertainty about what it will bring and how it will disrupt business in detail, but it's going to break down barriers between the real world and the virtual one (Scanlon, 2018). Østergaard (2018), the Universal Robots Chief Technology Officer, points out that the next step of Industrial Revolution will be necessary according to the consumers' high-demand of individualization in the products they will buy. He underpinned that statement by an article from Bloomberg where a car manufacturer from Germany already give more space to humans within the production factories by noting that customization is an important factor with modern consumers (Atwell, 2017).

Therefore, the Industry 5.0 will be increased collaboration between humans and smart systems like robots especially in the manufactory. With this step, machines take over all monotonous, repetitive tasks while humans take creative side to take on more responsibility and increased supervision of systems to elevate the quality of production across the board. However, this idea is not new, as Accenture's survey with 512 manufacturing execs world wide showed. Because 85% of the participants foresee a collaborative production line between humans and robots in their plants by 2020 (Atwell, 2017).

Furthermore, Østergaard (2018) mentioned that the products with distinctive mark of human care and craftsmanship are these where the customers will pay most for like designer items of every kind, fine watches, craft beers as well as black salt from Iceland hand dyed with local coal. This demand of human touch will be raising in the future much more because consumers seek to express their individuality through the products they buy. This outlines a new kind of personalization, feeling of luxury society where the business must deal with (Østergaard, 2018).

In addition, the European Economic and Social Committee (EESC) describes Industry 5.0 as "...focused on combining human beings' creativity and craftsmanship with the speed, productivity and consistency of robots" (EESC, 2018).

Another vision describes the Industry 5.0 as faster, more scalable and more people concern than the previous ones through the kind of technology at their disposal (Rundle, 2017). This will happen by the push toward more advanced human-machine interfaces by an improved integration, better automation of robots paired with the power and creativity of human brains (Shelzer, 2017). This will lead to improved productivity.

The mentioned efficient synergy between humans and technology will affect the economy, ecology, and the social world, too (Shelzer, 2017). Furthermore, these influences are accompanying by a waste prevention perspective applied in industrial upcycling (Rada, 2018):

- a) Physical waste - general trash and trash of production lines and logistics;
- b) Urban waste - not necessarily needed Greenfields, empty spaces, inadequate infrastructure;
- c) Process waste – overproduction, empty trucks on the roads, overstock;
- d) Social waste - People willing to work but having no opportunity and people who are not willing.

The four types waste prevention perspectives show major impacts on economy and environment in the field of reduced wasted materials and resources as manufacturers are concerned on reducing material expenses and minimizing the social impact of the industrial processes (Shelzer, 2017).

Artificial gene synthesis (artificial DNA or DNA printing from synthetic biology filed), new raw materials or sustainable uses of resources are further dimension of Industry 5.0 characterization with potential impacts on business. These fields put the human factor to the centre, too in relationship with nature and physical integrity (Sachsenmeier, 2016).

2.4. Evaluation of the scientific status

The analysis of references has shown a good fundamental basis of re-defining Industry 4.0 and characterized the next fifth Industrial Revolution; only a few definitions and characterizations, mainly in the manufactory industry are available. In summary all visionaries, thinkers or future observers see the main characteristic of Industry 5.0 in the human touch back to the centre of decision making by the collaboration between humans and machines. Furthermore, Industry 5.0 will lead to:

- The evolution of a global society (Pearce, 2017);
- Waste reduction and waste prevention activities (Shelzer, 2017; Rada, 2018);
- Strong bioengineering and biotechnology influence business and society (Sachsenmeier, 2016).

The most important benefits of the Industry 5.0 are (as promised for Industry 4.0): increasing productivity, agility and profitability or improved adaptability, change-readiness, a responsive working environment (Kospanos, 2017) and overall cost reduction (Rada, 2018). Nevertheless, there are two more core benefits to be consider (Rada, 2018):

1. The evolving global society which will take an important part of the ongoing digital transformation in business as well spare time next to supporting technology without fear of losing the job by the automation about new business models as well as the generation of open minded and well skilled forward-thinking employees;
2. Waste prevention within the four named types to generate sustainability, save costs, protect the environment and get better in touch with the society.

3. THE RESEARCH METHODOLOGY

To evaluate the business impact for the Industry 5.0, the status quo of implementation and execution of Industry 4.0 and the digitalization was analysed using the interview method. The raised data and information set the starting point for the assessment and benchmark on behalf of several attributes like company size by the number of employees, industry sector, customer segments, products, business models and so on.

With these insights, the business situation analysis was carried out to investigate existing weaknesses and threats parameter by the implementation and execution in comparison to other companies. Further on the outlook into the future like Industry 5.0 is part of the interview to analyse the visioning and scoping of the companies to derive recommended actions and opportunities for the business dynamics.

The interview started with the introduction of the topic and the objective. After a short socio-demographic part about the respondent like the management level or part of a decision instance, general company information like the amount of employee or business model and customer groups were asked too. The core of the interview dealt with questions about the knowledge, implementation, utilization and execution of Industry 4.0 technology as well as generated benefits and hurdles. Furthermore, the questions focussed towards the outlook of the companies for the next years and their vision by future transformations and the Industry 5.0. The used types of questions were open questions with grouping examples to get the opportunity of more information's within the answer of the interviewed person.

Part of the interview were small, medium and large enterprises from Europe; 450 company representatives were asked for an interview, 85 agreed to. The target persons were mainly Chief Information Officers (CIO), Chief Technology Officers (CTO), Chief Execution Officer (CEO), Chief Digital Officer (CDO), and Chief Automation Officer (CAO). For large enterprises, the communication or middle management representative supported for the interview.

4. RESEARCH RESULTS

In the following, the results of the interviews are presented and evaluated; 85 company representatives of eight different industries within the business-to-business and business to customer segment were interviewed - shown in the following table 2. These can be classified into 34 small (<100 employees) 42 medium sized (100-199 employees) and nine large enterprises (>200 employees).

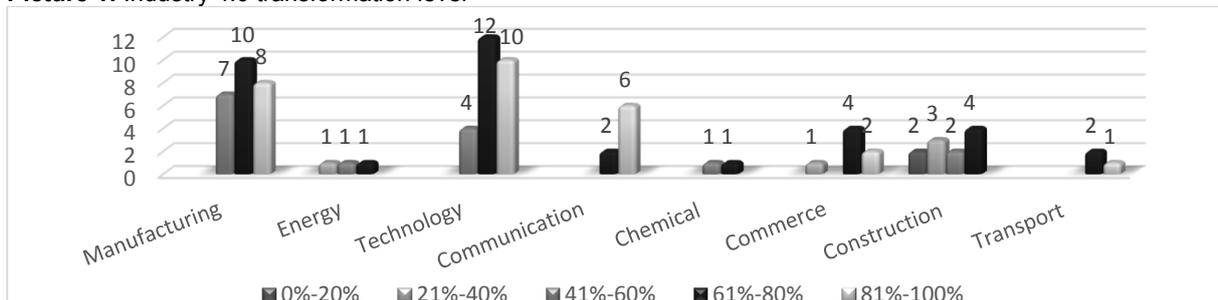
Table 2: Companies per industry classification

Industry	Number	Industry	Number
Manufacturing	25	Chemical	2
Energy	3	Commerce	7
Technology	26	Construction	11
Telecommunication	8	Transport / Logistics	3

Source: own presentation

The following Figure 1 shows the analysed transformation level of Industry 4.0. It is obvious that the manufacturing, technology, communication and transport industry are most transformed; the telecommunication industry leads the transformation level closely followed by the transportation industry. The technology industry is on the third place followed by the manufacturing and commerce sector on the same level. Critical situation can be seen at the three last sectors, mainly the construction sector is far behind of the transformation into the age of digitalization and Industry 4.0 (nearly 25%, just started the transformation now by keeping in mind that Industry 4.0 is named first in 2011). The energy industry takes place seven in the ranking of transformation level behind the chemical industry.

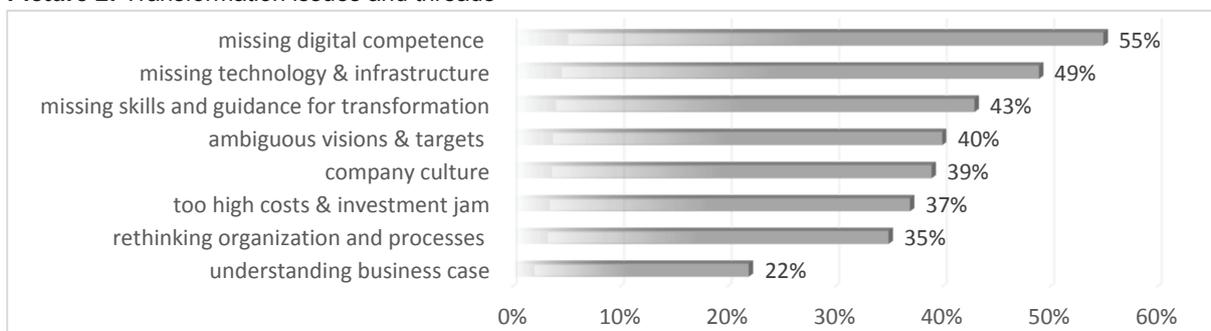
Picture 1: Industry 4.0 transformation level



Source: own presentation

This assessment confirms the assumption that the digital transformation into Industry 4.0 is still running and just at the beginning in some industries. The main reasons for these phenomena are depicted in Picture 2.

Picture 2: Transformation issues and threads



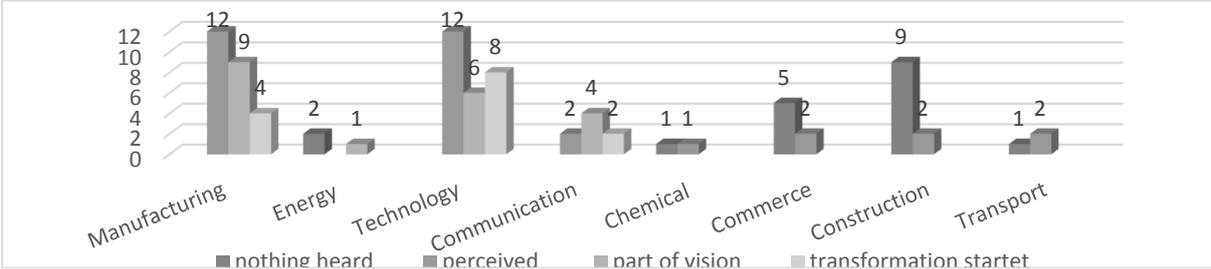
Source: own presentation

The most companies are struggling with the missing digital competence. Something new - with fast-developed technology have to implement in the company but the management did not understand it. At this stage, good skilled employees and an open culture could conquer the lack of knowledge of the management. Furthermore, the company culture represents one issue, if there are no workers who are forward thinkers by dealing with something new like technology or frameworks. The second largest issue, with 49% can be found in the missing infrastructure provided by the cities, countries as well as too long waiting periods for products and services. Nevertheless, missing transformation and technology skills associated with too high cost and an investment jam form together an issue of transformation for the business. Not to forget, clear business visions as well as not formulated business targets with 40 % lead to an unclear roadmap and hinder the transformation.

These issues and threats have to be avoided for future transformations by a clear business visions and a fundamental outlook with innovation by an open company culture and sustainable hiring process of skilled people. Derived by a clear strategy investment jams can be avoided, too. Less impact business

has on technological infrastructure like networks and so on, in this area the companies have to apply pressure to the government and countries. From this point the outlook to the fifth industrial transformation were analysed. The results can be seen in Picture 3.

Picture 3: Industry 5.0 readiness



Source: own presentation

The picture shows the good outlook of the technology, manufacturing and communication industry with started transformations to Industry 5.0. In contrast, the interviewed companies of the construction industry as well as commerce, chemical and transport industry have mostly nothing heard about Industry 5.0 or just perceived it. All interviewed companies of the manufacturing, technology and communication industry perceived the Industry 5.0 and the most of them already put it into their visions und strategy's like can be seen in Picture 3.

The analysis show that some industries have more impact on the industrial transformation stages and so they generate their outlook and think ahead. Other industries, like the chemical or the energy sector, seem to have other important priorities and did not recognize the next Industrial Revolution. In addition, there are no patterns to recognize regarding the size of companies.

It is alarming that not all companies and industries look ahead and are still at the beginning of Industry 4.0 and digital technologies. These technologies will build up the basic for the fifth Industrial Revolution. It can be conducted that the next revolution will have an impact on the business and management as well regarding the collaboration between humans and smart technologies. In this topic it is important to keep in mind, that the definition of Industrial Revolution contains the use of sophisticated machinery to make the work of humans easier and faster (Rundle, 2017). Therefore, the companies and industries should look ahead, participate from the ongoing enhancements (like the manufacturing and technology industries within this research), and follow the trends and developments for Industry 5.0.

5. CONCLUSION

Technology advancements as well as revolutions are occurring faster and faster, which is why a business needs clear visions for the company developments as well a clear mind-set for the transformation. The company must be able to support the unknown and to take steps to future-proof the business. Major businesses in Europe are still working on the implementation of Industry 4.0; they did not recognize yet, the next Industrial Revolution to Industry 5.0, as the presented research underlines. The business has to recognize that success will come to those who are more innovative as well as responsive to market changes to deliver quality products and service on customer requests. Industry 5.0 accentuates clear change from mass automation to the process of enhancing capabilities of human workers for achieving personalisation by product customization to the next level. Thereby future questions have to be answered like: what skills to be need and developed, what kind of rules between human and machine interaction have to defined and which impact may have AI and what conflicts may arise between humans and AI?

Stuart Scanlon, managing director for epic ERP says: “People have different opinions when it comes to predicting the start of Industry 5.0 but, if you consider the speed of transformation in technology, I believe it’s going to be here for sooner than most people think. The future is happening now and we need to rise to the challenges if we are to thrive in the next revolution” (Scanlon, 2018).

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