The Impact of Industry 4.0 on the Labor Market

Zofia Grodek-Szostak
Department of Economics and Enterprise Organization
College of Management Sciences and Quality, Cracow University of Economics
Kraków, Poland
grodekz@uek.krakow.pl

Luis Ochoa Siguencia
Faculty of Sport and Tourism Management
The Jerzy Kukuczka Academy of Physical Education
Katowice, Poland
l.ochoa@awf.katowice.pl

Anna Szelag-Sikora
Faculty of Production and Power Engineering,
University of Agriculture in Krakow
Kraków, Poland
Anna.Szelag-Sikora@ur.krakow.pl

Gilberto Marzano
Rezekne Academy of Technologies,
Rezekne, Latvia
gilberto.marzano@rta.lv

***Abstract* - The Fourth Industrial Revolution has changed the nature of many jobs and created new ones. It has also opened new opportunities for employees with qualifications and skills related to new technologies, and created opportunities to redefine business costs and expenses. An investment in technology can mean success in the future; by leveraging financial resources to carry out a large-scale technological transformation, entrepreneurs can expect an increase in their business' efficiency. For employees, automation and robotization is an opportunity for more efficient and friendlier workplaces, and for employers, greater profits. The jobs of the future require both technological savvy and human skills. This article aims to highlight potential opportunities and issues for both employees and employers in the conditions of Industry 4.0.**

Keywords - Industry 4.0, RPA, labour market, competences

I. Introduction

The Fourth Industrial Revolution is the term used to describe changes in the planning, production, operation and maintenance of production systems. In source literature, the name Industry 4.0 [1-5] is also used interchangeably.

Industry 4.0, more specifically, is a term introduced by the German government at the Hannover Fair in 2011 in relation to an initiative it brought forward to support German industry to address future challenges [18]. It refers to the 4th industrial revolution in which disruptive digital technologies, such as the Internet of Things (IoT), robotics, virtual reality (VR), and artificial intelligence (AI), are having an impact on industrial production.

The First Industrial Revolution was based on leveraging water and steam energy to mechanize production. During the Second Revolution, mass production was introduced thanks to electricity. In the Third - Digital - Revolution, electronics and information technologies have been used since 1950s to automate production. The current, Fourth Industrial Revolution draws from the Third and is characterized by a fusion of technologies, blurring the lines between the physical, digital and biological. According to PwC [6], the Fourth Industrial Revolution can take place in three stages: (1) The algorithm wave - an ongoing stage, will include the early 2020s. It focuses on the automation of simple computational tasks and the analysis of structured data in areas such as finance, information and communication. (2) The augmentation wave - this phase is also already underway, but will cover the market as a whole only in the late 2020's. It focuses on automating repetitive tasks such as form filling, communicating, exchanging information, as well as statistical analysis of unstructured data in partially controlled environments such as unmanned aerial vehicles and robots. (3) The autonomy wave - will start in the 2030s and will be noticeable in the automation of manual work and activities performed by employees. In addition, it is anticipated that the actions in dynamic, real-life situations, which require reaction and problem solving, e.g. in production and transport, will be replaced by machines and robots (autonomous vehicles). Industry 4.0 has changed the nature of many jobs and created new ones. The aim of the article is to diagnose potential opportunities for both employees and employers in the conditions of Industry 4.0. A review of the available subject literature was used as a research tool.

II. Industry 4.0 vs. Changes in the Labor Market

During the first stage of the Fourth Industrial Revolution (the algorithm stage), the labour market will not change much. Although automation and robotization are commonly perceived as a threat to jobs, in fact they create new tasks related to the operation of machines and robots. The resources of these devices do not fully duplicate human skills anyway. In early 2020s, a relatively low level of reduction of existing jobs is expected, approx. 3%. In the later periods, however, the demand for labour will increase significantly, although the scope of technological innovation in the entire economy has already lead to increasing automatization. By the mid-2030s, up to 30% of jobs could be automated (augmentation and autonomy waves), but an increase in the number of new professions is also expected [6]. As reported by the Massachusetts Institute of Technology [7], the growing role of automation and artificial intelligence (AI) creates new opportunities and threats to work in crisis situations such as the coronavirus pandemic. For example, the advantage of using technology is that many employees can work remotely. On the other hand, many basic professions such as driver and waiter can be completely replaced by machines and software.

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The structure of industry determines the situation on the labour market and affects the course of the automation process [6].

According to PwC [7], in the first stage of the Fourth Industrial Revolution in Poland, the number of jobs will be reduced by 2%. The next stage will bring a fairly large increase in automation (16% of tasks will be performed by machines), which will lead to a 18% reduction of jobs. Finally, in the 2030s (the automation wave), it is expected that the changes will include 33% of the labour market. The potential risks associated with automation vary greatly from industry to industry. It is estimated that transport, warehousing and manufacturing are the sectors that will potentially be automated the fastest. By 2030, reductions of approx. 52% and 45%, respectively, are forecast. Health and education are the sectors that are not threatened by any major change; in the sectors, automation will account for approx. 20% and 8% of jobs, respectively [7]. The World Economic Forum (WEF) [8] predicts that 133 million new jobs will be created in the years 2018-2022. If the current upward trends continue, they will provide 1.7 million new jobs in 2020, and by 2022, this number will increase by 51%, i.e. to 2.4 million. Another 2 million jobs are to be created in later years. As WEF points out [10], human labour cannot be fully replaced by robots or artificial intelligence, however automation and robotization have a significant impact on the labour market. They can create new opportunities for employees, new jobs, at the same time eliminating difficult and adverse work environment. Approx. 61% of workers believe that technological change and globalization will impact their current employment.

III. Consequences of Industry 4.0 for employees

Industry 4.0 has changed the nature of many jobs and created new ones. It has also opened new opportunities for employees with qualifications and skills related to new technologies. The new positions that will increasingly appear on the labour market include [8]:

- artificial intelligence specialists,
- medical transcriptionists, data scientists,
- customer success specialists,
- full stack engineers,
- social media assistants,
- growth hackers,
- landfill biogas generation-system technicians,
- wind turbine service technicians,
- green marketers.

The impact of automation and robotization will be the least significant in terms of care provider services and environmental professions. In the next three years, more jobs are expected in the emerging occupations, or an increase in the demand for workers. Growth will be observable in the care provider sector (37%), sales, marketing and content creation (17%), data analytics and artificial intelligence (16%), engineering and cloud computing (12%), as well as the culture sector (8%). The current forecasts for professions related to environmental protection and climate change remain low: only 117,200 new jobs (1.9%) are expected to appear worldwide in the years 2020-2022.

Technology, including artificial intelligence, changes the labour market, and thus the expected set of employee skills. The demand for certain professional profiles is changing. More and more often employers seek for employees with know-how and technological skills. STEM (science, technology, engineering and mathematics) skills are becoming necessary [7]. The new employment paradigm also values social and personal skills (the value of which cannot be replaced by technological processes) over specific expertise. Critical thinking, analytical skills, emotional intelligence or cognitive flexibility may become essential in a new reality.

The World Economic Forum [11] predicts that by 2022 approx. 54% of employees will have to retrain or upgrade their qualifications. Specialist skills, including analytical thinking and innovativeness, as well as active and purposeful learning will continue to gain importance. Skills such as software design and development are already growing in importance. On the other hand, proficiency in new technologies is not enough because "human" competences, such as creativity, originality and initiative, critical thinking, persuasion, negotiation skills, attention to detail, resilience, flexibility and comprehensive problem solving, are also important. Emotional intelligence, leadership, influence, and social networking are other important qualities desired in employees. Employers indicate employee training as one of their priorities. Approx. 50% of them want their current staff to stay in their workplaces and use new technologies in their work, which means that they are not planning layoffs. In addition, 41% want to allocate funds to retraining employees, and 33% said they would only finance training for those employees who need retraining and upgrading their qualifications the most.

A recent research carried out in Poland analyzing job offers shows that individual, social and managerial competencies play the crucial role on the labor market. [27]

Industry 4.0 means more than just job fluctuations. Technological changes create new opportunities for both employees and employers to establish and determine the rules of an employment relationship. Alternative, IT-based forms of employment (e.g., smart working) are becoming more and more common.

During the COVID-19 lockdown, smart working has been experimented to a massive and unprecedented degree.

Worldwide, most people involved in smart working evaluated their experience positively [28].

Smart working takes place at the most effective locations and at the most effective times, respecting the needs of the task, the customer, the individual, and the team. [12]. It also allow the integration of people with mobility disabilities. [29]

IV. Consequences of Industry 4.0 for employers

Industry 4.0 offers opportunities to redefine business costs. An investment in technology can mean success in the future; by leveraging financial resources to carry out a large-scale technological transformation, entrepreneurs can expect an increase in their business' efficiency. Ultimately, new technologies will allow entrepreneurs to cut costs and increase efficiency as they are more efficient. PwC estimates that automation can accelerate the productivity of the global economy from 0.8 to 1.4% of global GDP annually. It is indicated that the productivity growth, possible thanks to automation, will ensure further development for highly developed countries and may constitute an additional stimulus for rapidly developing countries [7]. The implementation of automation may bring benefits in the form of labour cost savings, or a significant reduction in the costs of some activities (e.g. due to the elimination of human errors). Automation can also increase the scale and speed of operations. For example, Nissan has cut the time it takes to bring prototypes to production by half by automating the

system, and BMW has reduced machine downtime by 30-40% by introducing computer-assisted automated maintenance of these machines [13]. Also, research by Deloitte [14] shows that automation and the adoption of cognitive technologies can lead to a reduction in production costs, and at the same time enable dynamic business growth.

The costs related to employee training are only one of the elements for which enterprises must allocate funds. Enterprises must also invest in costly adaptations and adjustments to new technologies [15]. Before automation and robotization can bring benefits to the enterprise, entrepreneurs must implement many changes in their business - from technology to human resources. First, they need to change their companies' existing production systems and models. Please note that the implemented technological innovations should be integrated with the entire enterprise, i.e. operating not only on production lines, but also in the entire production site. Additionally, a better approach is to use production systems, production cells, lines and factories that are easy to modify and adapt. It is indicated that developing, using, maintenance and product support will then be much more efficient [16]. An important change is the adjustment of staff skills to the requirements of automated processes. This will include re-configuring the training programs to help workers acquire both the digital and soft skills required in the new era, and replacing existing processes and systems with those that are more suited to accommodate new technologies, as well as temporary support for those who will lose to the impact of automation. Employers should follow emerging innovations and research results that will help implement the automation and robotization process and develop a policy that will protect customer data and help employees adapt to new requirements these technologies pose (e.g. by providing training) [7,17].

Three main categories of core managerial competencies for Industry 4.0 have been identified [26]. They include:

- Technical competencies, such as computing mastery, statistical knowledge, key performance indicators' proficiency.
- Managerial competencies, such as general problem solving and decision making, conflict solving, negotiation ability,
- Social competencies. Such as individual's social values, ability to transfer knowledge, leadership skills, ability to work in a team, interpersonal communication.

V. TEACHING INDISTRY 4.0

Organizing courses for teaching industry 4.0 presents several issues [22].

The concept of Industry 4.0 still lacks a shared definition [23]. It can be applied to the digitalization at any step of the value chain of an enterprise. A value chain is a business model that describes the full range of activities needed to create a product or service.

For companies that produce goods, a value chain comprises the steps that involve bringing a product from conception to distribution, and everything in between, such as the procuring of raw materials, manufacturing functions, and marketing activities.

As a consequence, Industry 4.0 encompasses the full range of activities of an enterprise necessary to create a product or service. The use of the term primarily focuses on how production shop floors currently operate, but also includes procurement and supply management [24].

The different levels of specialization make it impossible to deal with all the variety of topics related to Industry 4.0 appropriately. The didactic materials and learning programs available on the internet confirm the difficulty of creating a complete learning program that encompasses all the aspects that are connected to Industry 4.0.

One can find, for example, that an Industry 4.0 educational module should make students familiar with cloud computing and Robotic Process Automation. However, they should also understand key technologies related to IoT and industrial applications of Data Analytics. Nevertheless, experience teaches us that a course in Data Analytics requires many hours of study. The same is true for Cyber Security and Cyber-Systems from the Industrial systems perspective. Problems also arise with the use of Machine Learning and Artificial Intelligence. Finally, it is not easy teaching AI, since it covers a broad scope where there are many specializations, such as computer vision, natural language processing, machine learning, game playing, expert systems, decision support systems, speech recognition, intelligent information retrieval, robotics, etc. Each of these specializations require specific knowledge.

One has to consider that students participating in the module can have different backgrounds in computer science, and varying levels of familiarity with computer programming. It should be therefore necessary to spend some time introducing notions propaedeutic to the basic concept of AI. Furthermore, at the moment, free Industry 4.0 platforms are not available, although there are some webinars available that present good examples.

VI. ATTITUDES OF POLISH MILLENIALS TOWARDS INDUSTRY 4.0

In a survey [25], Deloitte studied nearly 13 500 people from 42 countries, including 300 respondents from Poland. The respondents were born between January 1983 and December 1994. In order to provide a more comprehensive generational perspective, the survey was expanded to include a more diverse group of participants (globally), including 31% of part-time employees and 34% of people with high school education only.

The responses of young adults from Poland differ from those of their global counterparts regarding the concerns of the Generation Y (Millenials). The Polish Millennials are most concerned about terrorism (as much as 34%), as compared to 19% of respondents globally. Political instability, wars and conflicts rank second – 29% (18% globally), followed by climate change and environmental protection – 27%, which is in fact no. 1 on the global list of concerns (29%).

However, against the backdrop of global results, young Poles turn out to be not so pessimistic in their perception of own opportunities in the era of Industry 4.0. Only 28% of respondents from Poland, working full-time or part-time, and 27% of those unemployed, believe that Industry 4.0 will make it more difficult for them to find or change jobs, while globally 46% and 45% of those surveyed responded accordingly.

Poles are more concerned about their skills. While globally 81% of the employed and 65% of the unemployed believe they have the skills required in a work environment shaped by Industry 4.0, in Poland 79% and 62% of the respondents

answered this way, respectively. Certainly, Industry 4.0 has impacted the labour market as digital technologies changed many jobs over the last ten years. Millennials learned to use technologies that did not even exist when they entered the labour market. So we can say that continuing education is not so much a prerequisite for promotion as for survival in the workplace. At the same time, the demand for education is growing, because every job is subject to change.

VII. Industry 4.0 as a Challenge for Public Administration

Industry 4.0 and the accompanying economic and social changes also force decision-makers and public institutions to take action to create new support tools to adapt public policies to the challenges of today's world and to handle the flow of public resources properly. The strategic vision of governments and their ability to promote innovation are key elements in the economic development process.

In this context, the so-called Business Support Institutions (BSI) play an extremely important role. An example is the activity of the Małopolska Regional Development Agency (Małopolska Agencja Rozwoju Regionalnego S.A., MARR). MARR is a company with a majority share of the Małopolska Province. Its main objective is to support the economic development of the region. MARR's leading clients are potential and existing entrepreneurs. Apart from the basic target group, MARR also supports local government units, non-governmental organizations (NGOs), housing cooperatives and homeowner associations. The objectives and functions of MARR are set out in its statute and in Article 13(2) of the Act on Local Government, which defines regional development agencies. Among the objectives listed in the statutes there are, among others:

- popularization of entrepreneurship and civic activity in the region;
- providing financial assistance for economic and social projects;
- cooperation with local government units in support of social and economic initiatives;
- participation in European programs;
- taking initiatives to create new jobs.

Traditionally, MARR is perceived as an institution that executes European projects, distributes grants and provides subsidies, loans and guarantees. However, the dynamic changes in the labour market, rapid technological progress and new challenges posed by Industry 4.0 are the stimulus to remodel the offer and create support tools appropriate to current needs.

The main challenges facing the economy in the Małopolskie Province include:

- Insufficient level of R&D investment; despite the positive signals, i.e. an increase in the number of organizations conducting R&D operations, changes in the structure of outlays (over 50% of R&D funds currently comes from business) and an increasing percentage of R&D staff in the total number of employees, Poland is still classified as a moderate innovator.
- Reluctance towards foreign expansion; due to the relatively large market such as Poland, many entrepreneurs see no need to look for new target markets. The low product processing level or the marginal participation of Polish companies in international tenders is still a problem.
- Problems with qualified staff (education structure inadequate to the needs, reluctance of business to engage in the process of education); this is one of the most pressing problems reported by companies. Lack of staff creates a pay pressure, which, on the one hand, is a positive signal for employees, but on the other hand, indicates a gradual loss of the competitive advantage provided by low labour costs.
- The shortcomings of the cluster policy.
- Dependence on public funds.

To answer the above challenges, MARR's offer includes:

- Projects related to the improvement of employee qualifications. Development and consulting vouchers, i.e. co-financing of all types of professional training, courses or post-graduate studies, are the answer to the labour market's shortcomings in terms of availability of qualified employees and the need to increase the scale of the so-called continuous education.
- HR consulting projects; MARR plans to continue and expand the programs to help develop personnel management strategies. First of all, it is about support of cooperation with vocational schools and attracting young workers, but also about retaining experienced workers in a retiring age in the labour market through consulting and support for improvement of working conditions.
- European programs H2020 and Interreg dedicated to implementing Industry 4.0 solutions and to creating a platform for the exchange of experience or support for entrepreneurs wishing to participate in European tenders.

Reaching out with MARR's offer and support to smaller centers throughout the Małopolskie Province, strengthening cooperation with partners in the region (territorial and economic local government, Business Support Institutions) are also an important subject for further analysis. The economic reality is changing and the goal of public decision-makers is to understand the needs and create appropriate solutions for them, all in order to develop entrepreneurship.

VIII. Conclusions

Industry 4.0 represents both potential opportunities and threats for employers, employees, and entire economies.

Despite the many challenges they face, well-implemented automation and robotization may induce economic growth resulting from increased labour productivity. Dynamic economies will create new jobs and generate funds that will allow the qualifications and skills of the workforce to be matched to the needs of the market. For employees, automation and robotization are opportunities for more efficient and friendlier workplaces, and for employers, greater profits. The jobs of the future require both technological savvy and human skills. Only few professions will be fully

automated (approx. 5%), but employees' tasks will change. Experts predicted that in the next future, over one-third of skills (35%) that are considered important in today's workforce will change [19-20]. Therefore it is necessary to provide them with educational opportunities, including creating an appropriate educational offer and training or retraining opportunities.

Nevertheless, teaching industry 4.0 is challenging. Real world is changing fast and learners should be trained accordingly. For this purpose, the involvement of stakeholders is essential and industry partners should support the educational institution's continuous professional development programs offering internship opportunities.

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