QUALITATIVE RESEARCH IN THE DEVELOPMENT AND IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE IN ECONOMY

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Abstract

We are currently feeling the effects of the Fourth Industrial Revolution (4IR) which has undergone considerable improvements as a result of the advancement of artificial intelligence and its related technologies, as well as other disruptive technologies components of Industry 4.0. The impact that artificial intelligence has had on humanity is spectacular, given that it is a much more present element in our lives than we would have thought. From translation software to virtual assistants (Siri, Cortana, etc.) artificial intelligence makes its presence felt and improves the way we live, communicate and work. Robotics is the most extensive field related to artificial intelligence and deals with the study and development of robots. They have great potential in improving the quality of our lives both at home and at work, and robots that work with human colleagues will help create new jobs and improve existing ones, giving people more time to focus on other activities. Collaboration in the process of work between man and robot will lead to the mutual completion of skills on both sides.

In this paper I will address topics such as artificial intelligence, automation, robotics, the impact of robots on jobs and as a practical part of the paper I will conduct a qualitative research on companies' perceptions of the adoption of artificial intelligence technologies.

Keywords: *Industry 4.0, artificial intelligence, robotics, automation, qualitative research*.

1. Introduction

The concepts of digital economy and technology have been called into question by the movement towards cutting-edge technologies in information, telecommunication and innovation that takes place in the 21st century (Tsyganov, 2016).

The concept of digital economy represents a digital technologies-based economy that mainly utilizes hardware, software, applications and telecommunications in the information technology in all of the economy's domains, as well as the organizations' internal and externa; activities (Domazet, 2017); (Sutherland, 2018). Also, digital economy makes reference to an economy that is based on creativity, market knowledge and a society based on innovation. Digital economy embodies a global level paradigm of the information society that is focused on technological platforms like the Internet, mobile devices being used for the production, distribution and goods or services exchange and consumption in global markets (Tsyganov, 2016); (Balcerzak, 2017).

The European Union Member States are in a conversion to a digital economy. There is a substantial difference between different countries in terms of development, denoted by the deficiency of harmonious relationship between the digital technology advancement level and the time required for their introduction in the business and industry spheres (Galichkina, 2014).

Artificial intelligence (AI) is a field of computer science that designates the development of intelligent machines. Artificial intelligence is specific to both machines (robots) and computers. Some of the activities for which artificial intelligence computers are dedicated include: learning, voice recognition, planning and problem solving.

It is well known that there is no widely accepted definition of artificial intelligence (AI) (Kirsh, 1991); (Allen, 1998); (Hearst, 2000); (Brachman, 2006); (Nilsson, 2009); (Bhatnagar, et al., 2008); (Monett, 2018), consequently, the term "artificial intelligence" being used with many different connotations, in the disruptive technologies field as well as apart from it.

Machine learning represents a fundamental part of artificial intelligence which requires the capacity of recognizing patterns in the appearance of entries concerning unassisted learning (unsupervised), while assisted learning involves numerical regression and classification.

Knowledge engineering is another cornerstone of artificial intelligence research. In order for machines to act in a similar way to humans, they must have pantagruelic information about the surrounding world.

Artificial intelligence can be grouped into four categories, as follows: reactive machines, limited memory, theory of mind and self-awareness.

The first type of artificial intelligence is a limited program of action that has no memory and cannot use its past experiences to change future ones. For example, Deep Blue, IBM's chess program that has limited objectives, analyzes the movements of its competitor and chooses the most advantageous movement.

The second type of artificial intelligence, limited memory can use past experiences to influence future selections. For example, self-driving cars have a section of functions that make decisions based on previous experience. Knowledge changes the actions that will

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take place in the near future, for example an unforeseen event such as a car bypassing an obstacle on the road.

The third type of artificial intelligence, theory of mind refers to other machines that have personal assumptions, aspirations and goals that influence their decisions. This type of artificial intelligence has not yet been developed.

The fourth type of artificial intelligence, self-awareness embodies artificial intelligence systems that possess the ability to memorize. Self-awareness machines can discern their current state and use the information to deduce the feelings of others. However, this type of artificial intelligence has not yet been developed.

Artificial intelligence (AI) tools and techniques' role in business and the global economy represent a topic of interest, of no surprise, given the recent advances and innovations in artificial intelligence, as well as the products and services becoming more and more ubiquitous that are already widely used. All this has led to speculation that artificial intelligence could introduce radical changes in human life and employment in particular.

2. The impact of artificial intelligence on economy

There is no generally accepted, precise and unambiguous definition of artificial intelligence. This is a generic notion for a large number of subfields, such as: cognitive computing (algorithms capable of reasoning and understanding at a higher level, similar to the human mind), machine learning (algorithms that learn to perform tasks), enhanced intelligence (cooperation between man and machine), AI robotics (artificial intelligence integrated in robots). However, the main objective of artificial intelligence research and development is to automate intelligent behavior such as reasoning, information gathering, planning, learning, communication, and manipulation.

Artificial intelligence is divided into two categories: restricted and general, the first being able to perform specific tasks, and the other any task that would require human thinking.

Recently, there has been an impressive progress in the restricted field of artificial intelligence, mainly due to the large amount of data available, the increase in computer processing power and the progress of machine learning (ML). Machine learning incorporates self-teaching algorithms that learn to perform specific tasks. The basis of this method is the processing of "data training", with which the algorithm learns to recognize patterns.

Deep learning (DL) is an embodiment of machine learning that uses neural networks based to some extent on the human brain and that learns through practice and feedback.

Artificial intelligence will have an enlarging impact on the global economy as the adoption of new technologies increases.

Research and development of artificial intelligence has concentrated for an extended period of time on the elements of reasoning, information gathering, communication and perception (visual, auditory and sensory). This has resulted in a large number of uses of artificial intelligence: virtual assistants, speech recognition, translation programs, text-to-speech programs, and so on.

Artificial intelligence is seen as an engine for economic growth and productivity, as it can increase production efficiency and analyze large amounts of data, thus greatly enhancing the decision-making process.

Artificial intelligence can also lead to the emergence of new services and products, as well as industries and markets, thus stimulating consumer demand and generating new revenue streams.

However, artificial intelligence can also have an extremely disruptive effect on the society and economy. Some speculate that AI could lead to the genesis of super-firms - resource and knowledge centers that could have detrimental effects on the expansive economy.

Artificial intelligence could also expand the gap between developed and developing countries and increase the demand for workers with certain skills, while making other workers redundant. This trend could have significant results for the labor market.

Despite the important advances that have arisen in the artificial intelligence (AI) and robotics' field, artificial agents still do not have the autonomy and versatility to interact properly with realistic environments. This requires agents to face unknown situations at the time of design, to discover multiple goals / tasks autonomously and to be endowed with learning processes capable of solving several tasks incrementally and online.

2.1. Ethics of artificial intelligence

Although artificial intelligence tools present a new range of functionality for companies, the implementation of artificial intelligence casts doubt on ethical issues. Because of the deep learning algorithms that underlie many of the most advanced artificial intelligence tools, they cannot be smarter than the data they receive in training. Since a person decides what data should be used to train an AI-based program, the potential for human prejudice is intrinsic and needs to be meticulously monitored.

The most important human skills that an AI system (a computer or a robot controlled by a computer) must manifest are: reasoning, understanding a given situation, generalization starting from a particular case and learning from previous experiences.

A vital objective in the ethical artificial intelligence development is consisted by the encouraging of general acceptance and trust in AI tools. Concerns regarding the business drivers for capitalizing AI have been expressed in the academic literature (Baldini G, 2018); (Bauer WA, 2019), predominantly from the most opportune strategies for the development of artificial intelligence (bottom-up approaches and to a considerable degree, hybrid approaches). Apart from that, the media has a notable impact on the process in which issues of interest, regardless of the field, are presented to the public (Racine E, 2005); (Society, 2018); (Chuan C-H, 2019). Consequently, the public opinion in what concerns the artificial intelligence acceptance will most probably be affected by media. Market economy consumers as well as liberal democracy members are the key stakeholders of the technology endorsement, as well as to a great extent, for public policy and legal framework. The public opinion could affect the further development of artificial intelligence and the way the government deals with its regulation. When referring to a considerably stigmatized subject, in some cases there is a discrepancy between the media representation and the public opinion (Ding, 2009). However, this shouldn't be the case of artificial intelligence.

3. Robotization

Artificial intelligence is also the major component of robotics, an integrative scientific and engineering subdivision that deals with the planning, assembly and use of mechanical robots. Robots need artificial intelligence to handle tasks such as manipulating objects and navigating, along with location problems, motion planning, and mapping.

Robotics is an interdisciplinary division of science and engineering, including mechanical and electrical engineering, computer science as well as others that deal with the design, construction, operation and use of robots, as well as computer systems for their handle, sensorial feedback and processing of information. Robots represent physical machines that possess sensors, controllers and motors that have the capacity of being programmed to execute tasks in an autonomous way.

Robots have great potential in improving the quality of our lives both at work and at home. Robots that cooperate with human colleagues will help create new jobs and improve existing ones, giving people more time to focus on other activities.

Robots are also better than humans at repetitive tasks because they do not get tired and have a higher work precision in the matter of numbers or typing certain information at which people often tend to make mistakes.

Humans surpass robots in abstraction, generalization, creative thinking given by their ability to reason and act based on their previous experiences.

However, the goal of robotics is not to replace human labor by automating tasks, but to find cost-effective ways of cooperation in the human-robot association.

Collaboration in the process of work between man and robot will lead to the mutual complement of skills on both sides.

However, there are significant gaps between where robots are today and the promise of a future era of "ubiquitous robotics", when robots will be integrated into the fabric of everyday life, becoming as common as computers and today's smartphones, performing many specializations, tasks and, often, operating side by side with people." (Rus, 2015)

The aim of current research is to improve robots in terms of manufacturing, the ability to handle objects, the way they reason, cooperate with humans and other robots and their perception of the environment.

"Creating a world of ubiquitous and customized robots is a major challenge, but its scope is no different than the problem computer scientists faced almost three decades ago when they dreamed of a world where computers would become integral parts of human societies. " (Rus, 2015)

The range of functionalities was made possible by innovations that came in the design of the robot and the development of algorithms that guide the perception, reasoning, control and coordination of robots.

Robotics has benefited greatly from advances in various fields, such as: data storage, computing, wireless communications, electronics, Internet performance, instrument design and manufacturing.

However, such a confined definition of robots ignores many of the important developments underway. "Robots are the latest expression of the growth and diffusion of ICT and can have a huge impact on the labor market" (van der Berge, 2015)

The term "robots" is referring not only to physical robots, but also to technologies like "softbots", artificial intelligence, sensor networks and data analysis. This is the Internet of Robotic Things, where the internet is extended by the senses (sensors), hands and feet (actuators) and, thanks to machine learning (ML) and artificial intelligence they can also be "smart" machines (Kool, 2015)

"Today's robots can recognize objects, map new environments, perform 'selection and placement' operations on the assembly line, imitate simple human movements, acquire simple skills, and even act in coordination with other robots and human partners. (Rus, 2015)

Robots as well as other machines bear different shapes and sizes (Hueck, 2014) and range from industrial and service robots to artificial intelligence-based robots. Industrial robotics is not yet a considerably developed field. According to the latest figures collected by the International Federation of Robotics (IFR) in 2020, there are 2.7 million industrial robots working worldwide and their number has increased for many years and will continue to do so, but not exponentially (IFR, 2020).

Many of the recent robotic applications do not immediately stand out as such. A car navigation system via satellite and the subway access gates represent examples of robotics.

NASA described the human as being "the smallest, nonlinear, universal 150kg computing system that can serve all purposes that can be mass-produced by unskilled labor" (Brynjolfsson, 2015). Unlike machines, humans are able to originate useful ideas and new alternatives for problems and have the power of empathy (Colvin, 2015); (Toyama, 2015).

Robots can considerably improve our lives as well as our work, but they cannot fully execute human tasks, or at least not yet. For instance, judges are aided by computer algorithms that seek jurisprudence and help organize material, but judges and not robots, will continue to issue judgments for the time being, because what matters is "the social need for individuals to be responsible for making important decisions." (Colvin, 2015).

Starting with developmental robotics (Lungarella, 2003); (Cangelosi, 2015) and gradually expanding into other areas, intrinsically motivated learning (sometimes called "curiosity-based learning") has been studied by many researchers as an approach to lifelong learning in machines (Oudeyer, 2007); (Schmidhuber, 2010); (Barto, 2013); (Mirolli, 2013). Inspired by the ability of humans and other mammals to discover how to produce "interesting" effects in the environment caused by self-generated motivational signals that are not related to specific tasks or instructions (White, 1959); (Berlyne, 1960); (Deci, 1985), intrinsically motivated open learning research aims to develop agents that autonomously generate motivational signals (Merrick, 2010) in order to acquire repertoires of various skills that are likely to become useful later when specific "extrinsic" tasks need to be performed. (Barto AG, 2004); (Baldassarre, 2011); (Baranes, 2013); (Kulkarni, 2016); (Santucci, 2016).

However, in 4IR we do not operate only with robots - they are the most visible component of this new industrial ecosystem. Basically, in a factory where the principles of Industry 4.0 function, the machines will operate independently or cooperate with people in a production process controlled through digital interfaces by the user and not by workers and whose maintenance, supply and logistics could be managed automatically. Thus, the factory becomes an independent and interconnected entity, which has the ability to collect data, analyze it and make automated decisions. The operation of such a factory depends to a lesser extent on traditional production engineers and more on IT specialists.

Table 1 Layers that form the structure of the sampling base

Layer	Sex	Age	Education	Income (lei)
1	F	18-23	pri/mid	<1000
2	F	18-23	pri/mid	1000-2000
3	F	18-23	pri/mid	>2000
4	F	18-23	high	<1000
5	F	18-23	high	1000-2000
6	F	18-23	high	>2000
7	F	24-39	pri/mid	<1000
8	F	24-39	pri/mid	1000-2000
9	F	24-39	pri/mid	>2000
10	F	24-39	high	<1000
11	F	24-39	high	1000-2000
12	F	24-39	high	>2000
13	F	40-57	pri/mid	<1000
14	F	40-57	pri/mid	1000-2000
15	F	40-57	pri/mid	>2000
16	F	40-57	high	<1000
17	F	40-57	high	1000-2000
18	F	40-57	high	>2000
19	M	18-23	pri/mid	<1000
20	M	18-23	pri/mid	1000-2000
21	M	18-23	pri/mid	>2000
22	M	18-23	high	<1000
23	M	18-23	high	1000-2000
24	M	18-23	high	>2000
25	M	24-39	pri/mid	<1000
26	M	24-39	pri/mid	1000-2000
27	M	24-39	pri/mid	>2000
28	M	24-39	high	<1000
29	M	24-39	high	1000-2000
30	M	24-39	high	>2000
31	M	40-57	pri/mid	<1000
32	M	40-57	pri/mid	1000-2000
33	M	40-57	pri/mid	>2000
34	M	40-57	high	<1000
35	M	40-57	high	1000-2000
36	M	40-57	high	>2000

Source: Own study

4. Qualitative research

Due to the unprecedented pandemic situation, the selection of respondents and interviews had to be conducted online via e-mail and specialized platforms for virtual conferences, respectively Zoom. The companies selected for the qualitative research were informed by e-mail and were asked to participate through one or more representatives that are relevant to the purpose of the research.

Participants in the semistructured (interviu semi-dirijat) individual interview were recruited via e-mail in which the recruitment criteria were verified and the attendance at the interview was confirmed.

The recruitment criteria discussed both by phone and in the online interview allowed the selection of those individuals who meet the criteria set out in the sampling process.

- Identification questions regarding some personal data of the interview participants: sex, age, education and income were used.
- At the same time, by the specific question "Are you familiar with collaborative robots, RPA and automation of production processes?", All respondents who answered "no" were eliminated.

The recruited participants were informed of the possible duration of the interview for participation. It was also decided on the date and time.

The interviews took place between February 1 and February 7, 2021 based on the interview guide (conversation guide). The interview guide contains five topics that were covered during the discussion:

- The purposes of using collaborative robots and RPA at the workplace (respectively within companies)
- Workers’ motivation to collaborate with robots within the companies where they carry out their activity
- The risk associated with collaborative robots or RPA
- Workers' confidence in robots
- Workers' satisfaction toward the collaboration with robots or RPAs within the companies where they work

4.1. Conclusions and remarks of the qualitative research

The need for exploratory research appears against the background of an atypical reality regarding the adoption of collaborative robots within companies.

Thus, the technique of the semistructured interview conducted on the basis of an interview guide was used, among 26 workers familiar with the robots. The interview followed five main topics on which conclusions were drawn.

All selected respondents are familiar with collaborative robots and RPA and also work with them in the field in which they operate.

Asked about their perception of collaborative robots at work, most respondents agreed that they make their work a lot easier and can also focus on other activities while the robot performs the task for which it has been programmed to execute.

Apparently, the number of repetitive and monotonous tasks is really quite high, and the fact that robots can take over some of these tasks makes labour easier for workers and at the same time considerably reduces the risk of making mistakes even by 99%. Human workers tend to make mistakes when performing repetitive tasks such as entering numbers into a computer.

Along with the benefits, there is also a risk associated with collaborative robots and RPA. Many respondents fear that they will lose their jobs due to the massive automation of certain work sectors in which robots have proven to be much more profitable and efficient than human workers. A robot can take over the work of more than 10 people depending on the tasks for which it is programmed to execute.

Fears also arise regarding the human-robot “symbiosis”, as some respondents stated that in some cases they feel compelled to compete with cars instead of collaborating with them. As most respondents have recently started collaborating with robots, they said that this adaptation is difficult and requires a lot of time and patience to reach a mutual completion of the tasks on the part of both human and robot.

Given that they perceive a high level of risk in terms of collaborating with robots, respondents said that they had to improve themselves in the field in which they operate. Precisely to reduce the risk of being replaced by workers who are more familiar with robotics and who know how to collaborate with it. The risk of being replaced by robots is not as high as that of being replaced by more competent people when it comes to highly skilled workers. However, for unskilled or low-skilled workers the forecasts are gloomy in the sense that they may lose their job much easier due to automation (introduction of a robot to take over their tasks).

There is a good level of satisfaction with collaborative robots, in the sense that most respondents consider them useful and even indispensable in the workplace given that they help them by taking over some of the monotonous, heavy, repetitive or dangerous tasks at the same time requiring a human partner (operator) to guide them in performing the tasks.

Of course, there are also reluctant people in the sample used who are afraid of the extent of automation, as it has undergone a rapid evolution in a relatively short time, and what is now present in factories and companies is far from the full potential of automation and robotization.

Most importantly, no respondents stated that they intend to change jobs due to automation, on the contrary, some of them responded that they are willing to specialize in robot-assisted work and unskilled and low-skilled workers who are the most exposed to the risk of automation of the industry responded that they are willing to undergo training if required or even specialized studies to continue their work in that field.

The use of robots to take on repetitive, monotonous and dangerous activities thus becomes a necessity and comes to the aid of human workers, relieving them of difficult, unpleasant or even life-threatening tasks.

5. Theoretical-Methodological and Practical-Applicative Conclusions

The world is in an era of fundamental transformation which is regarded as the Fourth Industrial Revolution, also called the cognitive era. Artificial intelligence is at the heart of this development, as full-fledged AI has the potential to disrupt every industry in the economy and virtually every aspect of human life in the next 20-50 years.

Today, artificial intelligence is in a period of constant innovation in which new technologies and ideas are emerging. It is transitioning from the advancement of the underlying theoretical concepts (e.g., machine and deep learning, neural networks) to a real impact in a multitude of industries and products. These include areas such as health, retail and e-commerce, transport, finance, national security, energy smart cities and more.

Predictions regarding the impact of artificial intelligence (worth US dollars) may differ, but a common fact is that artificial intelligence will be a disruptive force - not only in every industry and sector, but for society as a whole. Projections show that by 2030 artificial intelligence will have the potential to increase gross domestic product by 10% or more. This is mainly due to product improvements and increased productivity.

The countries which will benefit most from the continued progress of artificial intelligence and its associated technologies are China and the United States.

The current perspective on artificial intelligence now shows that smart cars will become a reality. Today's AI systems respond to voice commands, distinguish images and drive vehicles.

The main limitation of AI is its learning from data and the lack of other ways in which knowledge can be embodied. This means that any data errors will be displayed in the results and any subsequent analysis predictions must be added individually.

In conclusion, the objective of artificial intelligence is to provide software capable of reasoning at the input and explaining at the output. Artificial intelligence will provide human-type interactions with software and support specific tasks, but will not be able to replace the human element.

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