sustainability

MDPI

Article

Impact of Industry 4.0 and Digitization on Labor Market for 2030-Verification of Keynes' Prediction

Gábor Szabó-Szentgróti [1,*], Bence Végvári [1] and József Varga [2,3]

[1] Institute of Economic Sciences Department of Management and Leadership Sciences, Hungarian University of Agriculture and Life Sciences, Guba Sándor road 40, H-7400 Kaposvár, Hungary; gszabo.dr@gmail.com
[2] Institute for Business Regulation and Information Management, Hungarian University of Agriculture and Life Sciences, Guba Sándor road 40, H-7400 Kaposvár, Hungary; varga.jozsef@uni-mate.hu
[3] Corvinus University of Budapest, Fővám square 8, H-1093 Budapest, Hungary
* Correspondence: szabo-szentgroti.gabor@uni-mate.hu

Abstract: The research objective of this study is to examine the changes in technological unemployment and to evaluate Keynes' theory based on a literature analysis concerning the fourth industrial revolution. The methodology used in this study is a literature analysis of 86 papers published between 2011 and 2020 on topics related to Industry 4.0, the labor market, and technological unemployment. The change caused by the labor market raises employment sustainability issues. Among the goals adopted at the 2012 UN Rio+20 Conference on Sustainable Development, this study is directly related to goals 8 and 9, and indirectly to goal 10. Research evidence suggests that the impact of Industry 4.0 processes will reduce the amount of labor needed, bringing us closer to Keynes' vision of three hours a day. The analysis suggests that reduced working hours will increase economic efficiency through more intensive work. The literature is used to determine whether the trend of reduced working hours can be interpreted as a positive or negative phenomenon. The extent of technological unemployment is determined by the digitalization strategy of each country and the speed of its introduction, as well as the readiness of the education system in a given country to retrain vulnerable groups in the labor market. However, the overall picture is positive: on the one hand, digital transformation opens up a wide range of opportunities for a more human life, and on the other hand, from an economic point of view, digitalization will become an inescapable element of competition by reducing marginal costs. The study's novelty is that the effects of Industry 4.0 and technological unemployment on the labor market are analyzed in the context of Keynes' theory.

Keywords: Industry 4.0; technological unemployment; Keynes theory; labor market; digitalization

Citation: Szabó-Szentgróti, G.; Végvári, B.; Varga, J. Impact of Industry 4.0 and Digitization on Labor Market for 2030-Verification of Keynes' Prediction. *Sustainability* **2021**, *13*, 7703. https://doi.org/10.3390/su13147703

Academic Editor: Sebastian Kot

Received: 10 May 2021
Accepted: 5 July 2021
Published: 9 July 2021

1. Introduction

Significant changes are taking place in the world, which are fundamentally transforming the way the economy works, and with it, many areas of human life. Continuous technological development is an essential condition for companies to maintain their competitive advantage. Throughout history, actors in different industries have always sought to serve changing consumer needs, which have made continuous technological development inevitable. This technological development can be examined via the example of earlier industrial revolutions. However, the most significant technological and labor market turnaround were brought about by the third and fourth industrial revolutions, whereby computer-controlled automation was replaced by the digital transformation of the fourth industrial revolution, wherein devices communicate autonomously along the value chain. The spread of automation, robotics, digitalization, and the use of virtual autonomous systems has already led to an analysis of the impact on the workforce by many researchers [1–3], the magnitude of which has been significantly accelerated by the pandemic [4,5]

According to research on this topic, automation and digitalization are some of the most relevant labor market topics today [6], as the technological revolution brings about significant employment changes, the replacement of human work by robotics, and the need for workers and companies to adapt to changing conditions, as well as its social and economic impacts. Digitalization and the use of industrial robots are widespread; however, opinions are divided on their mass appearance, and the extent of their effects on employees and jobs [7,8]. Most analyses report huge changes affecting up to hundreds of millions of jobs worldwide [2,9,10]. In particular, according to the International of Federation of Robotics (IFR) [11] forecast, by 2022, nearly 4 million industrial robots may be present in various work processes, and this number might grow by up to 13% per year.

The analytical focus of our study is to evaluate the effects on the labor market of Industry 4.0, a term first used by the German government in 2011 when it announced its industrial development program [12]. Based on our literature analysis, Industry 4.0 seems more like a strong continuation of the third industrial revolution [13,14], as it is also a product of digital technological development, but due to its expected impact on society and the economy, it is not an exaggeration to talk about a revolution.

A prominent place in the debate on technological unemployment in economics is occupied by John Maynard Keynes's interesting lecture, which has been a central aspect of economic literature for almost a century. The lecture was aimed at university students and confronted the opinions that projected the collapse, or at least the decline, of capitalism—and the spread of socialism—as a result of the global economic crisis. Keynes wanted to show young people that the crisis is not the result of a recession, but of too rapid an economic transformation. "We are suffering, not from the rheumatics of old age, but from the growing-pains of over-rapid changes, from the painfulness of readjustment between one economic period and another." [15]. In his presentation and subsequent study, "The Economic possibilities for our Grandchildren" [15], he examined whether the increase in economic performance due to technological development brings about the possibility of a drastic reduction in working time and thus a substantial increase in leisure time. Here, Keynes envisioned achieving a 15-hour-a-week work week for a century later, in 2030. We are now nearly a decade from that date, and it is worth returning to this issue in light of the events of the fourth industrial revolution. In our view, the drastic changes in Industry 4.0 do make this question compellingly relevant.

The issue of technological unemployment has been addressed in the literature in several sub-areas [14,16–19]. Research over the past decade has analyzed the socio-economic impacts of Industry 4.0 and their expected consequences [1–3,7,8,20], but this study differs from previous research in that it seeks to discuss the relationship between Keynes's theory of technological unemployment and the fourth industrial revolution. Based on our analysis, the research gap in the topic can be observed in the fact that the reasons why technological development does not automatically lead to a radical reduction in working hours have not been revealed. At this point, our study seeks to contribute to the literature with a gap-filling analysis.

A number of scenarios are conceivable for future trends in employment sustainability. For example, one study [21] outlines four possibilities for the future. Of the four qualitative visions of capitalism developed by author [22], the Transformation and Steady State scenarios include the positive consequences of declining working hours, Disarray concerns the negative effects of this decline, and in the Continued Growth scenario, the amount of working time does not decrease. Of the possible scenarios listed, the fourth is the most likely, and thus Keynes' vision of a reduction in labor supply will not be realized by 2030.

The perception of sustainable employment is not uniform among sustainable development economists either. There are serious divisions on the main question of whether an economic transition that respects the environment means more or less work. There are those who say that we are currently maintaining the destruction of our environment to the very end in order to provide jobs for people, so that only less work can lead to a more sustainable world; while there are those who say that it will take a lot of human work to fix the damages of the last 200 years [23]. The authors criticize sustainable development professionals for paying too little attention to the issue of employment, even though the two (sustainability and employment) are extremely closely related. Many environmental efforts have been derailed by the difficulty of reconciling them with employment interests, when proper management of the issue and adequate policy planning could avoid a conflict between the two areas.

Based on the research problem formulated, Industry 4.0 has triggered processes that are likely to lead to a significant reduction in working time. Thus, based on this, our research objective is to investigate technological unemployment. To this end, we seek to evaluate Keynes' vision and to assess the employment impact of Industry 4.0.

2. Industry 4.0: Concept and Solutions

2.1. Industry 4.0: Concept

The Industry 4.0 concept, presented at the Hanover Exhibition in 2011, attracted the interest of manufacturers and of the scientific community as well [20]. The scientific literature defines the concept of Industry 4.0 in different ways. Some authors interpret Industry 4.0 [24] as the digital integration of production processes, in which production processes are automated, and products, devices and services are interconnected. It can be said that this industrial revolution is driven by the internet, through which not only humans but machines as well will communicate with each other in a cyber–physical system. Another view is that the development of manufacturing processes is driven by market demand for more efficient technologies and processes, reductions in costs and quality standards, and technological development [25]. Industry 4.0 plays an important role in intelligent data collection and interpretation, correct decision-making, and the timely implementation of both, enabling faster data collection and interpretation procedures [26].

It is an indisputable fact that Industry 4.0 is a broad concept and its content is constantly changing. Industry 4.0 encompasses a diversity of technologies, systems, and processes, and it aims to make manufacturing processes more flexible, autonomous and dynamic [27] and to incorporate these into a network. It uses digital and cybernetic resources in production and industrial management environments. Fundamentally, integrated manufacturing consists of 3D printing technologies, automation, and artificial intelligence. Intelligent manufacturing aggregates the Industrial Internet of Things (IIoT), cyber–physical systems (CPS) and virtual and augmented realities [25], and creates smarter and more adaptive processes through better use of production resources [28]. The definitions presented agree that Industry 4.0 will transform the entire corporate value chain, with impacts that will go beyond the organizational framework and have an impact on the global job market as well. The authors of this study commit themselves to the definition that Industry 4.0 encompasses automation, robotics, artificial intelligence, and Internet of Things (IoT) in services and manufacturing, and will result in systems that blur the boundaries of the real world and virtual reality, which will be connected by cyber–physical production systems (CPPS). Industry 4.0 cannot be described in one word; however, the literature often uses the terms digitalization or digital transformation [29,30]. Thus, based on this literature, these terms are also used as a synonym for Industry 4.0 in this study.

2.2. Industry 4.0. Smart Solutions

The continuous development and adaptation of various new technologies are essential to maintaining the competitiveness of companies. Some technological advances are so significant that they alone can change the rate of normal economic growth. These are described in the literature as general purpose technologies (GPTs) [31]. Steam power, electrical energy, the combustion engine, and the internet are all such GPTs.

Today, Info Communication Technologies (ICT) is one of the most outstanding examples of this, but Industry 4.0 itself incorporates a wealth of smart technologies that, while not as far-reaching as the examples mentioned earlier, may prove essential to the development of companies.

Industry 4.0 has six main principles: virtualization (virtual replicas of physical tasks as digital data), interoperability (connecting machines via the internet, enabling them to communicate with each other, and with humans), decentralization (autonomous decision-making ability of interconnected systems), real-time capacity (simultaneous flow of information between systems, for better and quicker decision making), service orientation (the ability of the system to provide services and functions to stakeholders), and modularity (adaptation of systems to possible changes or errors, addition or replacement of operational modules) [1,32].

Different solutions related to Industry 4.0 can contribute to these principles in different ways, which can result in companies becoming more competitive. Such solutions include the use of RFID (radio-frequency identification) chips and readers in the field of supply chain management (SCM) [33], which can support the operation of manufacturing companies by reducing unreliability and reusing products and components, monitoring inventories, and eliminating demand uncertainty [34]. They also include applying automated control guidelines to alleviate imperfect manufacturing processes, which can increase supply chain management flexibility [35], and reduce the production of defective products, the sale of which can harm a company’s image. In such a system, the entire quality control process is performed by machines, as a result of which the production of defective products can be further reduced [36,37].

Some remarkably important innovative solutions for Industry 4.0 (or automation/digitization) are the Internet of Things (IoT), cyber–physical systems (CPS; the interconnection and coordination of various physical processes and IT solutions, in which various processes are controlled and monitored by algorithms [38]), and the increasingly popular 5G technology, which can also play an important role in the operation of these systems. Adapting 5G technology can give a huge boost to the proliferation and operation of smart factories as it provides much stronger transfer rates and lower latency [39]. In addition, it is important to mention Big Data and Big Data analytics, artificial intelligence, cloud-based solutions, different virtual and augmented reality solutions, and cloud-based technologies, which to varying degrees can all contribute to the development and diffusion of Industry 4.0 solutions. In addition, it is important to mention the growing importance of cybersecurity, as the vulnerability of these complex, interconnected systems can result in huge damage, data leakage, and partial or even complete downtime in the event of a cyber-attack on a company.

3. Method

3.1. Research Questions

The aim of this research, based on a literature analysis, is to investigate the changes in technological unemployment and to evaluate Keynes’ theory.

In order to achieve our research goal, we sought answers to the following research questions:

RQ1: Why has Keynes's vision of three-hour working days not been fulfilled so far, and why do we presume that, based on the current processes of Industry 4.0, it will be—at least partially—fulfilled by 2030?

RQ2: What are the possible positive and negative future scenarios related to Industry 4.0?

3.2. Information Retrieval and Selection Strategy

The research was based on a literature analysis of studies published in the context of Industry 4.0 and labor market changes.

As a first step, keywords and bibliographic databases were identified. A Web of Science database was used to collect the keywords most frequently used by researchers in the field in their publications (Industry 4.0, digitalization, Keynes, labor market, employment, unemployment). The Web of Science database was chosen due to its wide scientific coverage. In addition, Web of Science is a multidisciplinary database and indexes the most cited journals in each field, providing tools for bibliometric data analysis. In addition, Web of Science is recognized worldwide as one of the main sources of information, both academic and general bibliometric [20].

As a second step, test queries were conducted to finalize the study period and keywords. After testing the keywords, they were refined because the test queries resulted in a low number of hits, which highlighted the lack of research on the topic. The term Industry 4.0 was first used by the German government in 2011 [12], so we linked the time interval for the compilation of the literature database to this date. In addition, the secondary literature (grey literature) was searched in Google Scholar.

As a third step, a macro bibliometric analysis was performed on the Web of Science and EBSCO databases for the period 2011–2020 using predefined keywords and their synonyms (industry 4.0 or industrie 4.0 or fourth industry revolution or digitalisation or digitalization and labour market or labor market or employment or unemployment or Keynes). The search strategy resulted in 628 records, from which studies other than English were excluded ($n = 108$).

As a fourth step, the literature was collected, and the articles found were sorted using a reference manager (Mendeley) ($n = 520$).

The fifth step was a multi-level content evaluation of the collected studies (title, abstract and content). Based on the content analysis of the title and abstract, 275 studies were excluded. For the final analysis, we selected studies from the Web of Science database sources that showed evidence of a research context analysis. After screening, the authors reviewed 245 full-length articles, of which 40 were included in the qualitative assessment after screening. In addition to the publications included in the qualitative assessment, gray literature sources were included, resulting in a total of 86 literature sources processed in our study.

3.3. Bibliometric Analysis

The aim of this chapter is to present the results of the basic bibliometric analysis of the literature selected on the basis of the search strategy, during which the year of publication, the ranking of journals and the country are taken into account.

The scientific value of the studies is determined by the ranking of journals in which they are published. The ranking is basically suitable for showing into which quarter a journal falls in a given field's ranking. This international ranking process distinguishes four main categories (Q1, Q2, Q3, Q4). Figure 1 shows the distribution of studies participating in the bibliometric analysis by year of publication and ranking. Of the studies examined, 37 were scientific journals and 3 were full-length conference proceedings.

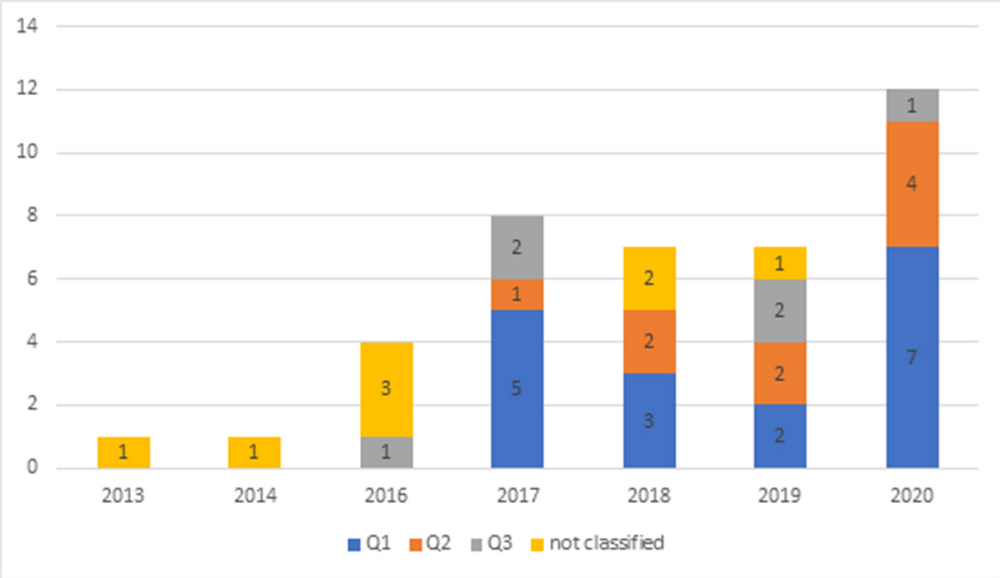

Figure 1. Distribution of the examined studies by year of publication and ranking.

In the examined time interval (2011–2020), the majority of publications (40/34) were published in or after 2017, in increasingly higher-quality journals. The majority of the studies evaluated (40/32) were published in qualified journals. Based on the table, it can be stated that the majority of the studies were published in Q1/Q2 journals. Of the qualifying journals, a noteworthy share have Q1 ratings (40/17). The journals are assessed as relevant based on their quality and field of expertise, and contain valuable scientific results.

An important content element of the bibliometric analysis is the territorial delimitation of the examined publications. The sample characteristics of the studies involved in the quality assessment are presented in Table 1.

Table 1. Distribution of the studies by authors and countries.

Authors	Location	Number of Study
Grigoli et al. (2020); Taylor (2020); Glaveski (2018); Sharma et al. (2020); Lee et al. (2016); Lee et al. (2014); Graetz and Michaels (2018); Weldon (2018)	USA	8
Chen et al. (2020); Cui et al. (2020); Liu et al. (2017); Zhou et al. (2016)	China	4
Eichhorst et al. (2017); Johansson et al. (2017) Albers et al. (2016); Jäger et al. (2016)	Germany	4
Habanik et al. (2019); Vojtovic, and Krajnakova (2013); Novakova (2020)	Slovakia	3
Da Silva et al. (2020); Tortorella and Fettermann (2018)	Brazil	2
Kamerāde et al. (2019); Frey and Osborne, 2013)	England	2
Zemtsov (2020); Vinichenko et al. (2020)	Russia	2
Sima et al. (2018) Türkeș et al. (2019;	Romania	2
Hat and Stoeglehner (2020)	Austria	1
Moeuf et al. (2018)	France	1
Ziaei Nafchi and Mohelská (2018)	Iran and Japan	1
Danaher (2017)	Ireland	1
Kim et al. (2017)	Korea	1
Piątkowski (2020)	Poland	1
Bányai et al. (2019)	Hungary	1
Ghislieri et al. (2018)	Italy	1
Sánchez (2019)	Spain	1
Hofmann and Rüsch (2017)	Switzerland	1
Bokrantz et al. (2017)	Sweden	1
Fergnani (2019)	Singapore	1
Krykavskyy et al. (2019)	Ukraine	1

The studies examined during the analysis period present current research results from a total of 24 countries. Of all the articles, 8 present the results of research conducted in the United States, and 4 each in China and Germany. In terms of the geographical location of recent research on the topic, the US is predominant. The data in the table show that research on this topic is at the center of interest for researchers around the world.

4. Results and Discussion

4.1. Theoretical Aspects of the Labor Market Situation in the 2020s

4.1.1. Theoretical Contexts of the Necessity of a Reduction in Working Time

The ultimate goal of economic activity and, interestingly, its reduction—in our case, the reduction in working hours—is to achieve happiness and, to a lesser extent, satisfaction. Happiness, in the Greek sense of eudaimonia, is the desirable result achieved by satisfying the many needs of the individual [40]. Happiness would be a "straightforward process" if only rationality would prevail in our lives. But this is not the case, because limited rationality rules our lives [41]. The power of rational thinking is limited; moreover, it changes over time, and within given individuals.

Immoderate greed and overconsumption compared to our needs deprives people from the feeling of satisfaction. Since in this case, we cannot order our senses to stop, we cannot appreciate what is sufficient, since it makes our wealth- and income-demand unfettered [42].

Researchers at Cambridge University determined that 8 h of work a week are enough to avoid the negative effects of unemployment. In addition to the generally well-researched effects of unemployment in general, this research is significant because it assesses exactly how much work needs to be done to ensure that these negative effects do not materialize. Exaggerated working harms people, which is especially relevant in Japan and other Eastern Asian countries [43].

An interesting experiment took place in Japan last year: Microsoft shifted to 4-day work weeks on an experimental basis, and the results were positive in every aspect. The productivity of the 2300 workers increased by 40%, energy usage fell by 23%, and paper usage decreased by 59%; 92% of workers were satisfied with the experiment and would like to continue working on a 4-day basis. The place of the experiment is especially relevant, because Japan is famous for its strict work culture [44,45].

The fourth industrial revolution raises a contradiction, according to which there are countries, regions and communities that have enough wealth and income to lead a comfortable lifestyle, but instead, the individuals of these communities often spend their lives undertaking hard work. This contradiction brings a famous saying of Epicurus to our minds: "Nothing is enough for the man to whom enough is too little."

The labor market is, by its nature different, from the commodity market and the capital market. In the latter case, after the purchase—apart from a quality objection—the transaction closes, but in the case of the labor market, it is the opposite—the agreement of employment marks the beginning of the process, not the end of it. The motivation of the employees is a key issue. If the employee feels that his or her wage is too small, he or she will not act motivated in the workplace. This leads us to the main thesis of effective wage theory: employees will pay a wage that is higher than necessary, so that employees would feel privileged to work there, and they would identify more closely with the goals of the company [46]. This bigger than necessary—or greater than the market equilibrium—remuneration is the main cause of unemployment. On the other hand, our society thinks of work as a moral obligation. Most people who are actively looking for work but cannot find any are still judged by society—not in a legal, but in a moral way.

There is a wide range of social arrangements wherein unemployment is also punished legally. In socialist societies, this was known as "publicly dangerous work avoidance". This social arrangement produced latent or "indoor unemployment", as opposed to the "outdoor unemployment" phenomenon of capitalism. It is also a common feature that the individuals condemn and devalue themselves, their self-esteem decreases, and their social relations weaken as a result. In his world-famous research, Nobel Prize winner Krugman placed not GDP decline, and not inflation, but the increase in unemployment at the heart of the 2008 financial crisis. "It's clear, that the focus of our research is involuntary unemployment" [47].

Within the phenomenon of unemployment, he also analyzed its numerical progress, but in his words, this indicator is "unable to seize the extent of human suffering" [47]. Based on his calculations, 40% of families in the United States suffered from the effects of shorter working hours, or lower income during the 2008 financial crisis. In the chapter named "lives destroyed", he thoroughly analyzes the different long-term negative societal effects caused by involuntary unemployment. People who stay too long without a job will be deemed unfit to work, sooner or later. The individual's happiness fractures, since our happiness greatly depends on knowing that we can keep our life together. That is, involuntary unemployment causes anxiety and depression. In addition, it also changes our social habits, forcing young generations to stay with their parents, which in Krugman's words is "almost unbearable for young people" [47].

Automation and replacement of the human workforce is not a new phenomenon. In the modern age, automation processes began during the Industrial Revolution. However, the perception of the consequences of these processes has changed significantly with Industry 4.0. Previously, when the technology of a sector of the economy was renewed through automation and this caused an increase in unemployment, this trend was considered temporary, but in the era of digitalization, this might be different. Riskbank's analysis shows that as the economy expands, new job opportunities will be created for those who have lost their previous jobs. Thus, overall, technological advances have not destroyed more jobs than they have created [48].

However, the impact of technological and digital development on unemployment has changed recently. Over the past few decades, rapid advances in technology have made infocommunication products cheaper, and as a result, made innovative technologies more economically attractive compared to the use of human labor.

From a technological point of view, recent innovations make it possible to replace more and more types of work. Many experts expect this trend to continue or accelerate. In an extreme case, over the next 20 years, it will be possible to replace half of the current human workforce with digitalized technology. Based on the findings of this study, the faster technology advances, the harder it will be for the workforce to adapt to change [48]. As a result, it is not a statutory claim that technological development creates at least as many jobs as it eliminates. A scenario in which unemployment caused by technology becomes an increasingly common phenomenon is more likely. Not only will the digital transformation have a significant impact on the labor market, but if the earlier statement comes true, a wider range of economic agents may experience downward pressure on wages, which may have a dampening effect on inflation.

4.1.2. The Theoretical Relationship between Industry 4.0 and Unemployment

Based on recent trends, and the lessons learned from earlier industrial revolutions, it is safe to say that a workforce disruption caused by Industry 4.0 is inevitable. Every industrial revolution brought increasing efficiency and productivity. With recent technological advancements, automation solutions have become cheaper and better. According to some researchers [49], this pushes the human workforce out of more and more jobs [50], which can lead to a phenomenon envisioned by Keynes and known as "technological unemployment" [15,51]. This theory says that technological advancements will replace human jobs faster than we can create new ones [15,52,53].

Many authors stand by the disappearance of jobs and the decrease in human work (Table 2), but their estimations differ in terms of the extent and speed of the negative effects [9,10,54]. Today, 50% of all work-related tasks can be automated with available technologies. There are only a few jobs (less than 5%) that consist of tasks that cannot be automated at all; meanwhile, in 60% of jobs, one-third of the tasks can be replaced by technology [9]. Technological advancements will no doubt make some jobs disappear in the short run [54], but based on the forecasts, structural unemployment seems drastic, although advancements can lead to serious consequences for both low-skilled and high-skilled workers [55,56].

In contrast, other research papers mention positive changes related to the spread of automation (Table 3). In the researchers' interpretation, the maintenance of human health will provide a greater benefit in the long run [57]. The mentioned benefits of automation are the replacement of dangerous and hazardous jobs, lower costs, better quality, increased safety, and environmentally friendly solutions [58]. According to some viewpoints, workforce automation does more good than harm, because machines are taking over tasks that are potentially dangerous or unhealthy for humans, such as welding or automotive painting. Beyond these points, some jobs or tasks could also be complemented by technological solutions, such as using virtual reality for training to reduce potential accidents to zero, or even enforcing sensor-driven quality control along production lines, which replaces a monotonous job [11,57,58,59].

Table 2. Negative effects of Industry 4.0.

Authors	Negative Effects
Frey and Osborne (2017) [55]	Increasing structural unemployment and inequality
Manyika (2017) [9] Nedelkoska and Quintini (2018) [10]	Decreasing job opportunities
Bokrantz et al. (2017) [60]	Lack of skilled people for the changing labor market
Gordon (2012) [61]	A slowdown in global economic growth
Manyika et al. (2017) [62]	The disappearance of 800 million jobs by 2030
Weldon (2018) [55]	Short-term job losses
Jäger et al. (2016) [63] Krykavskyy et al. (2019) [64]	New skills and training requirements Changes in the professional profile

Source: systemization by the authors.

Table 3. Positive effects of Industry 4.0.

Authors	Positive Effects
Keynes (1930, 2010) [15,51]	An increase in free time
Danaher (2017) [57]	Replacing human work with technology does not necessarily lead to a decrease in employment opportunities.
IFR (2017) [11]	Rising productivity, increasing competitiveness The creation of new jobs
Ghislieri et al. (2018) [58] Bányai et al. (2019) [65]	Economic and environmental aspects: higher quality, better safety, environmentally friendly solutions replacing hazardous or dangerous jobs
Oxford Economics (2019) [66]	Cost reduction
Manyika et al. (2017) [62]	Labor market restructuring towards the tertiary sectors, with a possible increase in overall number of jobs.
Albers et al. (2016) [67] Moeuf et al. (2018) [68]	Improving product quality and competitiveness

Source: systemization by the authors.

4.2. Labor Market Implications Linked to the Digital Revolution

4.2.1. The Practical Impact of Industry 4.0 on the Labor Market

In this chapter, our aim is to assess the medium- and long-term effects of Industry 4.0 on the labor market and to support Keynes's vision for 2030, and—if necessary—to perform a revision and correction of Keynes's vision.

Nowadays, it has become clear that technological change can replace the work processes performed by certain people, as well as affecting the structure of employment and the level of unemployment.

While the world's population is growing dynamically, employment levels are on a declining trend, which can only be offset by dynamic growth in the service sector.

There has been no significant employment growth in the industrial sector over the last three decades (+1.28 percentage points); it is operating at almost the same level, while at the same time world GDP has increased sixty-fold. Even these data predict the impact of changes in the primary market on automation and digitalization solutions in the industry.

Economic and social changes in the world (increasing consumption, overproduction, accelerating obsolescence, etc.) also strengthen this process, i.e., growing consumer demand drastically affects the growth of output of corporations with a stagnant level of employment.

Industrial revolutions cannot be separated from each other at a specific point in time; rather, the current industrial revolution is a continuation of the previous one. The data also show that the economic and financial crisis of 2008 had a significantly greater impact on employment than the fourth industrial revolution, which started in 2011. It is easy to see from global labor market data that crises can trigger or exacerbate different economic processes. Employment in the productive sectors (industry, agriculture) is likely to continue its downward trend in the coming decade, despite the conjuncture of the 2010s.

This change further reinforces the question of how labor that became redundant in the productive sectors can be reinstated in the future, and what absorption capacity the service sector has to offer to assimilate industrial labor surpluses. Nevertheless, we can assume that digitalization will have a number of positive effects on human life, especially on quality of life. In spite of all this, the number of jobs replaced by digitalization, and the economical and mental effects of this phenomenon, are also not negligible [69].

It is clear that the latest technological developments in digitalization solutions—cyber–physical systems, Big Data, Internet of Things, cloud computing and robotics—are having a negative impact on people's employment opportunities [70–72]. Several studies have shown a worrying decline in low- and middle-income employment resulting from the replacement of the human workforce with technologies [73,74]. For example, the manufacturing sector, which is currently the industry most effected by digitalization, suffered a loss of 1.7 million jobs worldwide between 2010 and 2016. If this trend continues until 2030, as much as 20 million jobs could disappear, thanks to digitalization, which means an 8.5% loss of jobs in the sector. The effects of lost jobs will vary from country to country, but it will affect less educated workers and the poorer countries the most, meaning a two-fold greater loss compared to richer countries [66].

The emergence of technological unemployment in the fourth industrial revolution is striking, as the pace of development of current automation technologies and science is exceptional; ordinary people have never experienced such changes [33] and rightly feel their lives are in danger.

We accept the viewpoint that labor markets keep gradually adapting to these changes [75] and that the economic growth of the world keeps slowing down, and even technological changes cannot offset the hunger for profit [61]. Additionally, the governments of different countries have a varying degree of interest in accelerating or slowing the spread of automation [76].

Government intervention and policy changes can help reduce the impact of technological development, and it must be considered in the future that a significant proportion of occupations are being transformed [73], to which members of society need to adapt.

Nonetheless, the trend of automation will likely continue, and different technologies, especially advances in artificial intelligence, machine learning, and machine-to-machine communication, will endanger a growing number of jobs and tasks. Moore's Law, which states that the computing capacity of computers doubles every 18 months, strengthens this even further. As different technologies that can replace human work become more advanced, more economically viable, and cheaper, more and more companies will choose to use them, both for cutting costs and for raising productivity [66].

Mapping the workforce changes of our times is a huge task for the researchers on the topic, because the spread of these changes is affected by many factors—for example, economic feasibility, legal frameworks, acceptance and preparedness of both companies and the workforce, and advances in different technologies—and no single study can give us all the answers. However, recent studies can provide us with useful information. The 2017 research conducted by the McKinsey Global Institute highlights the often-mentioned job disappearances, but also focuses on the potential new jobs that could be created, offering a new point of view on the topic of workforce changes, and showing the possible positive effects alongside the negative ones. The research shows that as many as 300 million new jobs could be created worldwide, resulting from increasing consumption and the aging of societies alone, by 2030, which would greatly vary from country to country, based on level of wages, raising incomes, demographical tendencies and the composition of the economy [62].

4.2.2. Labor Market Vision and Challenges

In relation to the employment effects of Industry 4.0, researchers point to two possible trends: massive technological unemployment in the future, and a shift of the workforce to new jobs with digital tasks and skills. The first approach is referred to in the literature as substitution-digitization, which forecasts the inevitability of massive technological unemployment due to the impact of new digital technologies and the loss of significant employment. The second alternative approach is called task-digitalization [18]. Digitalization does not eliminate entire occupations but specific tasks within jobs, eliminating some jobs and creating new ones, thus increasing global employment figures. It is necessary to underline that both scenarios coincide with the emergence of losers and winners resulting from digitalization.

An important question for our future, then, is how well-prepared countries' education systems are to meet the significantly changing needs of the workforce as the contents of professions are transformed. Based on predictions, technological spending is expected to rise by 50% between 2015 and 2030, resulting in the creation of 20 to 50 million new jobs worldwide, which would also help to offset the effects of Industry 4.0. These would be new and novel high-end jobs, such as Big Data analysts and machine learning specialists [77].

The future changes in unemployment are difficult to determine, as they are shaped by the combined effects of several factors and are strongly cyclical in nature. The employment impact of Industry 4.0 has the most negative effects on the physical workforce in the productive sectors. Based on the data, we can see that the unemployment rate of those with a low level of education remains persistently high, and that this vulnerable group of workers is likely to be hit hardest by Industry 4.0, while workers with higher education are more characterized by a declining unemployment rate.

Nonetheless, we cannot ignore trends such as taking care of the elderly in aging societies, handling climate change and energy efficiency challenges, or providing goods and services to the growing consumer class, as well as the advancement of technology, which can all lead to the creation of new jobs. Jobs created by these trends even have the potential to completely offset the jobs lost to digitalization.

It is expected that the positive effects of Industry 4.0 solutions will continue to dominate in the future, but negative labor market changes will nevertheless be dominant. With large-scale technological advances, as much as 375 million people—14% of the global workforce—could be forced to look for a totally new occupation. The estimation for the total number of jobs lost stands at 800 million globally by 2030 [9]. One of the key issues for the future is the social impact of the redundant labor force. The question arises as to how to provide them with decent employment in 2030 in order to avoid deep poverty.

We can expect that in addition to the economic effects of different technologies, there will also be significant changes in the structure of the labor market. An example from the past is the agricultural sector of the United States, which in the 1850′s employed 58% of the American workforce. Today, this proportion is under 2% [9]. Back then, workers who lost their jobs in agriculture moved to cities, and found jobs in factories, so this shift did not lead to huge unemployment, because workers were able to easily find new jobs that did not require much training or education. However, for the workforce changes of the near future, things might not be the same. Automation could also lead to economic growth, contributing 0.8 to 1.4% of growth to global GDP annually, if displaced workers are to return to the workforce quickly [9].

Most likely, there will not be a sufficient labor supply to fill the new kind of jobs created by technological advancements, because the occupational skills of people excluded from the labor market will be obsolete and the learning motivation of low-skilled individuals will be low.

As a result of this, technology-related unemployment will be replaced by structural unemployment in the medium-run, because employees leaving the workforce will not be able to learn a new occupation.

Alongside the job terminating effects of new technologies, it is important to talk about their job-augmenting possibilities. Workplaces that use a responsible digitalization strategy will not use these new technologies to displace workers, but to integrate the new possibilities into their employees' work, to complement it and optimize it, and with it not only making work easier, but also increasing the value added by individual employees. For this to work, companies should not focus on automating each and every possible work task, but only the repetitive routine tasks, and for the more complex tasks, they should use the available technologies to enhance the work done by their employees [77].

Other research papers also confirm this possibility, by distinguishing between automatable tasks, which can be replaced by different technologies, and augmentable tasks, which can be enhanced by various technologies. The research also talks about how these two phenomena can affect different workers in different positions: digitalization can greatly affect those who work in less complex, more routine occupations, with low to medium levels of education. Jobs that are more complex than these, which usually require higher education, could be affected mostly by augmentation [77]. Augmentation can surface through different channels in the workplace; for example, using virtual or augmented reality during various tasks, as well as during training and education, which is an approach that will increasingly benefit from new technologies [11]. Another possible effect of Industry 4.0, alongside a decrease in global working hours, could be the different levels of work being done by different groups. With a more even distribution of working time, groups that had a high workload will have fewer opportunities to work. The extent and trend of declining working hours over the past three decades also predicts this tendency (Figure 2), but there is no clear link between the reduction in working time and the digitalization effect.

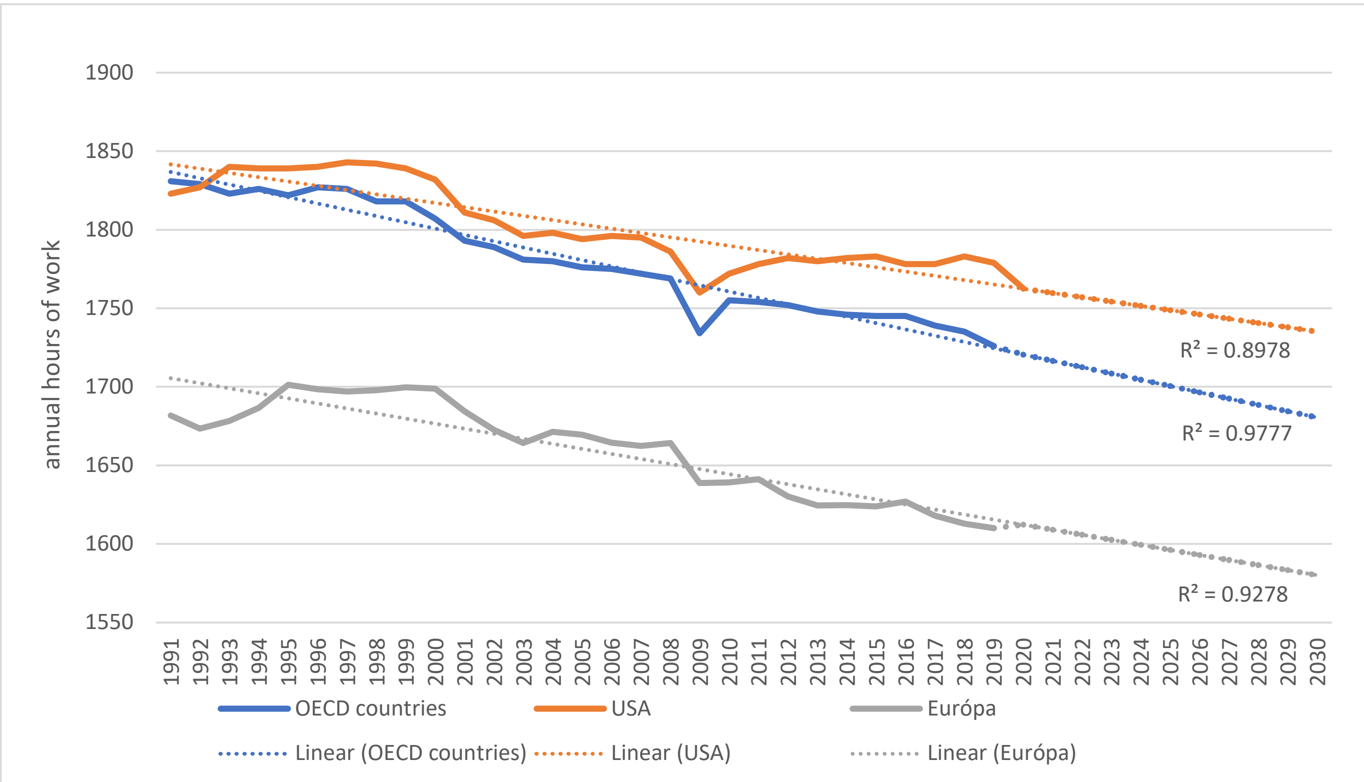

Figure 2. Average number of usual annual hours of work in total employment. Source: Own calculation based on OECD data [78].

The speed at which robotization and digitalization spreads can also be a huge factor in mitigating the challenges that workers might face in a changing workplace. Some argue that if Industry 4.0 technologies spread at a steady level and speed, workers will have an easier time adjusting to the new labor market conditions, and they will have an easier time picking up new skills to re-enter the workforce after being displaced [79]. However, the argument needs to be complemented by the fact that one of the prerequisites for the development of worker adaptability is the level of preparedness of the education systems in each country to provide up-to-date training for those entering and leaving the labor market.

Companies predict a shift in the tasks done by humans compared to the tasks done by robots in the near future. According to the research conducted by the World Economic Forum in 12 industries, 71% of tasks are done by humans today, with 29% being done by robots. The forecast for 2022 predicts tasks done by humans will fall to 58%, and tasks done by robots will rise to 42% [77]. These workplace rearrangements can put huge pressure on workers, who need to adapt to the new kinds of emerging tasks and jobs. Based on these predictions, 54% of workers will need further training or re-training by 2022; 35% of those affected will only need a training program of 6 months at most to be able to adapt to the new workforce situations, but 10% of them could need training of at least a year, which is a long time for those who want to re-enter the workforce [6,77].

Jobs related to technological advancements could also see an increase. New job openings are expected in positions such as computer scientist, engineer, system administrator, and so on. Overall, most of the new jobs created will require a higher level of education. Based on predictions, nearly half of all the new job openings in the European Union will fall into this category [80]. Jobs mostly affected by digitalization may include the following: cashier, office clerk, restaurant assistant, dishwasher, agricultural machine operator, driver, etc. However, with the advancement of algorithms, many jobs may be put in danger in finance and accounting too [9]. From this, we can see that the group of affected jobs is quite wide-spread, and most of them fall far from the sectors that could see the greatest numbers of new jobs created, meaning that it would be extremely beneficial to create a framework that would help affected workers to gain the skills and training necessary for newly created jobs. A study conducted by the Institute for Public Policy Research states that the current trend of automation—which mostly affects middle-wage, middle-skill jobs—will shift, and will significantly affect low-wage jobs, which makes the retraining of low-skilled workers a necessity [81]. This structural change in training and employment is strengthened by the fact that jobs mostly affected by automation usually require lower, or a medium level, of education, while the least automatable jobs mostly require higher education [3,82].

5. Conclusions

This study sought to answer the research questions formulated at the outset of the research, based on information from the literature. Literature sources were explored primarily using the Web of Science database, supplemented by secondary literature sources. A bibliometric analysis of the literature, finalized on the basis of a Web of Science database search strategy and sing specific selection criteria, was carried out. Based on the bibliometric analysis, it can be concluded that the literature on the researched topic suggests an increasing trend, and that higher-quality journals are covering the topic year by year. Based on the analysis, the dominant research location for the topic appears to be the United States; however, the topic is being researched in many countries around the world.

5.1. Evaluation of Keynes's Theory

The research goal of our study was to investigate technological unemployment based on Keynes's theory. To this end, we assessed why Keynes's vision of three hours of work per day has not been realized so far, and why we assume that, based on current processes in Industry 4.0, it will be realized, at least in part, by 2030.

One of the novelties of our study is proven by the fact that Keynes's work has been linked to technological unemployment in the literature, but not to Industry 4.0 processes. Based on the initial search strategy used in the Web of Science database, the combination of the keywords "Industry 4.0" and "Keynesian Theory" did not yield any results. With a novel approach to our research, we have linked these three concepts: Keynes' 1930 vision, technological unemployment, and Industry 4.0.

In order to answer the research question, we addressed the fact that the vision of the three-hour working day has not been fulfilled in the past 90 years, and in connection to this, we analyzed the current situation of the labor market (2011–2020).

Based on literature analyses, it can be concluded that Industry 4.0 has initiated processes that are likely to lead to a significant reduction in working hours [13,14]. As a result of this process, the amount of manpower required is reduced, bringing us closer to Keynes' three-hour-per-day vision. The result of our study is that we have processed not only theoretical but also practical examples so as to demonstrate that reduced working hours increase economic efficiency through more intensive work.

Several authors have argued that the level of technological unemployment is already significant [13], which is not supported by our research. Based on both theoretical and practical experimentally introduced labor reduction experiments [43,44,83], the amount of labor required will be significantly reduced by 2030, i.e., the phenomenon of technological unemployment is a real threat. Based on our research, the extent of technological unemployment is determined by each country's digitalization strategy and the speed of its adoption, as well as the extent to which the country's education system is prepared to retrain vulnerable labor market groups.

5.2. Assessing the Impact of Industry 4.0

In the context of the second research question, we looked at the possible positive and negative scenarios of Industry 4.0. We sought to address whether the literature evaluates this trend positively or negatively. Based on the analysis of the literature, two main groups can be identified. The first group sees the process of economic performance growth due to technological development as a clearly positive phenomenon. The most famous researcher of this group—and the most important stimulus for the research question of our study—is Keynes, who examined a question corresponding to our research question in his study. In his study, he explained that technological progress is creating the possibility of a drastic reduction in working time and thus a huge increase in leisure time. Keynes wrote this work in 1930, and envisioned this state being reached in a hundred years, in 2030. In Keynes' view, the trend towards a reduction in required working time is clearly positive, and a reduction in working hours creates the conditions for a more liveable, more human existence. The positive effects of digitalization can also be seen in some dimensions of sustainability. Some authors highlighted environmentally friendly solutions [58], higher product and service quality, and the replacement of unhealthy and monotonous jobs [65,67,68].

The second group within the literature clearly evaluated this process as a negative trend, i.e., a decrease in the amount of work done causes disadvantages to humanity [9,10,54]. As a consequence of this process, the negative, destructive tendencies of idleness will prevail, which will be expressed in the aggressiveness of society (specifically, of certain groups). Other authors have identified the needs to change professional profiles [64] and develop new skills [63] as problems.

Of course, authors in economics literature do not take a black-and-white view of the process, but rather stand between these two extremes. Everyone interprets this process as the result of both positive and negative effects, but in our classification, we have grouped the opinions that emerge as the result of opposing predictions.

The opinion of the authors is closer to that of the first group. The current digital transformation provides humanity with the opportunity to reduce working hours, and the meaningful use of increased leisure time will be one of the key challenges of the near future. There is no doubt that for certain groups in society, at certain times, this search for a path will be a bitter one, probably with many—hopefully temporary—setbacks, as well as despair and uncertainty. However, the whole process can be viewed positively: on the one hand, digital transformation opens up a wide range of opportunities for a more dignified life, and on the other hand, from an economic point of view, digitalization will be an unavoidable element of competition, reducing marginal costs.

5.3. Limitation and Future Research Directions

The current study, based on a literature analysis, sought to answer why Keynes' vision of three hours of working time per day has not been fulfilled so far, and why it can be assumed that, based on the current processes of Industry 4.0, this could be achieved by 2030. To answer the research questions, future scenarios and possible threats were analyzed. Following this objective, the study was limited to the literature found in research databases based on a predefined search strategy, and to grey literature sources that were identified during the literature review and that helped to elaborate on the topic. In order to ensure that the fulfilment of Keynes' vision in the context of Industry 4.0 can be discussed with perspective in the present study, a total of 86 peer-reviewed sources were assessed. The literature on the relationship between Industry 4.0 and technological unemployment has been less developed. The literature reviewed generally describes the employment effects of Industry 4.0 in broader labor market terms [6,14].

Due to the complexity of the topic and the significant economic and social impacts of Industry 4.0, further research is needed. In the period under review, the authors did not give a clear picture of the future of employment or address the effects of the reduction in working hours on the future. Consequently, further research is needed to address the modeling of factors influencing changes in working time [84], the development of human capital in the context of Industry 4.0 [20], and the development of a system for a human–machine division of labor [85] based on empirical data. From a research methodological point of view, two possible approaches can be formulated. On one hand, scenario-based research can be valuable [86] to help policy-makers to envision the impact on employment of Industry 4.0, and thus support strategic planning to establish the restructuring of employment in different countries. On the other hand, based on empirical data, we should assess the readiness of the population, and their willingness to retrain and obtain new skills [13], if decision-makers want to reduce the risks of the substitution effect of digitalization and promote sustainable business models [1] to which Industry 4.0 solutions can contribute.

Author Contributions: Conceptualization, G.S.-S. and J.V. methodology, G.S.-S. and J.V.; validation, G.S.-S., B.V. and J.V.; formal analysis, B.V.; investigation G.S.-S., B.V., J.V.; resources, G.S.-S.; data curation, G.S.-S. and B.V.; writing—original draft preparation, G.S.-S., B.V. and J.V.; writing—review and editing, G.S.-S.; visualization, B.V.; All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by European Union and the European Social Fund EFOP-3.6.1-16-2016-00007.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are taken from public databases.

Acknowledgments: The authors are thankful to all the employees for administrative and technical support.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Da Silva, V. L.; Kovaleski, J. L.; Pagani, R. N.; Silva, J. D. M.; Corsi, A. Implementation of Industry 4.0 Concept in Companies: Empirical Evidences. *Int. J. Comput. Integr. Manuf.* **2020**, *33* (4, SI), 325–342. https://doi.org/10.1080/0951192X.2019.1699258.
2. Frey, C. B.; Osborne, M. *The Future of Employment*; Oxford Martin Programme on Technology and Employment - Oxford Martin School, University of Oxford, 2013.

3. Servoz, M. The Future of Work? Work of the Future! On How Artificial Intelligence, Robotics and Automation Are Transforming Jobs and the Economy in Europe. *AI Rep.* **2019**, *44* (6), 566–571. https://doi.org/10.2872/50454.
4. Chen, B.; Marvin, S.; While, A. Containing COVID-19 in China: AI and the Robotic Restructuring of Future Cities. *Dialogues Hum. Geogr.* **2020**, *10* (2), 238–241. https://doi.org/10.1177/2043820620934267.
5. Sharma, A.; Zanotti, P.; Musunur, L. P. Drive Through Robotics: Robotic Automation for Last Mile Distribution of Food and Essentials During Pandemics. *IEEE Access* **2020**, *8*, 127190–127219. https://doi.org/10.1109/ACCESS.2020.3007064.
6. Piątkowski, M. J. Expectations and Challenges in the Labour Market in the Context of Industrial Revolution 4.0. The Agglomeration Method-Based Analysis for Poland and Other EU Member States. *Sustainability* **2020**, *12* (13), 5437. https://doi.org/10.3390/su12135437.
7. Hat, K.; Stoeglehner, G. Spatial Dimension of the Employment Market Exposition To-The Case of Austria. *SUSTAINABILITY* **2020**, *12* (5). https://doi.org/10.3390/su12051852.
8. Sima, V.; Gheorghe, I. G.; Subić, J.; Nancu, D. Influences of the Industry 4.0 Revolution on the Human Capital Development and Consumer Behavior: A Systematic Review. *Sustainability* **2020**, *12* (10), 4035. https://doi.org/10.3390/su12104035.
9. Manyika, J. A Future That Works: AI, Automation, Employment, and Productivity.; 2017.
10. Nedelkoska, L.; Quintini, G. Automation, Skills Use and Training. OECD Social, Employment and Migration Working Papers, No. 202, 2018, OECD Publishing, Paris https://doi.org/10.1787/2e2f4eea-en.
11. IFR. *The Impact of Robots on Productivity, Employment and Jobs*; Frankfurt, Germany, 2017. Retrieved from https://ifr.org/downloads/papers/IFR_The_Impact_of_Robots_on_Employment_Positioning_Paper_updated_version_2018.pdf
12. Zhou, K.; Liu, T.; Zhou, L. Industry 4.0: Towards Future Industrial Opportunities and Challenges. In *2015 12th International Conference on Fuzzy Systems and Knowledge Discovery, FSKD 2015*; Institute of Electrical and Electronics Engineers Inc., 2016; pp 2147–2152. https://doi.org/10.1109/FSKD.2015.7382284.
13. Johansson, J.; Abrahamsson, L.; Kareborn, B. B.; Faltholm, Y.; Grane, C.; Wykowska, A. Work and Organization in a Digital Industrial Context. *Manag. Rev.* **2017**, *28* (3), 281–297. https://doi.org/10.5771/0935-9915-2017-3-281.
14. Novakova, L. The Impact of Technology Development on the Future of the Labour marketin the Slovak Republic. *Technol. Soc.* **2020**, *62*. https://doi.org/10.1016/j.techsoc.2020.101256.
15. Keynes, J. M. Economic Possibilities for Our Grandchildren. In *Essays in Persuasion*; Keynes, J. M., Ed.; Palgrave Macmillan UK: London, 2010; pp 321–332. https://doi.org/10.1007/978-1-349-59072-8_25.
16. Eichhorst, W.; Hinte, H.; Rinne, U.; Tobsch, V. How Big Is the Gig? Assessing the Preliminary Evidence on the Effects of Digitalization on the Labor Market. *Manag. Rev.* **2017**, *28* (3), 298–318. https://doi.org/10.5771/0935-9915-2017-3-298.
17. Habanik, J.; Grencikova, A.; Krajco, K. The Impact of New Technology on Sustainable Development. *Inz. Ekon. Econ.* **2019**, *30* (1), 41–49. https://doi.org/10.5755/j01.ee.30.1.20776.
18. Sánchez, A. L. Digitalization, Robotization, Work and Life: Cartographies, Debates and Practices. *Cuad. Relac. Laborales* **2019**, *37* (2), 249–273. https://doi.org/10.5209/crla.66037.
19. Vojtovic, S.; Krajnakova, E. Trends in Economic Growth and Unemployment in Slovakia. In *Proceedings of the 2013 International Conference on Education, Management and Social Science*; Atlantis Press: Paris, France, 2013. https://doi.org/10.2991/icemss.2013.51.
20. Nagy, J.; Oláh, J.; Erdei, E.; Máté, D.; Popp, J. The Role and Impact of Industry 4.0 and the Internet of Things on the Business Strategy of the Value Chain—The Case of Hungary. *Sustainability* **2018**, *10*, 3491. https://doi.org/10.3390/su10103491
21. Fergnani, A. Scenario Archetypes of the Futures of Capitalism: The Conflict between the Psychological Attachment to Capitalism and the Prospect of Its Dissolution. *Futures* **2019**, *105*, 1–16. https://doi.org/10.1016/j.futures.2018.06.006.
22. Kőműves, Z. S.; Berke Sz. Labor Retention in the Domestic SME Sector in Somogy County. Regiokutatas Szle. **2021**, 6 (1), 66–77. https://doi.org/10.30716/RSZ/21/1/6.
23. Király, G. Útban a Fenntarthatóság Felé. Az Átmenetmenedzsment Megközelítése. *Kovász* **2013**, *17* (1–4), 3-28.
24. Hofmann, E.; Rüsch, M. Industry 4.0 and the Current Status as Well as Future Prospects on Logistics. *Comput. Ind.* **2017**, *89*, 23–34. https://doi.org/10.1016/j.compind.2017.04.002.
25. Türkeș, M.; Oncioiu, I.; Aslam, H.; Marin-Pantelescu, A.; Topor, D.; Căpușneanu, S. Drivers and Barriers in Using Industry 4.0: A Perspective of SMEs in Romania. *Processes* **2019**, *7* (3), 153. https://doi.org/10.3390/pr7030153.
26. Qin, J.; Liu, Y.; Grosvenor, R. A Categorical Framework of Manufacturing for Industry 4.0 and Beyond. In *Procedia CIRP*; Elsevier B.V., 2016; Vol. 52, pp 173–178. https://doi.org/10.1016/j.procir.2016.08.005.
27. Tortorella, G. L.; Fettermann, D. Implementation of Industry 4.0 and Lean Production in Brazilian Manufacturing Companies. *Int. J. Prod. Res.* **2018**, *56* (8), 2975–2987. https://doi.org/10.1080/00207543.2017.1391420.
28. Lee, J.; Kao, H.-A.; Yang, S. Service Innovation and Smart Analytics for Industry 4.0 and Big Data Environment. *Procedia CIRP* **2014**, *16*, 3–8. https://doi.org/10.1016/j.procir.2014.02.001.
29. Branca, T. A.; Fornai, B.; Colla, V.; Murri, M. M.; Streppa, E.; Schroder, A. J. Current and Future Aspects of the Digital Transformation in the European Steel Industry. *Mater. Tech.* **2020**, *108* (5–6). https://doi.org/10.1051/mattech/2021010.
30. Cerezo-Narváez, A.; Otero-Mateo, M.; Rodríguez-Pecci, F.; Pastor-Fernández, A. Digital Transformation of Requirements in the Industry 4.0: Case of Naval Platforms. *Dyna* **2018**, *93* (4), 448–456. https://doi.org/10.6036/8636.
31. Brynjolfsson, E.; McAfee, A. Race against the Machine: How the Digital Revolution Is Accelerating Innovation, Driving Productivity, and Irreversibly Transforming Employment and the Economy.; Digital Frontier Press, Lexington, Massachusetts, USA, 2011.

32. Manavalan, E.; Jayakrishna, K. A Review of Internet of Things (IoT) Embedded Sustainable Supply Chain for Industry 4.0 Requirements. *Comput. Ind. Eng.* **2019**, *127*, 925–953. https://doi.org/10.1016/j.cie.2018.11.030.
33. Guchhait, R.; Pareek, S.; Sarkar, B. How Does a Radio Frequency Identification Optimize the Profit in an Unreliable Supply Chain Management? *Mathematics* **2019**, *7* (6), 490. https://doi.org/10.3390/math7060490.
34. Sardar, S. K.; Sarkar, B.; Kim, B. Integrating Machine Learning, Radio Frequency Identification, and Consignment Policy for Reducing Unreliability in Smart Supply Chain Management. *Processes* **2021**, *9* (2), 1–16. https://doi.org/10.3390/pr9020247.
35. Sarkar, M.; Pan, L.; Dey, B. K.; Sarkar, B. Does the Autonomation Policy Really Help in a Smart Production System for Controlling Defective Production? *Mathematics* **2020**, *8* (7), 1142. https://doi.org/10.3390/math8071142.
36. Sett, B. K.; Dey, B. K.; Sarkar, B. Autonomated Inspection Policy for Smart Factory—An Improved Approach. *Mathematics* **2020**, *8* (10), 1815. https://doi.org/10.3390/math8101815.
37. Dey, B. K.; Pareek, S.; Tayyab, M.; Sarkar, B. Autonomation Policy to Control Work-in-Process Inventory in a Smart Production System. *Int. J. Prod. Res.* **2021**, *59* (4), 1258–1280. https://doi.org/10.1080/00207543.2020.1722325.
38. Jazdi, N. Cyber Physical Systems in the Context of Industry 4.0. In *2014 IEEE International Conference on Automation, Quality and Testing, Robotics*; IEEE, 2014; pp 1–4. https://doi.org/10.1109/AQTR.2014.6857843.
39. Wollschlaeger, M.; Sauter, T.; Jasperneite, J. The Future of Industrial Communication: Automation Networks in the Era of the Internet of Things and Industry 4.0. *IEEE Ind. Electron. Mag.* **2017**, *11* (1), 17–27. https://doi.org/10.1109/MIE.2017.2649104.
40. Taylor, K. B. The Passing of Western Civilization. *Futures* **2020**, *122*, 102582. https://doi.org/10.1016/j.futures.2020.102582.
41. Krämer, W. Kahneman, D. (2011): Thinking, Fast and Slow. *Stat Pap.* **2014**, *55* (3), 915. https://doi.org/10.1007/s00362-013-0533-y.
42. Skidelsky, R.; Skidelsky, E. *How Much Is Enough? Money and the Good Life*; Other Press: New York: New York, NY, US, 2013.
43. Kamerāde, D.; Wang, S.; Burchell, B.; Balderson, S. U.; Coutts, A. A Shorter Working Week for Everyone: How Much Paid Work Is Needed for Mental Health and Well-Being? *Soc. Sci. Med.* **2019**, *241*, 112353. https://doi.org/10.1016/j.socscimed.2019.06.006.
44. Glaveski, S. The Case for the 6-Hour Workday. 96 (5), *Harv. Bus. Rev.* 2018, Available online:https://hbr.org/2018/12/the-case-for-the-6-hour-workday (accessed on 02 February 2021).
45. Soojung-Kim, A. Shorter: How Working Less Will Revolutionise the Way Your Company Gets Things Done; Penguin: London, 2020.
46. Akerlof, G. A.; Shiller, R. J. Animal Spirits: How Human Psychology Drives the Economy, and Why It Matters for Global Capitalism; Princeton University Press, 2011.
47. Krugman, P. *End This Depression Now!*; W. W. Norton & Company, 2012.
48. Riskbank. *Digitisation and Inflation. Monetary Policy Report 2015 February*; 2015. Available online: http://archive.riksbank.se/Documents/Rapporter/PPR/2015/150212/rap_ppr_150212_eng.pdf (accessed on 12 March 2021)
49. Graetz, G.; Michaels, G. Robots at Work. *Rev. Econ. Stat.* **2018**, *100* (5), 753–768. https://doi.org/10.1162/rest_a_00754.
50. Grigoli, F.; Koczan, Z.; Topalova, P. Automation and Labor Force Participation in Advanced Economies: Macro and Micro Evidence. *Eur. Econ. Rev.* **2020**, *126*, 103443. https://doi.org/10.1016/j.euroecorev.2020.103443.
51. Keynes, J. M. Economic Possibilities for Our Grandchildren. *Nation & Athenaeum*. 1930.
52. Manyika, J.; Chui, M.; Bughin, J.; Dobbs, R.; Bisson, P.; Marrs, A. Disruptive Technologies: Advances That Will Transform Life, Business, and the Global Economy; 2013.
53. Cseh Papp, I.; Bilan, S.; Dajnoki, K. Globalization of the Labour Market – Circular Migration in Hungary. *J. Int. Stud.* **2019**, *12* (2), 182–200. https://doi.org/10.14254/2071-8330.2019/12-2/11.
54. Weldon, M. K. *The Future X Network : A Bell Labs Perspective*; CRC Press, 2018. https://doi.org/10.1201/9781315365756.
55. Frey, C. B.; Osborne, M. A. The Future of Employment: How Susceptible Are Jobs to Computerisation? *Technol. Forecast. Soc. Change* **2017**, *114*, 254–280. https://doi.org/10.1016/j.techfore.2016.08.019.
56. Nafchi, M. Z.; Mohelska, H. Effects of Industry 4.0 on the Labor Markets of Iran and Japan. *ECONOMIES* **2018**, *6* (3). https://doi.org/10.3390/economies6030039.
57. Danaher, J. Will Life Be Worth Living in a World Without Work? Technological Unemployment and the Meaning of Life. *Sci Eng Ethics* **2017**, *23* (1), 41–64. https://doi.org/10.1007/s11948-016-9770-5.
58. Ghislieri, C.; Molino, M.; Cortese, C. G. Work and Organizational Psychology Looks at the Fourth Industrial Revolution: How to Support Workers and Organizations? *Front. Psychol.* **2018**, *9*. https://doi.org/10.3389/fpsyg.2018.02365.
59. Hernandez-de-Menendez, M.; Morales-Menendez, R.; Escobar, C. A.; McGovern, M. Competencies for Industry 4.0. *Int. J. Interact. Des. Manuf. - IJIDEM* **2020**, *14* (4), 1511–1524. https://doi.org/10.1007/s12008-020-00716-2.
60. Bokrantz, J.; Skoogh, A.; Berlin, C.; Stahre, J. Maintenance in Digitalised Manufacturing: Delphi-Based Scenarios for 2030. *Int. J. Prod. Econ.* **2017**, *191*, 154–169. https://doi.org/10.1016/j.ijpe.2017.06.010.
61. Gordon, R. J. Is U.S. Economic Growth Over? Faltering Innovation Confronts the Six Headwinds; 2012. https://doi.org/10.3386/w18315.
62. Manyika, J.; Susan Lund; Michael Chui; Jacques Bughin; Jonathan Woetzel; Parul Batra; Ryan Ko; Saurabh Sanghvi. *Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation*; 2017.
63. Jäger, J.; Schöllhammer, O.; Lickefett, M.; Bauernhansl, T. Advanced Complexity Management Strategic Recommendations of Handling the "Industrie 4.0" Complexity for Small and Medium Enterprises. *Procedia CIRP* **2016**, *57*, 116–121. https://doi.org/10.1016/j.procir.2016.11.021.

64. Krykavskyy, Y.; Pokhylchenko, O.; Hayvanovych, N. Supply Chain Development Drivers in Industry 4.0 in Ukrainian Enterprises. *Oeconomia Copernicana* **2019**, *10* (2), 273–290. https://doi.org/10.24136/oc.2019.014.
65. Bányai, T.; Tamás, P.; Illés, B.; Stankevičiūtė, Ž.; Bányai, Á. Optimization of Municipal Waste Collection Routing: Impact of Industry 4.0 Technologies on Environmental Awareness and Sustainability. *Int. J. Environ. Res. Public Health* **2019**, *16* (4), 634. https://doi.org/10.3390/ijerph16040634.
66. Lambert, J.; Cone, E. *How Robots Change the World. What Automation Really Means for Jobs and Productivity. Economic Outlook*; 2019. 1-64 Oxford Economics: London Available online: https://www.oxfordeconomics.com/recent-releases/how-robots-change-the-world (accessed on 11 February 2021)
67. Albers, A.; Gladysz, B.; Pinner, T.; Butenko, V.; Stürmlinger, T. Procedure for Defining the System of Objectives in the Initial Phase of an Industry 4.0 Project Focusing on Intelligent Quality Control Systems. *Procedia CIRP* **2016**, *52*, 262–267. https://doi.org/10.1016/j.procir.2016.07.067.
68. Moeuf, A.; Pellerin, R.; Lamouri, S.; Tamayo-Giraldo, S.; Barbaray, R. The Industrial Management of SMEs in the Era of Industry 4.0. *Int. J. Prod. Res.* **2018**, *56* (3), 1118–1136. https://doi.org/10.1080/00207543.2017.1372647.
69. Bakhshi, H.; Downing, J. M.; Osborne, M. A.; Schneider, P. *The Future of Skills Employment 2030*; Pearson and Nesta: London, 2017.
70. Malathi, M. Cloud Computing Concepts. In *ICECT 2011 - 2011 3rd International Conference on Electronics Computer Technology*; 2011; Vol. 6, pp 236–239. https://doi.org/10.1109/ICECTECH.2011.5942089.
71. Liu, Y.; Peng, Y.; Wang, B.; Yao, S.; Liu, Z. Review on Cyber-Physical Systems. *IEEE/CAA J. Autom. Sin.* **2017**, *4* (1), 27–40. https://doi.org/10.1109/JAS.2017.7510349.
72. Mohamed, M. Challenges and Benefits of Industry 4.0: An Overview. *Int. J. Supply Oper. Manag.* **2018**, *5* (3), 256–265.
73. Kim, Y. J.; Kim, K.; Lee, S. The Rise of Technological Unemployment and Its Implications on the Future Macroeconomic Landscape. *Futures* **2017**, *87*, 1–9. https://doi.org/10.1016/j.futures.2017.01.003.
74. Brynjolfsson, E.; McAfee, A. The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies.; WW Norton & Company., 2014.
75. Smith, A.; Anderson, J. *AI, Robotics, and the Future of Jobs*; Pew Research Center, Report, 6 (51) 2014. Retrieved from https://5y1.org/download/6042b8dba7ffcec7cac5f4b9cc7d2264.pdf (05 April 2021).
76. Zemtsov, S. New Technologies, Potential Unemployment and 'Nescience Economy' during and after the 2020 Economic Crisis. *Reg. Sci. Policy Pract.* **2020**, *12* (4), 723–743. https://doi.org/10.1111/rsp3.12286.
77. Forum, W. E. *The Future of Jobs Report 2018*; Centre for the New Economy and Society: Geneva, 2018.
78. OECD. Average annual hours actually worked. Database. Available online: https://www.oecd-ilibrary.org/employment/data/hours-worked/average-annual-hours-actually-worked_data-00303-en (accessed on 18 January 2021), doi.org/https://doi.org/10.1787/lfs-data-en.
79. Harris, K.; Austin Kimson; Schwedel Andrew. Labor 2030: The Collision of Demographics, Automation and Inequality. Bain & Company, Report, 2018. Available online: https://www.explodingafrica.com/wp-content/uploads/2018/04/Labor-2030.-The-Collision-of-Demographics-Automation-and-Inequality_Bain-Company-1.pdf (accessed on 22 April 2021).
80. Frey, C. B.; Osborne, M. A.; Holmes, C.; Rahbari, E.; Garlick, R.; Friedlander, G.; McDonald, G.; Curmi, E.; Chua, J.; Chalif, P.; Wilkie, M. *Technology at Work v2. 0: The Future Is Not What It Used to Be.*; Oxford, 2016.
81. Berger, T.; Frey, C. B. Bridging the Skills Gap. In *Technology, globalisation and the future of work in europe essays on employment in a digitised economy*; Dolphin, T., Ed.; Institute for Public Policy Research: London, 2015; pp 75–80.
82. Vinichenko, M. V; Melnichuk, A. V; Karácsony, P. Technologies of Improving the University Efficiency by Using Artificial Intelligence: Motivational Aspect. *Entrep. Sustain. Issues* **2020**, *7* (4), 2696–2714. https://doi.org/10.9770/jesi.2020.7.4(9).
83. Cui, F.; Ma, L.; Hou, G.; Pang, Z.; Hou, Y.; Li, L. Development of Smart Nursing Homes Using Systems Engineering Methodologies in Industry 4.0. *Enterp. Inf. Syst.* **2020**, *14* (4), 463–479. https://doi.org/10.1080/17517575.2018.1536929.
84. Schulte, P. A.; Streit, J. M. K.; Sheriff, F.; Delclos, G.; Felknor, S. A.; Tamers, S. L.; Fendinger, S.; Grosch, J.; Sala, R. Potential Scenarios and Hazards in the Work of the Future: A Systematic Review of the Peer-Reviewed and Gray Literatures. *Annals of Work Exposures and Health*. Oxford University Press 2020, pp 786–816. https://doi.org/10.1093/ANNWEH/WXAA051.
85. Inshakova, A. O.; Frolova, E. E.; Rusakova, E. P.; Kovalev, S. I. The Model of Distribution of Human and Machine Labor at Intellectual Production in Industry 4.0. *J. Intellect. Cap.* **2020**, *21* (4, SI), 601–622. https://doi.org/10.1108/JIC-11-2019-0257.
86. Oláh, J.; Aburumman, N.; Popp, J.; Khan, M. A.; Haddad, H.; Kitukutha, N. Impact of Industry 4.0 on Environmental Sustainability. *Sustain.* **2020**, *12* (11), 4674. https://doi.org/10.3390/su12114674.