

Industry 4.0 - Development and Consequences for Sustainable Development of Bulgaria

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Abstract - The report presents analytical information about the state of play of the processes of the Fourth Industrial Revolution in different areas of the Bulgarian economy and industry. Based on a survey conducted in Bulgarian SMEs, the respondents' idea of the challenges and obstacles faced by company guides in its implementation in production, digital education, qualification and training in the course of the work is summarized. Data from a survey on key skills and competences needed to work in digitalization conditions have been released. Recommendations and sample applications have been formulated to ensure a successful symbiosis of Industry 4.0 with Industry 5.0.

Keywords - digital education, challenges, competences, Industry 4.0

I. INTRODUCTION

The digitalization coming into the world poses new challenges for Bulgarian organizations from different economic sectors. The COVID-19 pandemic has led to numerous changes, and the economic crisis has affected the whole world. Many business and non-profit organisations have been placed in a new business environment where consumer's behaviour has changed and conditions have become even more precarious. The most affected by the crisis is the small business. This sector of the economy is most vulnerable because it represents over 90% of the entire business in Bulgaria. In turn, the average occupies only about a percentage, and the large one – below 0.5% (as of 2019) Given the situation, digitalization has proved to be the key to the flexibility and adaptability of each company.

II. EXPOSITION

In the exceptional difficult conditions in which modern business is to function, Industry 4.0 has become ubiquitous in the following economic areas, characterized by enhanced digital connectivity and mobility of people of

active working age, whose existence has become part of the large digital community:

- information and communication technologies;
- cyber-physical systems;
- storage and processing of large-scale data sets (so-called cloud systems);
- systems for modeling, simulating and virtual presentation of information;
- tools for interaction between humans and computing machines.

A significant proportion of companies surveyed by university lecturers [5],[6] put new materials into their production using computer systems for production management, the essential elements of which are the minimization of waste and the use of technology for their recovery. In 40% of them, new information technologies have entered into administrative activity, accounting, pricing, stock and order management. About 1/2 of the companies surveyed do not yet have developed a comprehensive system for training and upskilling of the staff needed for working in the conditions of Industry 4.0. About 1/3 of the companies are in the process of developing such a system, and the remaining 20% already have a developed and operational system. In recent decades, it has become obvious to everyone that the problems faced by organizations are becoming more complex, dynamic and multidimensional. These include transformation in all areas of the business related to automation and digitization of workflows, constant economic uncertainty, employee engagement, etc. The internal dynamics of these problems are constantly changing and complicated by the advancing Industry 5.0, in which people and machines will have to interact as harmoniously as possible in order to maintain their competitiveness and adapt to the new way of working.

Many SMEs have managed to reap the benefits in the country for creating added value and successfully

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participating in industry 4.0 processes. Positives for the digital transformation of the Bulgarian industry are: well-developed ICT infrastructure with high-speed broadband; excellent tradition in the IT sector; access to European programmes; widespread use of the Internet.

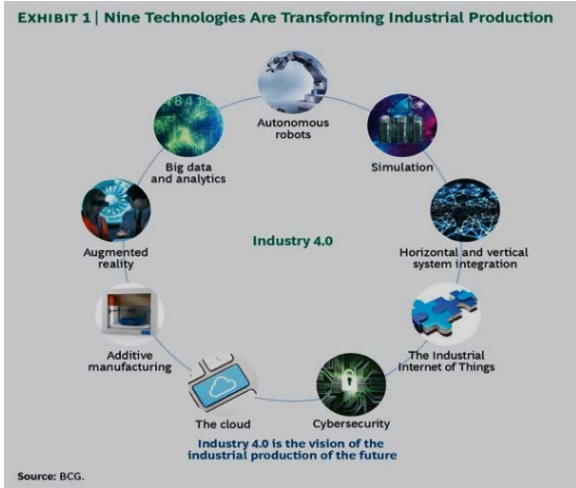


Fig. 1. Vision of Industry 4.0

Source: Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries

The unfolding global pandemic has accelerated the digital transformation process in almost all sectors and united industries in their efforts to be more cooperative for a functional digital future. The ability to use digital tools and channels has become a major tool for entrepreneurs trying not only to survive the current crisis, but also to make the most of it. In a world of forced contactlessness, a huge part of the interaction of companies with their customers and employees must take place virtually. In many of these cases, the digital presence becomes the only way for the Bulgarian small, medium and large business to survive in the conditions of forced closure and social isolation.

When looking at the issues of "Industry 4.0" in the context of the sustainability of the national economy, we need to address not only the industrial sector, but also the other areas relevant to the management of sustainable development.

1. Socio-economic development
2. Sustainable consumption and production
3. Social inclusion
4. Demographic changes
5. Public Health
6. Climate change and clean energy
7. Sustainable transport
8. Natural resources
9. Global Partnership
10. Effective management

The digital transformation of the business is studied and analyzed in the publications of a number of Bulgarian researchers through different approaches [1], [2], [3], [4]. Flexible adaptation of modern enterprises to dynamic changes requires the development and use of new business models.

Through them, management teams can respond quickly and adequately to ever-evolving technologies, enabling them to collaborate in a new ecosystem, effectively manage data as a valuable asset and tackle cybersecurity.



Fig. 2. Technological aspects of Industry 4.0 [11]

The following figure traces innovations during individual industries in the course of their evolution:

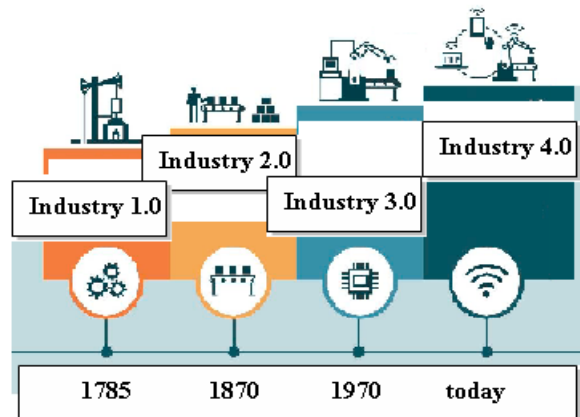


Fig. 3. Industry development

Legend:

- **Industry 1.0** - mechanization, steam power; weaving loom
- **Industry 2.0** - mass production, assembly line; electric energy;
- **Industry 3.0** - automation, computers, electronics]
- **Industry 4.0** - cybernetic systems, the Internet of Things, networks.
- **Industry 5.0** – the future industry – collaboration between robots and humans, the so-called "koboti"

The Internet of Things, cloud technologies, large databases and analytical tools, mobile communications and social networks are the strategic solutions needed for digital transformation of organizations. They all set up a quality new business model that achieves maximum operational efficiency through data mining, forecast modelling and forecast analysis; development of a digitised ecosystem of products and services. The digital

skills of the workforce combine digital and technical skills with problem-solving skills; create new job descriptions, incentives and career paths for the recruitment and retention of skilled employees; flexibility in the workplace; build global teams.

IMD's Global Digital Business Transformation Centre has developed a so-called „grand piano model“ in which it describes seven areas of organisational change presented in Figure 4: [7]

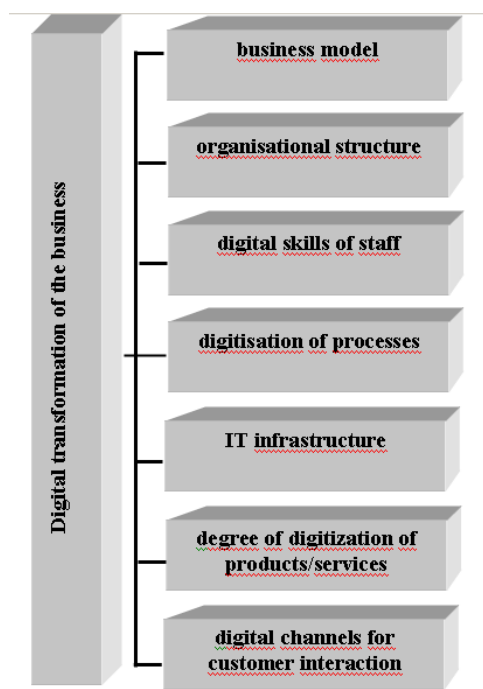


Fig.4. Digital Royal

The new draft digital transformation strategy in the country for the period 2020-2030, prepared by the Ministry of Transport, Information Technology and Communications, sets out the implementation of the following main objectives:

- deployment of secure digital infrastructure;
- ensuring access to adequate technological knowledge and digital skills;
- unlocking the potential of the data;
- digitisation in favour of a circular, low-carbon economy;
- improving the efficiency of government and the quality of public services.

Gigabit connectivity will be ensured by 2030 for all major socio-economic drivers such as schools, transport hubs and major public service providers, as well as digitally intensive enterprises. Support for high-speed connectivity will be accompanied by trainings for acquiring new or improving key competences and professional qualifications; new skills for specific new jobs. Strategic measures include enhancing citizens' digital skills and stimulating demand for internet-based services from the population and businesses.

Bulgarian small and medium-sized enterprises (SMEs), which make up more than 99.8% of enterprises in Bulgaria, face many challenges posed by digitization and Industry 4.0.

Purpose of the study and methodology

This publication aims to explore the potential of Industry 4.0 for Bulgarian SMEs and their level of readiness (digital, infrastructure, etc.). The arguments formulated above are set out in the questions of a questionnaire, with the help of which, in the framework of project 2009C "Management of technological change as a structured process for finding effective and flexible solutions through Industry 4.0, funded by the Research Fund for 2020, a study has been carried out on the problems related to digitization in Bulgarian SMEs. Some of the answers to the questions received in the survey are presented graphically.

For respondents were selected company managers, as well as managers from the average management levels – mainly operating managers, who are directly related to the implementation of Industry 4.0 in their enterprises. The results obtained, although the relatively small number of SMEs surveyed cannot be claimed to be of great representativeness, are interesting and indicative of the problems and what is to be done for the preparation of Bulgarian SMEs for the implementation of Industry 4.0. The survey covers 86 companies from different districts in the country By subject of activity they are allocated as follows:

- processing industry – 42%;
- services – 50%;
- mechanical engineering – 8%.

By their size, the sample SMEs are relatively "evenly distributed": medium – 35%, small – 32.5% and micro – 32.5% (Fig. 5).

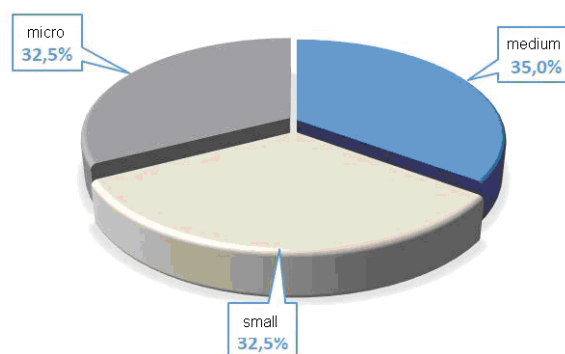


Fig. 5. Structure by size of SMEs

According to a poll conducted, more than 80% of respondents rated the role of digital in their company as "decisive" or "very significant." With regard to the current level of digitisation, more than half of respondents replied that it was above average. Nearly 90% of the companies where the survey was done indicated that within three years they would have already taken steps towards

digitizing the processes. The survey participants were asked the questions:

1. What topics were discussed in the companies surveyed last year?

We received the following responses, calculated in percentage terms of the figure:

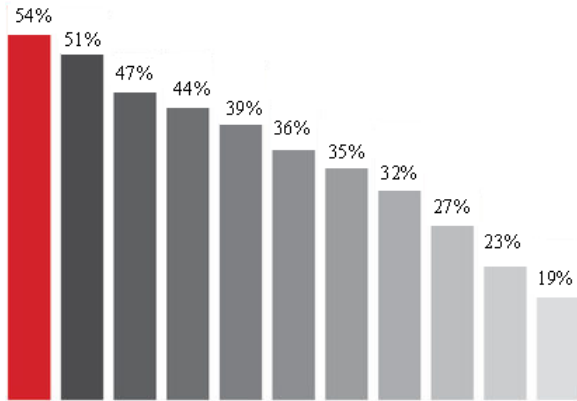


Fig. 6. Topics discussed in companies

Legend:

- development and implementation of innovations – 54%;
- productivity gains – 51%;
- achieving growth – 47 %;
- expansion of markets – 44 %;
- introduction of new business models – 39%;
- implementation of modern technologies – 36%;
- attitude of the staff for change – 35%;
- minimizing operating costs –32%;
- protection against cyber attacks – 27%;
- achieving competitive advantages -23%;
- management of creative human resources (talents) – 19%.

2. In which of these areas will Industry 4.0 have the greatest impact on the public?

Each respondent gave up to three answers:

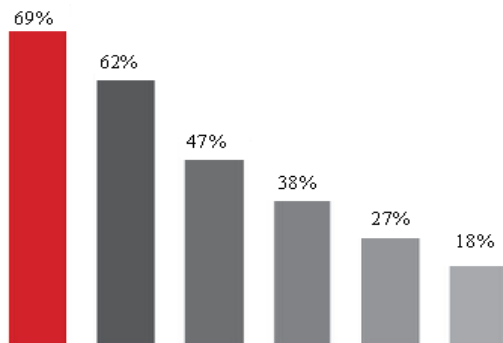


Fig. 7. Influence of Industry 4.0

Legend:

- public sector – 69%;
- private sector – 62%;
- state regulators – 47%;
- intergovernmental cooperation - 38%;

- electoral attitudes- 27%;
- non-governmental organizations – 18%.

3. What are the most common difficulties (obstacles) in digital transformation of company processes?

The surveyed top managers formulate several main obstacles in developing new business models to ensure strategic competitiveness of the companies they manage.

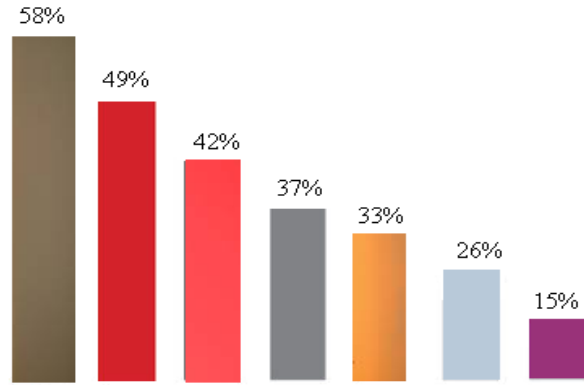


Fig. 8. Barriers to introduction of Industry 4.0

Legend:

- lack of internal ranking of strategic objectives - 58%;
- lack of cooperation with external partners - 49%;
- lack of a specific business case to justify investments in the necessary IT structure – 42%;
- lack of adequate complex skills to absorb the approach to Industry 4.0 – 37%;
- difficulties in coordinating the actions of the different units – 33%;
- insufficient attitude and motivation to participate in radical transformation – 26%;
- undesirables for changes by elderly employees in enterprises – 15%;

4. How will the process optimization help you grow your business?

Only strategic managers in the companies where the survey was carried out answered this question. Of these, 25% working in SMEs and 34% of large enterprises pointed to automatic connectivity with suppliers and customers.

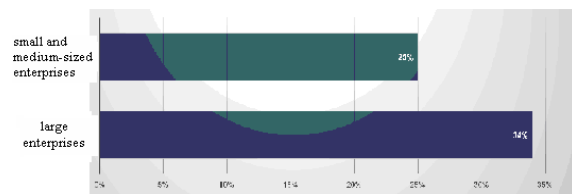


Fig.9. Automatically connected business processes with suppliers and customers

Fig.10 presents survey data among regional managers on the necessary competencies of their employees:

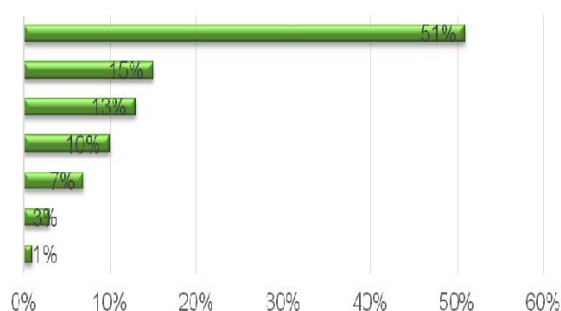


Fig.10. Key competences of HR

Legend:

- digital skills – 51%;
- technical competences – 15%;
- entrepreneurial attitudes – 13%;
- creativity – 10%;
- organizational skills – 7%;
- communication – 3%;
- others – 1%.

5. What challenges do company executives face from the entry of Industry 4.0 into their organizations?

When interviewing linear and functional managers, we ranked the following challenges for SMEs related to Industry 4.0:

- security and cybersecurity issues;
- reliability and stability in critical communication;
- the need to preserve the integrity of production processes;
- avoiding costly large interruptions;
- protection of industrial know-how in control files for industrial automation;
- risk of redundancies in IT departments;
- challenges in integrating data from different sources.

The analysis of challenges identifies a number of new specific opportunities and management solutions in the context of digital transformation.

Findings

Industry 4.0 has different aspects that can affect Bulgarian SMEs. It can transform business models and value chains by connecting built-in systems and intelligent manufacturing processes.

Nearly 50% of the study participants believe that Industry 4.0 can significantly change their production systems. Some 23% of respondents said that the 4th Industrial Revolution could affect their business in all aspects, while 15.6% of them believe that only IT systems can benefit from the concept of Industry 4.0.

Based on the survey results, 36.8% of respondents stated that the lack of internal digital culture and training, insufficient opportunities for the introduction of new business models, as well as dynamically changing market requirements are the most critical barriers to the implementation of Industry 4.0 in their organizations.

After conducting extensive interviews with some of the managers in the machine building industry, they point out that not only technological and product company

renewal is necessary, but also the implementation of modern technologies contributing to environmental protection, in accordance with national and European requirements.

Challenge analysis identifies a number of new specific opportunities and management solutions in the context of digital transformation.

On the other hand, the world's data on consumption and nutrition of the population is extremely worrying - over a billion and a half people on the planet suffer from malnutrition. Between 30 and 50 per cent of all food produced in the world is thrown away, according to a sensational report by the British Association of Engineers. This equates to between 1.2 and 2 billion tonnes per year. In the UK itself, 30% of vegetables produced are not even picked because they do not meet the appearance requirements of distributors. Half of the food bought in the US and UK goes to rubbish bins dumped by shoppers. Globally, about 550 billion cubic meters of water are wasted each year to grow crops that never reach consumers. The energy costs of supply exceed at times the energy costs of producing a particular unit of each type of fruit and vegetables. In this aspect, Industry 4.0 can provide crucial support for optimal use of fertile areas and the development of modern agriculture.

The solutions consist in the design and commissioning of integrated complexes for organic production, harvesting and delivery of fruit and vegetables on indoor and outdoor areas, based on existing technologies, technological solutions and finished elements. In order to be efficient, integrated production complexes need to be introduced on large vacant areas. They are suitable for the territory of the Republic of Bulgaria and due to the lack of labour. Variant of the application of Industry 4.0. are mobile autonomous robots (drones, drones and ground robots) used in the country for precise grain production.

In recent decades, large enterprises in the Bulgarian mining industry have been among the leading ones in Europe in the pace of introduction of new technologies in all aspects of their activities. Modern solutions are integrated both to achieve high safety at work in mining sites and to minimise environmental footprints and greenhouse gas emissions. Modern digital technologies are successfully implemented and implemented programs for complete digital transformation of production processes. They cover automation, mining equipment management and monitoring systems. The results are higher productivity, better cost and quality of the finished product, as well as the possibility of optimal and longer utilization of natural resources. Mining companies can observe different aspects of the modern concept of the circular economy, which are actually implemented.

With the development of automated vehicles, the use of clean technologies and, in particular, the emergence of low-emission trucks and electric vehicles is increasing. New digital technologies in the transport and logistics industry reduce costs and improve efficiency by offering automated analyses for business in real time.

In Bulgaria there are good examples of digital transformation in both the leading sector of information

and communication technologies, as well as in traditional sectors and banking services. Over the past five years there has been a rapid growth rate of employees in information technology (by 56.2%) Bulgaria is at the forefront of ICT start-ups in the EU.

Outside of the information and communication technology sector and digital marketing agencies, good examples of a holistic approach to these processes have some of the banks in the country. Factors for the success of the digital transformation in the Bulgarian banking sector are the provided financial resource and the targeted work to change the attitude of employees towards replacing traditional processes with digital ones. With regard to customers, the digital transformation is aimed at narrowing the market segments based on more precise processing of information, increasing the access opportunities and speed of the service, as well as the individualization of promotional offers in branch banking structures.

Digital innovation for the Bulgarian banking market is the introduction of the Factoring.bg. The platform shortens the time and effort in the exchange of information, improves the speed and transparency of factoring transactions, speeds up advance payments, minimizes manual document filling and ensures transparency throughout the process.

The force majeure circumstances has accelerated the processes for the digitization of the Bulgarian economy, from which it will continue to benefit in the long term. The digital revolution achieved in a short time significant objective advantages, some of which are:

- Increased efficiency. The digital economy has the undoubted potential to optimize operations and automate processes in a number of industries. As a result, each company can optimize its time and human resources, minimize its waste and environmental footprint, and focus on revenue-generating activities.

- Improve the customer experience. The Internet of Things (Internet of Things or IoT) is the basis for creating a "smart world" - a reality built of objects, devices and infrastructure connected to the Internet and, accordingly, to each other. IoT has the capacity to accelerate and refine a number of processes across industries. The digitization of trade can be based on technologies such as IoT and artificial intelligence to offer its customers the personalization of next-generation services and respond to needs already in the bud of their emergence.

- Excellent security. Contrary to some outdated perceptions, technologies such as blockchain and decentralised data storage could make digital processes far more secure and reliable than easily manipulative physical reality.

- Adaptability. The digital economy gives tremendous leeway in a physically limited world. It opens the door to the practices of the future - remote teams, virtual operations, omnichannel marketing, automated payments and flexible co-op terms with partners and customers.

- Repeated return on investment. Digitization is a complex process that requires a certain amount of time and capital investment. Virtual operations save extremely much time, resources and losses in the long term,

providing a much wider scope and adaptability of the business to competition.

The digital trend for working from home achieves much more connectivity and many more people learn to use the digital environment, which means that there are many more consumers for the digital products that entrepreneurs create.

Short-term consequences

One of the most obvious consequences we are likely to see in the coming years is the decline in demand for labour. This will be the result of the slowdown of the global, European and Bulgarian economies. The most endangered groups will be older workers, as well as people with lower education and skills. The decline can be offset somewhat by demand in other sectors that will remain less affected by the crisis. Employment will hold certain levels as the virus flows less lightly in people of working age.

Long-term consequences

Social isolation required many companies to introduce compulsory work from home - something that before the pandemic was typical of only a few of them, especially the liberal professions. On the one hand, if working from home proves just as productive as working from an office, it can become much more prevalent after the end of the virus crisis. If it delivers well, many companies will have more confidence in people in their teams to work outside the office. At the same time, the offices of many companies may prove to be an unnecessary cost of rent, consumables and overhead.

This would also depend on the dynamics of working at home and what results companies will show. Technological developments will be one of the few positive long-term consequences of the crisis. The need for remote work will speed up the process of developing new and improving existing technologies. The projected expectations are for an increase in the rise of high technology and the number of software and hardware specialists without which remote operation is impossible.

The industry, in particular manufacturing, will continue on the path of robotisation, but at a higher rate due to market needs. Automation is one of the solutions to curb the pandemic in the manufacturing sector, where many people usually work in the same room. This will provide more personal space for employees in factories and other manufacturing plants.

The social distance will inevitably also require changes in the work of the state administration. New electronic administrative services and optimisation of existing ones will need to be introduced. The inability to physically go to the institutions will also require the administration to change the way it works.

Many sectors will suffer huge economic losses. One of the first sectors concerned is transport, as the production and supply of raw materials and goods will decline. Trade, restaurant business, culture and sport are also among the most affected industries. Last but not least comes tourism, which suffers severe consequences.

CONCLUSION

In conclusion, we can say that the 2020 pandemic has opened the doors of the digital economy, which is currently creating its "creative destruction" - a process in which an outdated system collapses and goes into the past to pave the way for something new, more accurate, smarter and better. COVID-19 has become the catalyst for digital transformation.

The results of the survey show a high level of awareness of the Bulgarian managers for Industry 4.0. Respondents demonstrated widespread use of IT infrastructure in their accounting and financial systems (78%), and also had significant benefits in supply management and set-aside/stocks (around 67%). Participants in the survey indicate the existence of a developed company strategy for the implementation of Industry 4.0, yet most top managers are working on creating one and intend to invest up to 10% of their realized profit in the digitization of their processes in the next 1-2 years.

The new industrial revolution has the potential to improve productivity as well as life and quality of jobs, if properly accompanied by a stable mix of policies for inclusive and sustainable, innovation-driven growth.

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