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Industry 4.0: SMEs Challenges and Opportunities in the Era of Digitalization



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Industry 4.0: SMEs Challenges and Opportunities in the Era of Digitalization

1. Introduction

Over the centuries, different industrial revolutions have taken place and have shaped the way of living, working and producing. Nowadays, epochal changes occur in few years and companies that do not keep abreast of these evolutions are likely to disappear. We are now experiencing a revolution that is already transforming the entire society and, more deeply, all industries. In this context, digitalization is a process that affects companies of all sizes, notably Small and Medium-sized Enterprises (SMEs). This business category can benefit from the implementation of such technologies, but they are facing several challenges such as the existing lack of digital skills within the labor market and the increasing number of cyberattacks jeopardizes data and commercial secrets.

The European Union has always played a key role in boosting competitiveness of its businesses through a wide variety of laws and continuous investments to help Member States in developing cutting-edge technologies. The EU, thanks to its innovative financial programs, is now more ambitious and aims at becoming autonomous and competing with other economic and technological giants such as China and the United States. Strengthening the industrial system is a key element for the future of Europe and a long-term strategy is necessary to maintain its competitiveness. The European Commission has presented the *Digital Europe programme* for the

next EU financial period 2021-2027, which plans to invest in five main areas: supercomputers, Artificial Intelligence (AI), cybersecurity and trust, digital skills and ensuring a wide use of technologies across the economy and the society.

The core of this paper focuses on the main opportunities and concerns for businesses and in particular for SMEs in embracing new technologies. Furthermore, it will take into consideration the current level of digitalization in Europe and the strategies that have been implemented to facilitate this transition. This study will analyze and compare German and Italian initiatives with a further focus on the bilateral cooperation between these two countries. Last but not least, this paper will examine the main European Commission legislative proposals aimed at strengthening the role of the European Union Agency for Network and Information Security (ENISA) and to tackle cybercrimes in all Member States. Finally, this paper will also examine the European digital shortage and how the EU will reinforce the role of Digital Innovation Hubs (DIHs).

2. Historical changes: from the steam engine to Industry 4.0

The term industrial revolution refers to a transition period in which radical changes occurred. The first industrial revolution, known as Industry 1.0, took place at the end of the 18th century in Great Britain. Large amounts of capital, steam engines and a massive use of coal allowed the transformation of industry, mainly the textile one, and facilitated the migration of people to the cities with the birth of the first factories. Consequently, workforce started to boost productivity, increasing efficiency and production rates, thanks to the new scientific innovations. Furthermore, the transport revolution opened markets and productivity started to increase exponentially.

At the end of the nineteenth century, the steel and chemical industries played a key role during the second industrial revolution. Meanwhile, new forms of energy were also being developed, and

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electricity started to change the production process. The new doctrine of this revolution was named Taylorism and it allowed Henry Ford to implement the assembly line. This innovation spread globally and evolved in order to be applied to other economic systems outside the United States. This progress has shaped the society and triggered several social changes, notably the rural-urban migration that started during the first industrial revolution. Some countries, such as Germany, Italy, the Netherlands and France, started their industrial revolution in different ways though sharing a common factor: all their governments implemented legislative reforms and actively supported industrialization by funding it. These nations transformed their economic and social structure to improve the well-being of the population and to compete with the British hegemony.

The third industrial revolution or digital revolution began with the introduction of Information and Communication Technology (ICT) and the use of Internet. These innovations connected people all over the globe by initiating the process known as globalization. This term was used in relation to the internationalization of enterprises and the opening of markets, but today it has assumed a more complex meaning. In the 1970s, after the oil crisis the world economy has faced stagflation, i.e. a period of slow economic growth combined with inflation. Governments started to invest in technologies to revive economy. Initially, these investments focused on energy, with the search for alternative sources. Subsequently, the innovation encompassed all sectors reaching its peak when information technology and computers became an instrument for everyone.

Today, a new innovative revolution is occurring and its impact on our lives is remarkable. “In this revolution, emerging technologies and broad-based innovations are spreading much faster and widely than in the previous ones, which continue to unfold in some parts of the world.”¹

1 Schwab, Klaus, *The Fourth Industrial Revolution*, Portfolio Penguin, 2017: 8.

It is generating consequences in all economic sectors, but it is not fully possible to foresee the future of the society as the potential of this revolution is still at an early stage. The term Industry 4.0 was adopted for the first time in Germany in 2011, during the Hannover Fair. On that occasion, a working group announced a project for the development of the German manufacturing sector, the Zukunftsprojekt Industrie 4.0, with the aim of bringing the country industry to a leading role in the world. The German model inspired many European initiatives and Industry 4.0 widespread at international level.

“Industry 4.0 is a term applied to a group of rapid transformations in the design, manufacture, operation and service of manufacturing systems and products. The 4.0 designation signifies that this is the world’s fourth industrial revolution, the successor to three earlier industrial revolutions that caused quantum leaps in productivity and changed the lives of people throughout the world”.²

Due to its complexity, it is difficult to give a comprehensive definition of this fourth stage and several factors must be considered in order to understand its implications for businesses. Indeed, Industry 4.0 encompasses a series of sophisticated technologies including Cyber Physical System (CPS), Internet of Things (IoT), Big Data, Cybersecurity, Additive Manufacturing. Some of the above-mentioned terms were coined many years before Industry 4.0, such as IoT described as the “... IT systems connected to all sub-system, processes, internal and external objects, supplier and customer networks that collaborate with humans.”³

The main element driving investments in new technologies is the primary need to customize the products, to improve time-to-market

2 European Commission, Industry 4.0, Digitalisation for productivity and growth, September 2015: 2. Online at: [http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS_BRI\(2015\)568337_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS_BRI(2015)568337_EN.pdf). Last accessed 14 February 2019.

3 European Parliament, Directorate-General for Internal Policies, Policy department Economic and Scientific Policy, Industry 4.0, Study for the ITRE Committee, 2016: 22. Online at: [http://www.europarl.europa.eu/RegData/etudes/STUD/2016/570007/IPOL_STU\(2016\)570007_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/STUD/2016/570007/IPOL_STU(2016)570007_EN.pdf). Last accessed 14 February 2019.

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and to produce more efficiently. Whereas in the past, production was based on standardization, the Taylorism has become obsolete because of the change in demand. It has become possible to produce high-quality non-standardized goods, in limited series and at a lower cost, thanks to the new technologies adopted in the production system. Based on this assumption one of the main factors that has influenced this revolutionary change is the volatile market demand. Enterprises are facing this global trend by adapting their production processes to new consumers' needs. Advanced technologies allow businesses to monitor consumers behavior and respond to new preferences with target strategies based on data analysis and statistics. Moreover, globalization leads enterprises to be more interconnected during all phases of production and Industry 4.0 could optimize partnership among countries.

3. *SMEs challenges and opportunities*

All productive sectors can benefit from “Industry 4.0” and new production models can be applied to all businesses, regardless of their size. Even if new technologies represent potential advantages for businesses, the success of a digitized enterprise depends on certain preconditions: standardization of systems, changes in work organization reflecting new business models, digital security, advanced digital skills and continuing investments in R&I. These potentialities could transform the entire business community, especially SMEs. “The category of micro, small and medium-sized enterprises is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million.”⁴ Productivity gains are one of the main opportunities for SMEs in the digital era. In general terms, productivity measures the

4 Recommendation (2003/361/EC) of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises. Annex, Title I, Article 2. Online at: <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:124:0036:0041:EN:PDF>. Last accessed 14 February 2019.

level of efficiency by which an economic system organizes inputs in order to generate outputs. The most common indicator, adopted by the OECD, is the GDP per hour worked, which is the quantity of output produced in an hour. An increase in productivity and lower labor costs would allow companies to keep the production processes in their own country. These dynamics could have a positive impact on employment, especially in Western countries and therefore significant cost savings with environmental benefits, thanks to the reshoring flow. “This will enable a new level of mass customization as more industrial producers invest in Industry 4.0 technologies to enhance and customize their offerings.”⁵

The most innovative element of Industry 4.0 is the capacity of machines to solve a problem faster than before, due to the increasing information captured by the system: the so-called machine learning. This information could be shared with the rest of the world for similar problems that may occur in another country. In these circumstances, algorithms play an increasingly important role to compare machine performances (benchmarking). The availability of such data generates an added value in terms of range of services and efficiency in managing supply chains. Furthermore, businesses can define customer needs in real time and respond to specific trends.⁶ A digitized enterprise can also identify new partners and with a more efficient supply chain increase the cooperation with the previous ones.

Moreover, growing computing power, availability of data and progress in analytics have turned Artificial Intelligence into one of

5 Michael Rüßmann/Markus Lorenz/Philipp Gerbert/Manuela Waldner/Jan Justus/Pascal Engel/Michael Harnisch, Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries, The Boston Consulting Group, 9 April 2015. Online at: https://www.bcg.com/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries.aspx. Last accessed 14 February 2019.

6 European Commission, Digital Single Market, Big Data. Online at: <https://ec.europa.eu/digital-single-market/en/big-data>. Last accessed 14 February 2019.

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the most strategic technologies of the last few decades. AI could be an important tool to address socio-economic challenges and to pursue the human development, which raises new ethical, legal and even democratic issues. This technology will make machines and robots able to interact with each other and above all will enable them to learn from the various situations. Automotive, aerospace, energy, pharmaceutical are the main sectors in which AI has been already applied.

As digitalization spreads rapidly worldwide, SMEs have to develop the related digital skills. In fact, a successful digitized enterprise mostly depends also on the availability of a qualified workforce. “The effects of the digital transformation manifest in job destruction and creation in different sectors, the emergence of new forms of work, and a reshaping trade landscape, in particular for services.”⁷

Robotics, artificial intelligence, biotechnology, nanotechnology and genetics are having more and more relevant implications in the labor market, in all sectors: industry, commerce, energy, aerospace, etc. On one hand, there is a gradual disappearance of some professional profiles while, on the other, new types of work that will be more focused on the human-machine interaction. If the creation of new job opportunities is not properly addressed, there is the effective risk of losing jobs. New qualified profiles should be attained by training-on-the-job initiatives and new vocational and academic programs for the future 4.0 native. The digital skills shortage and the high bureaucratic costs create barriers to the SMEs digital transformation. Therefore, there is the need to strengthen the European strategy to reduce the gap among countries.

7 OECD Digital Economy Outlook 2017: 12. Online at: <https://espas.secure.europarl.europa.eu/orbis/sites/default/files/generated/document/en/9317011e.pdf>. Last accessed 14 February 2019.

In this process, both businesses and workers play a fundamental role to reduce the gap that creates the *digital mismatch*.⁸ Companies will have to invest heavily to train their employees or at least update their digital knowledge, thus avoiding lagging behind their competitors. In particular, the models of work have to be revised and new innovative strategies have to be introduced.

During the last few years, the European debate has also focused on the growing vulnerability of data generated by the introduction of new technologies. The international scenario sees the growing cyberthreat to sensitive information and commercial secrets, which are the result of huge investments on the company's side. The number of cyberthreats and cyberattacks is increasing along with greater connectivity and thus enterprises need efficient protection tools.

“The fourth industrial revolution brings a new operational risk for smart manufacturers and digital supply networks: cyber. In the age of “Industry 4.0”, cybersecurity strategies should be secure, vigilant, and resilient, as well as fully integrated into organizational strategy from the start.”⁹

In 2018, according to the *Cyberthreat Defense Report*, 77% of organizations have been victim of one or more successful cyberattacks. Therefore, businesses are enhancing their digital and information security frameworks to prevent any external attacks or accidental digital system failures.

Affordable access to a secure and adequate ICT infrastructure is crucial to enable digitalization and it has a great impact on the competitiveness of SMEs. “If the actual awareness already exists, the threat posed by cybercrime is often underestimated by SME

8 It means the gap between the skills owned by workers and those required today and in the future. Online at: <https://www.eesc.europa.eu/en/news-media/press-releases/skills-mismatches-eu-businesses-are-losing-millions-and-will-be-losing-even-more>. Last accessed 14 February 2019.

9 Industry 4.0 and cybersecurity, Managing risk in an age of connected production, Deloitte University Press, 21 March 2017. Online at: <https://www2.deloitte.com/insights/us/en/focus/industry-4-0/cybersecurity-managing-risk-in-age-of-connected-production.html>. Last accessed 14 February 2019.

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management.”¹⁰ As just stated, SMEs do not consider useful to invest in cybersecurity as they are not aware of the negative consequences on their activities. For this reason, SMEs are the most targeted and vulnerable businesses of cyberattacks. Compared to larger companies, the small business community is increasingly having difficulty in coping with these attacks due to inefficient security systems. Therefore, sensitive data and information should be protected against cyberespionage and attacks conducted mainly by third countries. It is important to define a strategy against cyber-enabled economic espionage which constitutes potentially an irreversible damage from the target’s point of view, namely in the manufacturing sector.

4. Industry 4.0 National Initiatives across Europe

Since the fourth industrial revolution has started, several SMEs struggle to adopt such technologies, but some production solutions remain a challenge due to the high cost of investments and the lack of economic resources.¹¹ Before analyzing the current situation at European level and the initiatives carried out by the European Union, it is important to define what has been implemented at national level. The different industrial policies adopted have as their common ground a deep integration between research, innovation and industrial production. Indeed, these elements are the essential factors able to develop economies and maintain competitiveness at a global level. Traditional and manufacturing sectors require specific investments and a long-term vision in order to remain the main strength of the European leadership. Italy and Germany are the main

10 European Economic and Social Committee, Cybersecurity: Ensuring awareness and resilience of the private sector across Europe in face of mounting cyber risks-Study, 2018: 32. Online at: <https://www.eesc.europa.eu/sites/default/files/files/qe-01-18-515-en-n.pdf>. Last accessed 24 January 2019.

11 Tokarski, Slawomir, Director of innovation and advanced Manufacturing, DG GROW European Commission, Industry 4.0: an opportunity for SMEs, 21 April 2017. Online at: <https://www.europeanfiles.eu/industry/industry-4-0-an-opportunity-for-sme>. Last accessed 24 January 2019.

diversified manufacturing powers in Europe and their governments have already planned, with different results, the policies aimed at facilitating SMEs access to new technologies. German policy makers have adopted the *Plattform Industrie 4.0* to encourage the digital transformation of businesses in the framework of High Tech 2020 Strategy. In close cooperation with politics, scientists, employers' associations and trade unions, more than 300 stakeholders from at least 160 organizations are actively involved in the platform. It represents the main considerable network that supports companies, in particular SMEs in implementing new technologies. The number of international agreements between Germany and the rest of the world highlights its key role in the global debate on Industry 4.0. Following the German approach, Italian government has embraced its strategy towards a radical innovation in industry and services, i.e. Manufacturing 4.0.

Italy is the second largest manufacturer after Germany and the sixth in the world for export. New solutions have already been implemented and consist of an increasing human-robot interaction fostering a connected and efficient industry. Specific strategies identified by the Italian plan Industria 4.0 are based on a horizontal approach that stimulates the digital innovation for the growth and development of the country. The implemented measures have produced significant results in the last few years to meet the new needs deriving from I4.0. Industria 4.0 was launched in 2017 by the Italian government and subsequently renamed *Impresa 4.0*, as the scope of intervention goes beyond manufacturing. The ambition is to strengthen the competitiveness of Italian companies by increasing investments in digital skills and research. Moreover, the plan includes other supportive measures such as communication standards in the Internet of Things or investments in the private sector. The amount established for the period 2017-2020 is €18 billion addressed to the business world without any limits of size, sector or territory. However, the main beneficiaries remain the SMEs for their central role in the Italian landscape.

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The excellent results demonstrate the viability of such instruments at a growth rate of 9% in machinery investments and 10% in R&I. If new technologies are well integrated and incorporated into a consolidated operating model (also called production system), they could generate more outputs than before. Thanks to these transformations, the number of innovative start-ups and SMEs is still increasing. According to the annual report of the Italian Ministry of Economic Development, the situation has changed over the past years. Moreover, most of the potential of Industry 4.0 is within businesses that adopt digital solutions, rather than in the industries that produce such solutions. The Ministry of Economic Development has estimated the goal for the period 2017-2020: greater investments with the focus on I4.0 in the area of skills, enabling infrastructures and public support tools. The effects of the digital disruption on production processes are evident, but less obvious are those on market labor. Indeed, it is important to rethink workforce in an era in which employees will be replaced by machines.

It is therefore necessary to innovate the study paths to train students and maximize the new job opportunities related to the fourth industrial revolution by developing digital related skills. For this purpose, national strategies involve Digital Innovation Hubs and Competence Centers. A DIH acts as a link among companies, research centers and financing and they are located throughout Italy to spread business awareness of existing opportunities and to support interaction with the European ones. The public-private partnership is of primary importance because it facilitates the exchange of information and best practices. Investments, research, institutional innovations and operational strategies in an appropriate cultural context, could also increase the Italian resilience. Finally, international cooperation, especially across Europe, is an essential tool to renovate industry and guarantee the access to the world best talents, professionals and resources.

5. Bilateral cooperation: Confindustria and BDI

Over the last few years, Germany and Italy have consolidated their cooperation to respond to these challenges. The dialogue between *Confindustria*, the general Confederation of Italian industry, and its German peer *Bundesverband der Deutschen Industrie* (BDI) has the aim to strengthen their industrial basis in an increasingly digitised world economy. Every year, representatives of these confederations organize a business forum to stimulate a strategic debate on the main priorities of the EU. The last edition, “German-Italian industry priorities for the future of the EU”, has focused on the EU industrial, innovation and cohesion policies in the Multiannual Financial Framework 2021-2027. In particular, *Confindustria* and BDI have remarked the need to sustain the digital transformation of the EU; cybersecurity, artificial intelligence and the digital infrastructure must be consolidated as well.

It is also necessary to invest in skilled people to create job opportunities in order to prepare human capital for the digital revolution. Moreover, policy makers should ensure a common effort to sustain all industrial companies, especially SMEs to embrace the ongoing revolution.

Since 2017, Germany, Italy and France “... have agreed on a trilateral cooperation to support and strengthen the digitization processes of their manufacturing sectors as well as to promote European efforts in this field.”¹² These countries have adopted a shared action plan¹³ in which a working group is dedicated to SMEs to support them in the transformation process. Nowadays, national

12 Germany, France and Italy join forces to promote digitizing manufacturing, Platform Industrie 4.0, press release, 20 June 2017. Online at: https://www.mise.gov.it/images/stories/documenti/press%20release_trilateral-cooperation.pdf. Last accessed 24 January 2019.

13 Shared Action Plan, Industrie du Futur, Industrie 4.0, Industria 4.0 in France-Germany-Italy, June 2017: 3. Online at: <https://www.plattform-i40.de/I40/Redaktion/EN/Downloads/Publikation/shared-actionplan-fr-de-it.html>. Last accessed 14 February 2019.

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initiatives boost enterprises, especially SMEs, towards new technologies and new business models. Despite the successful implementation of the mentioned strategies, the development of smart devices, big data management, digital production and skills are the main difficulties of the industrial sector. For this reason, it is necessary to adopt all the policies and instruments both at national and European level to address these new challenges. A supportive industrial policy is needed, above all for the sectors that will be most affected by the new industrial revolution: aerospace, automotive, manufacturing, traditional industry, energy, defense, transport, health, building and construction.

As a result, new investments can offset the negative impact on employment and have a positive return if properly managed. In this frame, it is necessary to promote public and private partnerships and create a data ecosystem with open standards and encourage universities and research centers to develop skilled human capital.

6. *Digital transformation and new skills: a priority for the European Union*

Digital transformation has been for a long time on the EU agenda and the initiatives adopted at European level facilitate the access to finance, technologies, knowledges for enterprises, notably for SMEs.¹⁴ The EU has to face international giants as the United States and China whose influence is steadily increasing on a global level.

14 Communication from the Commission to the European Parliament, the Council, the European Economic & Social Committee and the Committee of the Regions, Digitising European Industry, Reaping the full benefits of a Digital Single Market, 2016: 2-3. Online at: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0180&from=EN>. Last accessed 24 January 2019.

“In 2015 the European Commission initiated an ambitious strategy to achieve a DSM. A key success factor for reaping the full benefits of a DSM is a highly competitive digital industry in Europe and the integration of digital innovations in all sectors. Embracing digital technologies will help companies to grow beyond the EU internal market and make the EU an even more attractive location for global investments.”

However, the EU can rely on many global sectors, including manufacturing, automotive, chemical industry and energy.¹⁵ Even if Member States have improved their digital performances the digital divide among countries is still evident.¹⁶ In 2018, the Austrian Minister for Digital and Economic Affairs has remarked the necessity of substantial investments in Europe to spread new technologies, cybersecurity solutions and digital skills. Europe's workforce still lacks advanced digital skills, which affects the labor market and more generally the European economy. Moreover, it is important to face up the dangerous cyberattacks by reinforcing the role of ENISA. For these reasons, the EU institutions are now focusing on the following priorities:

- Strengthening of the European industrial policy and other connected areas such as environment, climate issues and consumer protection.
- The theme of digitization as a great opportunity for the reindustrialization of Europe. One of the objectives is to build an ecosystem that promotes businesses and makes it easier for them to operate.

15 European Commission, Digitising European Industry. Online at: <https://ec.europa.eu/digital-single-market/en/policies/digitising-european-industry>. Last accessed 14 February 2019. "Industry is one of the pillars of the European economy, the manufacturing sector in the European Union accounts for 2 million enterprises, 33 million jobs and 60% of productivity growth. On the other hand, the smallest industrial community are now facing different challenges and huge disparities characterized Member States performances."

16 European Commission, The Digital Economy and Society Index. Online at: <https://ec.europa.eu/digital-single-market/en/desi>. Last accessed 14 February 2019. The Digital Economy and Society Index (DESI) examines the relevant indicators on Europe's digital performance and highlights the evolution of EU member states in digital competitiveness. Denmark, alongside Sweden, Finland and the Netherlands have the highest score, followed by Luxembourg, Ireland, United Kingdom, Belgium and Estonia. Other countries such as Italy, Romania and Greece, have a long way to go in order to become digitized and compete with international actors.

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- Education and training are other essential topics for the EU. The dissemination of digital skills through dual training systems permits to limit youth unemployment and develop competitive advantages vis-à-vis other markets.
- In the field of commercial policy, the aim is to establish new valuable partnerships with third countries.¹⁷

European leaders and the members of the European Parliament have agreed that investments in research and innovation are essential for a competitive Europe. In order to maintain its leadership position, Europe shall encourage enterprises to invest in targeted areas and cooperate with the public sector to promote innovation. To achieve these goals, the European Commission has presented some ambitious proposals to the European Parliament and to the Council, for a modern EU budget law. The new program published by the European Commission titled “Horizon Europe” will succeed Horizon 2020 and it has been approved by the European Parliament in December 2018.¹⁸

“The Program’s general objective is to deliver scientific, economic and societal impact from the Union’s investments in research and innovation so as to strengthen the scientific and technological bases of the Union and foster its competitiveness, including in its industry, deliver on the Union strategic priorities, and contribute to tackling global challenges, including the Sustainable Development Goals.”¹⁹

17 Presidency of the Council of the EU, Visit of Heinz Faßmann, Austrian Federal Minister for Education, Science and Research and Margaret Schramböck, Austrian Federal Minister for Economic and Digital Affairs, ITRE Committee, 10 July 2018. Online at: <http://www.europarl.europa.eu/ep-live/en/committees/video?event=20180709-1530-COMMITTEE-ITRE>. Last accessed 24 January 2019.

18 European Parliament, MEPs want to fund crucial areas to stimulate European growth, December 2018, press release. Online at: <http://www.europarl.europa.eu/news/en/press-room/20181205IPR20934/meps-want-to-fund-crucial-areas-to-stimulate-european-growth>. Last accessed 24 January 2019.

19 Art. 3, paragraph 1, European Commission, Proposal for a Regulation of the European Parliament and of the Council establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, 2018. Online at: https://eur-lex.europa.eu/resource.html?uri=cellar:b8518ec6-6a2f-11e8-9483-01aa75ed71a1.0001.03/DOC_1&format=PDF. Last accessed 22 January 2019.

SMEs as a crucial source of employment and innovation receive a particular attention in this program. They can collaborate on projects as part of a consortium and receive support through dedicated tools created specifically for innovative enterprises. These instruments will help SMEs to assess the market feasibility of their ideas in the high-risk phase and develop them. According to the monitoring report of the European Commission, after three years of implementation of Horizon 2020, the SME instrument has produced positive results in term of allocated investments and signed grants. Indeed, Italy, Spain and the United Kingdom have presented the highest number of applications to benefit from this instrument with a success rate between 6 and 10%.²⁰

7. *Digital Europe programme: a new innovative strategy for digitalization*

Given the results achieved, the European Union is implementing different strategies in the area of the Digital Single Market. Last June, the Commissioner Gabriel presented a proposal for a Regulation to establish the new *Digital Europe programme*, an integral part of the Single market, innovation and digital chapter of the Next Multiannual Financial Framework.²¹ The European Parliament has always supported the proposal and agreed to invest €8.2 billion under the EU budget 2021-2027.²² The benefits of this

20 European Commission, Horizon 2020 in full swing, Three years on key facts and figures 2014-2016, December 2017. Online at: https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/h2020_threeyearson_a4_horizontal_2018_web.pdf. Last accessed 29 January 2019.

21 “An ambitious proposal, because it calls on the Member States to put 1,246 billion payments (real cash resources) and 1,279 billion commitments (at the current prices) on the plate”. European Commission, press release, 2 May 2018. Online at: http://europa.eu/rapid/press-release_IP-18-3570_en.htm. Last accessed 24 January 2019.

22 European Parliament, MEPs back proposal to create first EU programme to boost digital investment, December 2018. Online at: <http://www.europarl.europa.eu/news/en/press-room/20181213IPR21705/meps-back-proposal-to-create-first-eu-programme-to-boost-digital-investment>. Last accessed 24 January 2019.

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funding will encompass all sectors from health care to renewable energy. A funding of €2.7 billion will ensure a more effective and wider use of supercomputers in both public and private sectors. The budget of €2.5 billion planned aims to boost investments to spread AI across the European economy and society, and to guarantee a suitable ethical and legal framework. This program will help public authorities and small businesses to have a better and easier access to AI solutions. “Open platforms and access to data spaces for artificial intelligence will be made available across the EU in Digital Innovation Hubs, providing test facilities and knowledge to small businesses and local innovators.”²³ Furthermore, the program provides other investments in cybersecurity field and trust in order to safeguard the EU’s digital economy, society and democracies improving cyber defense as well as the development and equipment of the needed skills through targeted courses, especially for SMEs. In this context, the role of the network of Digital Innovation Hubs is considered essential to secure a widespread use of digital technologies across every sector, as it will provide a better and wider geographical access to technological expertise and experimentation facilities. “This program will help ensure that the benefits of the digital transformation will reach all citizens and businesses. It will boost investment in crucial areas such as cutting-edge cybersecurity tools and artificial-intelligence-based innovations.”²⁴ The *Digital Europe programme* will seek to secure the EU’s innovation capacity and competitiveness to reduce the existing gap not still addressed by the current budget of the EU.

23 European Commission, Press release, June 2018. Online at: http://europa.eu/rapid/press-release_IP-18-4043_en.htm. Last accessed 24 January 2019.

24 Norbert Hofer, Minister for Transport, Innovation and Technology of Austria, President of the Council, December 2018. Online at: <https://www.consilium.europa.eu/en/press/press-releases/2018/12/04/digital-europe-programme-council-agrees-its-position/>. Last accessed 24 January 2019.

8. *Cybersecurity and Big Data: the role of ENISA*

In the recent years, cybersecurity has become a matter of concern due to the increasing risk of cyberattacks. In this context, the European Union Agency for Network and Information Security plays a fundamental role in network security, in checking whether products entering the EU territory meet the established security criteria and in the dissemination of skills and competences necessary with due awareness campaigns for Member States. With the entry into force of the NIS Directive²⁵ the overall level of cybersecurity in the EU started to increase. In September 2017, the European Commission adopted a cybersecurity package built on three strategies: ensuring a greater resilience and defense of the information systems of the Member countries, the development of better ability to generate deterrence in third parties from cybernetic attacks and the cooperation among Member States and facilitate the transmission of information between public and private sectors. The Cybersecurity Act has been adopted for the purpose of creating a European framework for the certification of cybersecurity of ICT products and digital services, as well as to strengthen the role of ENISA. Being a Regulation, once adopted and entered into force, the Cybersecurity Act will be immediately applicable in all Member States, without the need for implementation by national legislators.

Recently, 80% of European enterprises have been victim of a cyberattack and 50% of all crimes are concentrated in some countries. These numbers make security and defense necessary and they cannot be limited on a national basis; that is why Europe is working to increase the efficiency of instruments that should be capable of facing the risks. One of the major challenges in cybersecurity is to secure the 5G networks, crucial for the

25 Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union. Online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.194.01.0001.01.ENG&toc=OJ:L:2016:194:TOC. Last accessed 24 January 2019.

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advancement of Industry 4.0, which is progressively under cyberattacks sponsored by third countries and to ensure the improvement of block chains. Some Member States have already implemented targeted solutions to counterattack cyberthreats. For example, Estonia has solved this problem, mostly in adopting AI solutions and machine learning. It is necessary to create a strong network and an information security system to make them work as an efficient tool. It includes a deep cooperation for more transparency and common standards.²⁶ It is also important to increase awareness among SMEs on the need to enhance cybersecurity and exchange information and best practices at EU level. Besides, the European Parliament has adopted a new proposal of the European Commission: the free flow of non-personal data. “This Regulation seeks to ensure the free movement of data other than personal data within the Union by laying down rules relating to data localization requirements, the availability of data to competent authorities and data porting for professional users.”²⁷ In other words, it will ban the national rules, which require the storage or processing of data in a specific Member State. Any restrictions on the location of the data will only be allowed for reasons of public security, as defined in the Treaties and as interpreted by the Court of Justice of the European Union. These rules ensure that competent authorities have access to data processed in another Member State for regulatory control purposes, such as inspection and audit. This Regulation will remove barriers on cloud services to promote the e-government growth and an open public. Moreover, it has the aim of encouraging the development of IOT, block chains, and other AI solutions.

26 Speech by Clyde Kull, Ambassador, Deputy Permanent Representative of Estonia to the EU, High-level seminar on Artificial Intelligence and Cyber Security, Norway House, Brussels, September 2018.

27 Article 1, Proposal for a Regulation of the European Parliament and of the Council on a framework for the free flow of non-personal data in the European Union, 13 September 2017. Online at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2017%3A495%3AFIN>. Last accessed 24 January 2019.

Simultaneously, code of conducts will be set up to facilitate data portability and data transfer. A regulatory framework is essential as the ownership and the economic value of non-personal data is fundamental to boost digitalization.

As next step, the European Commission has proposed the creation of a Network of Cybersecurity Competence Centers and a new European Cybersecurity Industrial, Technology and Research Competence Centre under the new *Digital Europe programme*. This proposal points at developing the cybersecurity in the EU and industrial capacities to secure its Digital Single Market; encouraging better cooperation between relevant stakeholders and spreading cybersecurity solutions across Europe. “Furthermore, the proposal will contribute to closing the skills gap and to avoiding a brain drain by ensuring access of the best talents to large-scale European cybersecurity research and innovation projects and therefore providing interesting professional challenges.”²⁸

9. Advanced digital skills and Digital Innovation Hubs

As the labor market is constantly evolving, new professional profiles require new skills and capabilities. Nowadays, the existing general skills shortage is common in all European countries and concerns more deeply the smaller businesses community. In fact, the elements of Digital Europe proposal mutually need each other. For example, AI can help improve cybersecurity but without workforce investments, it will not generate results in terms of growth and innovation. Moreover, these capabilities shall be accessible to public sectors and industry, in particular to SMEs.²⁹

28 European Commission, Digital Single Market, Proposal for a European Cybersecurity Competence Network and Centre. Online at: <https://ec.europa.eu/digital-single-market/en/proposal-european-cybersecurity-competence-network-and-centre>. Last accessed 21 January 2019.

29 Speech by Lorena Boix Alonso, Director of Policy Strategy and Outreach, DG Connect, High-Level seminar on AI and Cybersecurity, Brussels, 20 September 2018.

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In 2017, it has been estimated that 56% of individuals in the EU28 have basic digital skills. Luxembourg, Denmark, the Netherlands and the United Kingdom have the highest percentage followed by Finland, Sweden and Germany. Whereas in Romania and Bulgaria between 72-74% of citizens do not have any basic digital skills.³⁰

Despite high levels of unemployment, the lack of digital skills continues to increase in all sectors. The labor market will need more ICT specialists and a qualified workforce. In the European Union some countries are more digitalized than others. Finland, Denmark, Sweden and the United Kingdom have the highest number of ICT specialists in the workforce. Today, 44% of "... European citizens do not have basic digital skills and 37% of people in the labor force, farmers, bank employees and factory workers alike, also lack sufficient digital skills, despite the increasing need for such skills in all jobs."³¹

At the same time, there is also a gender digital gap: women have fewer digital competences and lately no progress has been registered. Moreover, it is necessary to reorganize the network in education and training to prepare students to keep abreast of those changes. Competences connected to digitalization need to be improved thus a minimum level of digital competences is becoming more and more important. An innovative education-working environment requires advanced digital services by encouraging investments in education. Training in education has an important role in establishing digital competences, which affects the most vulnerable part of the population.

30 European Commission, Digital Single Market, The Digital Skills Gap in Europe, Digital Society and Economy Index, 19 October 2017. Online at: <https://ec.europa.eu/digital-single-market/en/news/digital-skills-gap-europe>. Last accessed 24 January 2018.

31 European Commission, Digital Single Market, A digital Europe needs Digital Skills, 29 September 2017. Online at: <https://ec.europa.eu/digital-single-market/en/news/digital-europe-needs-digital-skills>. Last accessed 25 January 2019.

An equal access to digital education is essential for the future. Universities should co-operate with corporations to establish a link between education and employment, offering traineeships in the area of digital opportunities and thus boosting ICT specific skills.

Digital Innovation Hubs are strategic to support businesses in understanding the opportunities of Industry 4.0. According to the European Commission, “Digital Innovation Hubs are one-stop-shops that help companies to become more competitive with regard to their production processes, products or services using digital technologies.”³² These hubs play a central role in the majority of the European countries as the main access to Industry 4.0. *Digital Europe programme* offers the establishment of a pan-European network of Digital Innovation Hubs able to provide access to digital capabilities in the domain of Artificial Intelligence, cybersecurity and support the digital transformation of the European industry. They also provide access to digital skills and facilities for experimenting with technologies. For the European network of DIHs each Member State will be able to select the candidates on the basis of a series of criteria indicated in paragraph 2 of the article 16 of the Regulation. DIHs will carry out targeted programs to help SMEs and public administrations to train employees to advanced skills necessary to access the new opportunities of the Industry 4.0. SMEs should be more conscious of these new technologies by encouraging the mobility of IT professionals, workforces and entrepreneurs across Europe.

In fact, the Commission has underlined the importance of supporting trainings and courses for entrepreneurs, small business leaders and workforce. The European strategy will support specialized courses and internships in businesses that implement advanced technologies, such as data analysis, robotics, blockchain technology, computer security and high-performance computing. In the cybersecurity field,

32 European Commission, Smart specialization platform, Digital Innovation Hubs. Online at: <http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs>. Last accessed 25 January 2019.

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the new program aims at strengthening and securing public and private sector infrastructures and provide tools, data and expertise to prevent and tackle cyberattacks. In conclusion, it is a win-win program, through the best use of available resources to improve the capacity of the EU in terms of digital transformation. The European strategy guarantees many advantages to SMEs that are left behind. However, there are some concerns about the generation gap and the difficulty of some regions accessing the technologies the Industry 4.0 offer.

10. Conclusion

The fourth industrial revolution is radically changing the industrial framework as well as the world of businesses, especially SMEs. Industry 4.0 has several advantages for companies, in terms of productivity, cost savings and real-time data that make it possible to respond to consumer demands. On the other hand, European companies are facing various challenges towards their digitalization. Over the last few years, several countries have developed their I4.0 plans, by funding businesses. The results achieved so far have seen the growth of digital SMEs and innovative start-ups that represent 99% of the industry. Despite the efforts made by national governments, EU Member States have achieved different levels of digitalization and significantly differences still remain. In order to support sustainable growth and tackle the challenges related to the digital transition, national policies should be strengthened and developed in close connection with the main EU forward-looking strategies.

The EU has implemented several programs to allocate huge investments in research and innovation and leads European companies to compete globally. The new *Digital Europe programme* addresses these issues and provides substantial investments in the areas of cybersecurity, digital skills, public administration and public and private sectors. Investments in new technologies must

therefore go hand in hand with the spreading of digital skills to cope with the changes that Industry 4.0 is already bringing into the labor market.

We are moving towards a future in which digital technology will be increasingly important and this evolution must be managed in a timely manner. Europe should support the digital transformation of its economy starting from the traditional industry, robotics and manufacturing sectors in order to enhance European competitiveness vis-à-vis China and United States.

Finally, the European development must be fueled by human capital at the level of the great digital transformation and of the new business models triggered by the fourth industrial revolution. In order to achieve this goal, it is necessary to directly influence the training of new generations, particularly in higher education and universities as well as to vocational paths. What is certain is that Industry 4.0 is already changing our lives, but will businesses be able to handle this revolutionary transformation?

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