UNIVERSITÀ POLITECNICA DELLE MARCHE
FACOLTÀ DI ECONOMIA "GIORGIO FUÀ"

Corso di Laurea Magistrale in International Economics and Commerce

INDUSTRY 4.0: THE IMPACT ON ENTERPRISE DIGITIZATION

INDUSTRIA 4.0: L'IMPATTO SULLA DIGITALIZZAZIONE DELLE IMPRESE

Relatore: Chiar.mo
Prof. Giancarlo Vilella

Tesi di Laurea di:
Alessandro Ciuffolotti

Anno Accademico 2021 – 2022

It does not matter how slowly you go so long as you do not stop.

-Confucius-

INDEX:

ABSTRACT **1**

INTRODUCTION **3**

1 INDUSTRY 4.0

1.1 Dawn of a new revolution 6

1.2 Industry 4.0 and its evolution 8

1.3 The fundamental principles 10

1.3.1 Virtualization & real time capability 11

1.3.2 Modularity & mass customization 12

1.3.3 Orientation to the service 14

1.3.4 Decentralization 16

1.3.5 Interoperability 16

1.3.6 Sustainability 17

1.4 Enabling technologies 18

1.4.1 Big data & analytics 20

1.4.2 Cloud computing 22

1.4.3 Cybersecurity 24

1.4.4 System integration: Vertical & Horizontal integration 25

1.4.5 Advanced manufacturing solution 27

1.4.6 Augmented reality 28

1.4.7 Additive manufacturing 30

1.4.8 Simulation 30

1.4.8.1 Digital twin 32

1.4.9 Industrial internet of things 34

2 THE EFFECT OF DIGITATION ON ENTERPRISE'S ORGANIZATION

2.1 The business transformation 36

2.1.1 From traditional company to the new model 38

2.2 Organizational agility 45

2.2.1 Organizational ambidexterity 45

2.2.2 IT ambidexterity 49

2.3 A new organization: Combination of two different approaches 51

2.3.1 Flexibility & autonomy of teams 53

2.4 The network effect 55

2.5 *Policies & strategies* 57

2.5.1 Digitising European industry strategy (DEIS) 58

2.5.2 Digital single market 62

2.5.3 eCommerce 63

2.5.4 The Italian case 65

3 THE IMPACT OF DIGITAL TRANSFORMATION ON JOB SKILLS

3.1 Integration with human capital 69

3.2 How work & workers change with industry 4.0 70

3.2.1 Skills of the worker 4.0 73

3.2.2 The role of manager 4.0 77

3.2.3 Human resources management 80

3.2.4 Outlook for labor market & employment 81

3.3 Artificial intelligence (A.I.) 84

3.3.1 The machine learning 86

3.3.1.1 Customer segmentation & customer churn rate 87

3.3.2 The predictive maintenance 89

3.3.3 The potential of artificial intelligence to increase productivity & profit 90

3.3.4 The impact of artificial intelligence on economy 92

3.3.5 The future of artificial intelligence 96

4 THE IMPACT OF COVID 19 & THE RUSSIA-UKRAINE WAR

4.1 Covid 19 pandemic 97

4.1.1 Economic crises brought up by Covid 19 99

4.1.2 Impact of Covid 19 on industry 4.0 100

4.1.3 Digital in the days of Covid 19 103

4.1.4 Next generation EU 104

4.1.4.1 The centerpiece of next generation EU: The recovery & resilience facility 106

4.1.5 The transition plan 4.0 111

4.2 Russia-Ukraine war 113

4.2.1 The NATO's choice 115

4.2.2 The socio-political impact of the war 118

4.2.3 The economic impact of the war 121

4.2.3.1 EU energy independence 122

4.2.3.2 Food markets 126

4.2.3.3 Mobility of people & goods 127

5 AN OUSTANDING CASE: AMAZON, THE WAREHOUSE OF THE FUTURE

5.1 Evolution of Amazon 129

5.2 The warehouse of the future 133

5.2.1 Amazon warehouse operation 137

CONCLUSION **139**

BIBLIOGRAPHY **145**

SITOGRAPHY **147**

ACKNOWLEDGEMENTS **148**

ABSTRACT

Questa tesi, si compone di 5 capitoli, che hanno come obbiettivo quello di definire gli essenziali strumenti e principi alla base dell'industria 4.0.

Nel primo capitolo si cercherà di dare una definizione dell'industria 4.0 e di come essa sia percepita dagli esperti del settore. Si andrà a chiarire se si tratta di una vera e propria rivoluzione o di un upgrade delle precedenti. Si definiranno i principi fondanti alla base di questa industria e delle tecnologie abilitanti che sono state scoperte ed implementate e di come il tutto (l'industria 4.0 nel suo insieme) sia maggiore della somma delle singole parti.

Nel secondo capitolo, si analizzerà gli effetti della digitalizzazione nelle imprese, come questa avviene, le difficoltà da superare e come può essere migliorata e resa più efficiente. In particolare ci si soffermerà nel passaggio da una società tradizionale ad una totalmente rivoluzionata, il nuovo modello di business che si andrà a creare, la ricerca continua dell'efficienza e tempestività e infine anche le maggiori implementazioni politiche e strategiche implementate dall' Unione Europea e dall'Italia.

Nel terzo capitolo, si andrà a vedere come il mondo del lavoro sia cambiato a seguito di queste implementazioni. Analizzeremo i nuovi lavori che stanno nascendo, le nuove skills richieste, il nuovo ruolo del manager d'azienda e, probabilmente cosa più importante, la convivenza tra lavoratore e macchina.

Nel quarto capitolo, parleremo della situazione storica attuale e di come questa abbia avuto un ruolo importante per questa rivoluzione. In particolare parleremo della pandemia da Covid-19 e di come le dovute esigenze sanitarie legate a tale pandemia, hanno determinato un massiccio sviluppo dell'implementazione dell'industria 4.0 in Italia, in Europa e nel mondo. Parleremo della crisi scaturita da questa pandemia, della nascita del lavoro in smart-working e delle politiche Europee ed Italiane adottate per cercare di contrastarla. Successivamente analizzeremo anche un altro evento che ha avuto una risonanza mondiale sia dal punto di vista geopolitico che economico: la guerra Russo-Ucraina. Si analizzerà l'impatto economico, sociale, politico portato da questa guerra dal punto di vista Europeo e la precaria situazione d'equilibrio e come, anche se non sembra direttamente correlato, abbia rallentato in maniera considerevole questo sviluppo industriale.

Infine nell'ultimo capitolo si parlerà di un esempio concreto di utilizzo d'industria 4.0: Il magazzino Amazon. In particolare vedremo cosa rappresenta oggi Amazon dal punto di vista economico e sociale e di come il magazzino al suo interno adotti in maniera rivoluzionaria questa tecnologia al fine della ricerca perpetua dell'efficienza, tempestività e della soddisfazione del cliente.

INTRODUCTION

Over the past few years, technological change has been reshaping the economic, social and cultural scenarios in which we live, transforming the world of work.

This paper aims to highlight the impact and effects of digital transformation on business organization and workers' skills as a useful means of increasing business productivity and work skills.

Industry 4.0, referred to by many as the fourth industrial revolution because of its disruptive scope, is that digital transformation that is affecting the way humans act and live. It does not manifest itself simply as a change in the way of producing or in the resources that are used, but is a real cultural change that requires a rethinking in the way of doing business, in the organization of the company, in the production and management processes but also in the roles and responsibilities of the people who make up the organization. The digitization that companies are experiencing is something that cannot be ignored, but represents a major opportunity for the recovery of the world economy.

The first chapter discusses Industry 4.0, the starting point for eventual digital transformation and from which benefits for companies can flow. Next, the principles that characterize Industry 4.0 and its enabling technologies are described.

The second chapter analyzes the effects of digital transformation on the organization of companies, from production, organizational and strategic perspectives, arriving at a new conception of the business model.

Business digitization brings with it consequences, so the benefits and risks associated with the new Industry 4.0 model will also be analyzed. The policies applied among the various countries belonging to the European Union and those adopted in Italy will be analyzed, and we will see how digital transformation has been perceived by these countries.

The third chapter addresses the impact of digitization on job skills, analyzing how work and the figure of the worker change with Industry 4.0. Thus, companies are called upon to retrain their workforce, review their organizational models, and undertake strategies for recruiting personnel with so-called digital skills.

The fourth chapter highlights two historical facts that we are experiencing nowadays: the coexistence and consequences caused by the pandemic, and the political and economic impact that the Russian-Ukrainian war has generated.

Initially, we will discuss the impact of Covid-19 from both socio-political and economic perspectives. We will analyze the central role that technology takes in this pandemic context, leading companies to accelerate digitization processes.

In addition, we will focus on what policies Europe and Italy are working on to succeed in recovering from this crisis.

After that we will look at the impact of the war between Russia and Ukraine, what it was triggered by, and what consequences politically and economically they have generated. I will explain why I think it is appropriate to mention this historic event, although not entirely related to Industry 4.0, and its impact on the prices of energy,

gas and fossil fuels that practically form the basis of economies and how all this has only slowed down digitalization and made the situation even worse, especially the European situation.

Finally, in the last chapter we will look at Amazon, and in particular its warehouse, as a practical example of Industry 4.0. In fact, it is well known how this company is totally aimed at the use of Industry 4.0 and the continuous innovation that enabling technologies such as artificial intelligence, robots, cloud computing and the internet of things can bring in terms of efficiency.

1 INDUSTRY 4.0

1.1 DAWN OF A NEW REVOLUTION

When we speak of the "industrial revolution" we generally refer to the process of global transformation of socio-economic organization that has marked European and world history in recent centuries, conditioning every form of civil organization and life experience. Innovation is the pivotal concept of industrial evolution. The main trigger for industrial revolutions is the role assumed by technological innovations within the production process, the integration of which is facilitated by man's ability to use them in order to improve production-related activities. Industrialization began in the late 18th century with the introduction of mechanical production equipment, made possible by the discovery and use of steam power in the production of goods. This First Industrial Revolution was followed by a Second Industrial Revolution (late 19th century), marked by the use of new sources of energy (electricity) and the introduction of the assembly line, which led to the origin and later development of mass production. Later, in the early 1970s, a Third Industrial Revolution emerged, marked by the use of knowledge in electronics and information technology to achieve greater automation of production processes.

From here on, increasingly advanced advances in digital technologies have transformed, and continue to transform, the industrial sector at an unprecedented

pace. The impact has crossed all major sectors of the economy and spread globally, initiating the "fourth industrial revolution."

The Fourth Revolution incorporates all the positive aspects of the previous ones, but it is characterized by its more rapid and more geographically expansive assertion due in part to a changing social environment where continuous competitive challenges can be found on a global scale due in part to phenomena such as globalization. A characteristic element of this fourth revolution is the formation of a digital element: data, knowledge and digital user behavior are sold.

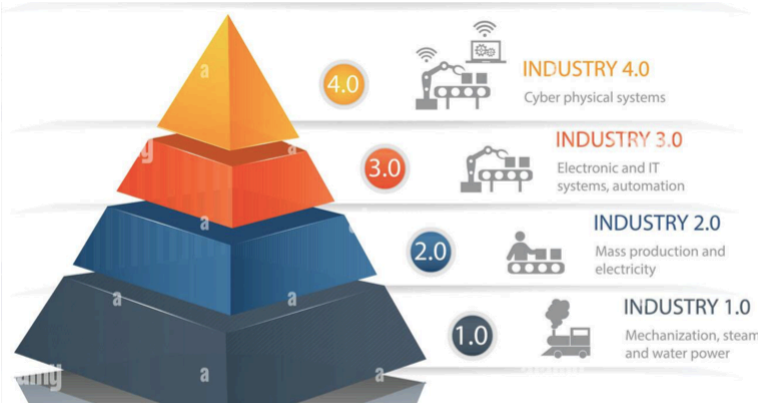

Figure 1.1, "The 4th industrial revolution" Source: Industry 4.0: An Insights into the Big Picture

1.2 INDUSTRY 4.0 AND ITS EVOLUTION

The term Industry 4.0 was introduced by German National Academy of Science and Engineering researchers Henning Kagermann, Wolf-Dieter Lukas and Wolfgang Wahlster at the 2011 Hannover Trade Fair.

The Zukunftsprojekt Industrie 4.0 project was presented, the goal of which was to completely revamp the German manufacturing system and thus bring Germany among the world's leading manufacturers. Most academics tend to consider Industry 4.0 an evolution of the Third Industrial Revolution because, unlike the latter, it does not focus on automation of production processes alone, but introduces a new factory paradigm based on the digitization, integration and connectivity of processes, not only internal but of the entire value chain, through the combination of information and digital technologies with manufacturing technologies. It represents its own evolution in that, instead of focusing only on the automation of machines and processes, it seeks to digitize everything around humans, from the machinery used in factories to the most commonly used objects, combining the physical and virtual worlds together and modeling a totally digital ecosystem. The use of such technological innovations has led to the creation of barrier-free intelligent contexts where data and information are used much more efficiently, enabling a reduction in transmission time and costs.

We are talking about a transformation that not only affects the production phase, but also includes the organizational and strategic phase being able, thus, to benefit from the advantages which allow companies to become effective, efficient and able to cope with different market configurations. In doing so, new business models can come into being by putting companies before the decision to step out of their comfort zone by adapting to new market needs. It is therefore appropriate to emphasize that Industry 4.0 represents a reality that extends far beyond the boundaries of virtualization of production processes and factory automation.

The deeper meaning of Industry 4.0 can be grasped precisely by analyzing the link of continuity with the technical and organizational solutions adopted since 1980. Unlike the past three industrial revolutions, in fact, the fourth one is not driven by the advent of a specific technology, but is the child of the conjunction of several technologies, some existing, some entirely new, that can now work together. Industry 4.0 aspires to develop IT solutions to optimally control and manage the complexity of material and information flows, due to their flexibility and adaptability to changes in demand.[1]

[1] Rüttimann and Stöckli, 2016. "Lean and Industry 4.0—Twins, Partners, or Contenders? A Due Clarification Regarding the Supposed Clash of Two Production Systems"

1.3 THE FUNDAMENTAL PRINCIPLES OF INDUSTRY 4.0

Digital transformation is based on a number of fundamental principles that profile the business and organization within Industry 4.0. These principles must be conceived as “facilitators” that utilized effectively in business practices will have a major impact on the organization, such that the company will be more profitable than more traditional organizations.

It should not be forgotten that the essence of innovation 4.0 presupposes that, through the increased interconnection between subjects, machines and devices, there is a unification of all technological innovations with the aim of integrating the entire production chain. Underestimating this important aspect would run the risk of equating digital transformation with the sole and exclusive adoption of new technologies.

This transformation at the production level must be accompanied by an evolution of the company's strategic vision seen as a whole understood as retraining not only the workforce, which must be educated of the skills necessary for this purpose, but also of readiness in the face of an increasingly changing market demand, all aimed at a medium- long-term vision.

The way of doing business cannot change either immediately or easily, so the manager responsible for digital transformation must take the initiative to change the

mindset of every member of the organization and must create an environment in which the experiences gained day by day are at the center of every process, while keeping the company's mission intact.

In the next paragraphs we will analyze the basic principles of Industry 4.0.

1.3.1 Virtualization & real time capability

Virtualization consists of a virtual reproduction of the company, made by use of sensors applied to the components of the physical processes, which enable the configuration of the company's "digital twin," whose combination with the physical assets generates the cyber-physical system that underlies the concept of Industry 4.0: Each element of the value chain (warehouse, workshop, machinery and the product itself) has a digital counterpart.

It is necessary to make a distinction between Virtual Reality and Augmented Reality. Virtual Reality platforms allow the user to interact with a digital model that is independent of the physical one, to enable him to learn procedures and test acquired knowledge in a scenario very similar to the operational one. Augmented Reality tools, on the other hand, overlay the two worlds, physical and real, providing the user with a range of additional information that he or she would not be able to easily find in reality. Examples of Augmented Reality are represented by mobile or wearable devices such as tablets, smart glasses or displays that support

operators in daily activities by increasing productivity, reducing time and errors in the execution of various tasks, thanks also to the possibility of sharing the information displayed on the devices with other users and receiving remote support. The creation of this virtual twin of the enterprise makes it possible to conduct evaluations and implement improvement and corrective actions on the present functionalities and flows, without compromising or harming the integrity of the physical processes being performed. As a result, waste along the value chain, production defects and downtime on the line are drastically reduced and minimized. This opportunity is contingent on another guiding principle of Industry 4.0: The Real time capability, that is the ability to collect data, process the resulting information, and make decisions, based on that information, in real time[2]. The desired benefits are obvious: smart, interconnected objects and autonomous control systems are able to reflect customer demand in real time.

1.3.2 Modularity & mass customization

Industry 4.0 needs more flexible and agile planning, production and logistics systems, i.e., modular systems that are perfectly scalable and can react quickly to changes in demand. Modularity allows, through the integration of the value chain with the information system, production mechanisms to be changed in response to

[2] *Ghobakhloo, 2018. "The future of manufacturing industry: a strategic roadmap toward Industry 4.0"*

market demand. Indeed, the principle of modularity is further expressed in product customization, which is nothing more than a reinterpretation from the customer's perspective of the concept of mass customization. *Cyber Physical Systems and the Internet of Things* (Paragraph 1.4.1), are open-ended architectures based on three-dimensional virtual models printed layer by layer, which have made it possible to reconfigure the product, according to the customer's ever-changing preferences[3]. Therefore, the adoption of increasingly flexible technologies to manage the complexity and variety of products on the market today is increasingly crucial. A module represents a standardized unit or subsystem, having a certain functionality, that can relate to others to build a larger system capable of performing different combinations of activities. It is easy to configure, upgrade, expand, and analyze. The construction of these modular systems simplifies maintenance, service, and reduces the time to change failed or damaged components. In addition, this design ensures that a product or even a system can be used for a longer period of time due to the ease of replacing individual modules and the continuous development of updated components. It also turns out to carry, therefore, a set of values related to sustainability and is an efficient, intelligent and environmentally friendly response to the demands for customization coming from the consumer goods market.

[3] *Ghobakhloo, 2018. "The future of manufacturing industry: a strategic roadmap toward Industry 4.0"*

1.3.3 Orientation to the service

Orientation to the service refers to the ability to identify and recognize the needs of others in order to best meet them by adopting a caring and cooperative attitude. In an increasingly competitive market, in which the types of customers are more and more varied, it is essential to possess this ability, that is, to be able to grasp the needs of internal and external customers by constantly orienting one's activities toward satisfying their needs, consistent with organizational standards and objectives. For these reasons, customer orientation has become a real business necessity. In fact, understanding what the customer means to the company, what his expectations, needs, solving his problems and showing him one's attention represent the foundations of an exclusive, long-lasting and fulfilling relationship with the customer, building loyalty in the business relationship.

The role of technology has been and still is to help not only to create a new product or process but to offer services that can be exploited for the enterprise's own benefit. Just as at present it is now inconceivable to think of the enterprise as uniquely defined by the geographical boundaries of the place of production, the product itself transcends its tangible dimension, following the application of the concept of product as a service (PaaS). Product as a service merges into itself physical objects, ancillary services, such as transportation, maintenance and service, and monitoring software, delineating a novel model of offering, in which the buyer no longer tends

to definitively appropriate the object of interest, but becomes a user of a service or the protagonist of a hybrid experience between the physical and virtual worlds. The single product as the sole source of value for the customer is giving way to brand perception and consumer choice strongly conditioned by the communication and distribution channel adopted by the company.

The term manufacturing as a service (MaaS), on the other hand, refers to the collective use of a production infrastructure to manufacture products, whereby the service orientation concerns not only the production outcome but the entire production process. In this environment, complex production activities are not to be considered the responsibility of the individual, but can be carried out collaboratively by different companies, which provide the production service. The concept involves manufacturers using the Internet to acquire and make available production capacity.

Today it is now possible to assume the realizability of XaaS or Everything as a service models, in which production capacity, products, and business processes break out of silos and become horizontal services, accessible and exploitable across the boundaries of the organization as a whole.

1.3.4 Decentralization

The need for greater responsiveness of the production process and the long waiting times, for receiving feedback from the centralized control system, have set the stage for realizing in Industry 4.0 the decentralization of control. Centralized systems have a limited capacity that, once saturated, prohibits them from expanding in relation to increasing requirements. Moreover, should a single failure occur within the system, due to its centralized architecture, it is compromised overall. Decentralization, refers to the ability that intelligent systems, made as such by technology, have to make decisions autonomously and act without human intervention, being able to recognize any anomalies in processes and modify in autonomous ways their behavior. This is the case with all mechanisms with artificial intelligence, such as robots, which, precisely through this, can understand what is happening around them and act accordingly without external intervention.

1.3.5 Interoperability

It is the ability of two or more systems belonging to different companies to exchange data in order to create networks of companies that can extend beyond national borders so that even small and medium-sized companies can increase their competitiveness. There are two types of interoperability: Syntactic and semantic interoperability.

Syntactic interoperability is the condition that must occur for systems to be able to exchange data in a format known to both parties. Semantic interoperability, on the other hand, is the automatic interpretation of shared information in an accurate and meaningful way by both systems. This requirement is met by the adoption of a common reference model[4]. Interoperability, therefore, does not take the form of data standardization alone, but is accomplished in the full understanding of information content by all units involved. Full interoperability of a system is thus manifested in the ability of all its components, be they human resources, products, workshops and relevant technologies, to connect, communicate and collaborate via industrial internet of things (IIoT). Interoperability and security represent two key factors that have always affected the way manufacturing systems are organized, which play a key role in Industry 4.0 due to the increasing interaction between sensors, machinery and humans on a global scale.

1.3.6 Sustainability

It consists of optimizing the consumption of energy resources to enhance the environmental and social aspects, while also improving working conditions. This is an aspect strongly linked to industry 4.0 also due to the increasingly catastrophic

[4] *Laurini and Murgante, 2008. " L'informazione geografica a supporto della pianificazione territoriale"*

and persistent effects that pollution and the resulting climate change have on our society and way of life.

1.4 ENABLING TECHNOLOGIES

Industry 4.0 is made possible by the introduction of evolving technologies into manufacturing, the potential of which is set to expand over time, but also by the reevaluation and promotion of already familiar solutions and tools (Figure 1.5), which in the new context can actually be a source of competitive advantage for companies. Enabling technologies represent the technological core behind the implementation of Industry 4.0, the confluence of which forms the technological complex of a company's manufacturing operations.

According to the definition provided by the European Commission, "these are knowledge-intensive technologies associated with high R&D, rapid innovation cycles, substantial investment expenditures, and highly skilled jobs"[5].

To make the most of the potential of these technologies and realize efficient and effective smart factory solutions, it is crucial to trigger synergies among them. In fact, the technological devices offered by Industry 4.0 generate value only when considered at the systemic level, according to the rule of "super additivity," whereby

[5] *European Commission, Brussels,2012. "A European strategy for Key Enabling Technologies – A bridge to growth and jobs"*

the whole is more than the sum of its individual parts. Therefore, the possibility of achieving synergies from the integration of enabling technologies is far more important than the use of individual technologies[6]. Thanks to the integration of these technologies within the company and their interconnection, it is possible to achieve benefits such as optimization of consumption of resources, the enablement of new business models, improvement in product lifecycle management, reduction of time-to-market, mass customization, and the ability to know the needs of consumers in real time.

Figure 1.2, "The 9 technologies of industry 4.0", Source: Industry 4.0: The future of productivity and growth in manufacturing industries

[6] *A. Martin, 2019. "Industry 4.0, Challenges and Opportunities for Made in Italy. Technologies. Scenarios. Success Cases"*

1.4.1 Big data & analytics

Big data & analytics represents a process of collecting and processing a large amount of data that is produced daily on our planet; this data comes mainly from online activities as communications, photos videos, and the Internet of Things. In fact, practically all of the actions we perform daily online, always leave a digital trail, data indeed, that businesses and institutions can use to their advantage. Big data and analytics specifically make it possible to improve asset efficiency and performance, support product customization, prevent breakdowns and sudden machine downtime through predictive maintenance practices, and lay the foundations for speeding up the production process and making supply chain management more effective[7]. It is thanks to the analysis of this data that businesses can optimize their production processes, understand the behaviors of potential customers, intuit market changes and anticipate competition, thus transforming a set of simple data into added value.

It was introduced a model, called the 5V model, that highlights the special characteristics of Big Data, focusing on the variables along which this technology develops. These variables are:

[7] *Ghobakhloo, 2018. "The future of manufacturing industry: a strategic roadmap toward Industry 4.0"*

1. *Volume*: refers to the size of the databases used to store the data;

2. *Variety*: the type of data available to the company is no longer uniform, so integrating structured data (usually numerical) with unstructured data (text, images, video) requires specific platforms and qualified personnel;

3. *Velocity*: refers to the speed with which data is transmitted. The speed of data transmission and analysis is a key point for the success of Big Data;

4. *Value*: the acceleration of the digitization process is affecting all industries. The need is to store, classify and analyze data appropriately. This is all aimed at extracting value in order to identify new business opportunities;

5. *Veracity*: data must be reliable. However, the quality and integrity of the information remains an indispensable pillar to give rise to analyses that are useful and reliable.

Figure 1.3, "The 5V's of Big Data" Source: Industry 4.0: A deeper analysis

1.4.2 Cloud computing

According to the National Institute of Standards and Technology (NIST), Cloud Computing is a model that allows convenient access from anywhere and on demand, via a network, to a set of shared and configurable computing resources that are quickly made available and released with minimal management effort or interaction by the service provider. It is a very flexible technology that can change the contract terms agreed with the provider in real time to suit its needs. It consists mainly of 3 parts: *Storage space, Computing Nodes and Controllers.* When we talk about Cloud we have to distinguish between IaaS (Infrastructure as a Service), PaaS (Platform as a Service), SaaS (Software as a Service). SaaS is "a model that includes applications and software systems, accessible from any type of device (computer, smartphone, tablet, etc.) through the simple use of a client interface." PaaS is "a model in which the services of online platforms are found,

through which a user, usually a developer, can perform the installation of the applications and web services he or she intends to provide." Finally, IaaS is "a model in which virtualized hardware resources are made available, so that the user can create and manage, according to his needs, his own infrastructure on the cloud, without worrying about where the resources are allocated." SaaS, PaaS and IaaS thus differ in the type of service that can be delivered: a service offered by an IaaS supports a PaaS service, which in turn supports a SaaS service. The main critical issue arising from the adoption of a Cloud infrastructure certainly concerns data security. This implies not only the risk of a loss of full control of one's data and resources, but there is also the risk of oligopoly with centralization in the hands of a certain number of companies where data no longer reside on the single hard disk, but are increasingly being remoted elsewhere. It will, therefore, be up to the individual user to implement an informed use of cloud services by weighing the risks and benefits of the services offered as a priority.

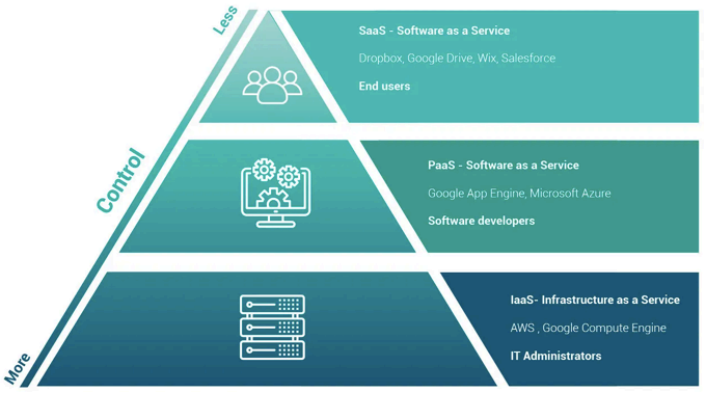

Figure 1.4, "Cloud Computing: IaaS-PaaS-SaaS" Source: Industry 4.0: The cloud computing and its structure

1.4.3 Cybersecurity

Cybersecurity groups all those technologies that help protect the information system from attacks that can cause the loss or compromise of sensitive data. Factory 4.0 is increasingly connected to the outside world and, as a result, more vulnerable than before to the issue of data security. This situation leads to the need to understand how to securely execute data transmission at each step and identify the most appropriate security solution. It is no longer sufficient to encrypt data but it is necessary to deal with Cybersecurity in a structured way. Fundamental to this is the development of the security by design paradigm, a requirement that must be present at every stage of the system's life cycle. This approach involves designing predictive systems that can anticipate threats and implement effective and timely action plans. The activities that must be performed to have proper Cybersecurity management, are: *Identify, Protect, Detect, Respond and Recover.*

1.4.4 System Integration: Vertical & Horizontal integration

Originally, the automation pyramid consisted of four clearly defined levels: the field, i.e., the place of the process to be controlled, equipped with sensors to measure the quantities of interest; the control, where processors decided on the actions to be taken; the supervision, with personal computers and systems assigned to monitoring; and the enterprise, where other business activities resided. In the context of Industry 4.0 devices and machines interact directly with each other, exchanging information automatically and thus without due operator intervention, through machine-to-machine communication (M2M) technologies and services. The goal of Industry 4.0 is to promote the integration of processes both within the factory and throughout the value chain in order to achieve a single interconnected system, thus aspires to achieve a continuous flow of information and planning across different levels, for which purpose vertical integration is required. Vertical integration is made possible by acquiring data from sensors installed on board the machine, processing it using Data Analytics techniques and Cloud platforms, and then sharing it with the different actors in the production chain. By doing so, it is possible to significantly increase coordination within the supply chain and realize optimal global solutions and no longer local ones[8]. Smart factories need to be vertically connected with databases and control processes, by merit of smart

[8] *A. Martin, 2019. "Industry 4.0, Challenges and Opportunities for Made in Italy. Technologies. Scenarios. Success Cases"*

products and systems, and be horizontally connected with all functions and data, found along the globally distributed value chain. Horizontal integration, on the other hand, is to network, via Cyber-physical Systems, all business functions so that access to the same production data is guaranteed. In this new conception of production, dynamic and innovative new technologies allow physical and digital production to converge, concretely realizing smarter production. Moreover, the real-time connection of resources, services and people take place throughout the entire production process and along all stages of a product's life cycle, from the acquisition of raw materials, which are necessary for its realization, to production, use and disposal, according to the principle of end-to-end engineering[9].

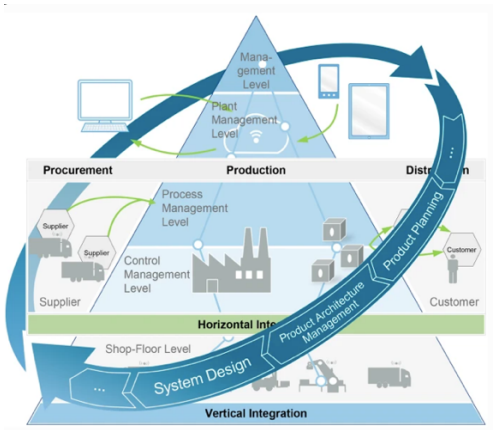

Figure 1.5, "Vertical Integration in industry 4.0" Source: Industry 4.0: Combination of two approaches

[9] *Strandhagen et al., 2017. "The fit of Industry 4.0 applications in manufacturing logistics: a multiple case study"*

1.4.5 Advanced manufacturing solution

In recent years, a profound innovation is being observed with regard to robotics, with improvements in various aspects, such as autonomy, flexibility, and cooperativeness. All of this is leading to greater cooperation between humans and robots, the integration of which will lead, on the one hand, to a reduction in the cost of accessing the availability of this new generation of robots, and on the other hand, to an increase in the capabilities of robots, compared to those currently used in manufacturing. The potential offered by Industry 4.0 lies, in fact, in the possibility of improving human-machine interactive dynamics, through a new generation of robots, collaborative and capable of automatic learning, in full correspondence with the human- centered enterprise vision adopted in the new industrial era[10]. Thanks to advances in robotics and artificial intelligence, so-called Collaborative Robots, or Cobots, have taken hold in the industrial sphere, accompanying workers on production lines, without barriers and in safety. The latter is ensured by effective safety systems that constantly monitor their surroundings through sensors, cameras and special anti-collision systems.

While traditional robots have to be programmed every time a new operation needs to be performed, Cobots work on the basis of self-learning mechanisms, drawing

[10] *Schneider, 2018. " https://www.industry4business.it/risk-management/schneider-electric-a-sps-italia-2018-con-lindustry-4-0-di-ecostruxure/*

on experience or replicating maneuvers shown by the human operator. The adoption of industrial robots makes it possible to reduce the time needed to manufacture a component, achieve superior quality and reliability of the finished product, minimize waste and optimize the use of space during the production process.

Automation from a 4.0 perspective is not geared toward the gradual replacement of human capital with machines and tools, to contract production and organizational timelines, but rather provides for a better trade-off of time, cost and quality, reserving the most repetitive and routine tasks for tools and machines, supporting human resources, which can now focus more on developing high-level skills, being, therefore, no longer threatened, but enhanced by the process of factory automation and digitization.

1.4.6 Augmented reality

Augmented reality (AR), is the enrichment of human sensory perception through information, manipulated and conveyed in the form of electrical outputs that cannot be perceived with human senses. Continued research on AR integrated with the ongoing digital transformation has resulted in this Industry 4.0 driver achieving its first positive results for the industrial sector.

Technically, augmented reality uses a 3D CAD (computer aided design) diagram and through sensors that send input to the various devices that contain the CAD,

such as smartphones, tablets, it creates an image capable of having a totally different perception of reality thanks to the addition of multimedia elements.

This new production system will also change the relationships of companies with their suppliers, customers and will also change the existing relationship between man and machine.

Thanks to ultra-fast internet connections, efficient cloud systems, and the presence of big data, it will be possible to achieve high flexibility in production, high product customization that will make it possible to consider the consumer no longer as a mass but as an individual with his or her own specific needs, and optimized production through automatic calibration. All this will impact the reduction of production costs, given mainly by the reduction of waiting time between the design, manufacture and marketing of products. The sectors in which AR can be applied are as varied as construction, emergency and health care. Another application of this technology is virtual training, which makes it possible to improve the preparation of technicians by integrating theoretical study with immediate practical application. Most of these technologies are already in use in many large companies, so it can be said that the real innovation introduced by the fourth industrial revolution is nothing more than the unification of all traditionally isolated production activities into a single integrated production stream, made possible through the combined use of these nine technologies.

1.4.7 Additive manufacturing

Additive manufacturing (AM) is a technology that enables the creation of objects three-dimensional objects, starting from a virtual model, without the use of tools but through special machines, called 3D printers. What particularly characterizes this innovation, typical of the fourth revolution, is precisely the possibility of customizing the product according to the customer's wishes, differentiating such production from the mass production of the second revolution. Despite the fact that the 3D printer has already been used in the past years, its development and improvement from the technological point of view have allowed a significant reduction of waste and consequently of material stocks, reduction of production costs and time-to-market, producing any kind of product. Product customization also entails some problems, particularly that related to the very high costs that the company faces for all the changes that are made to the product in order to satisfy each specific customer. For this reason, this type of manufacturing is not considered, at least for the time being, to be the most suitable to support mass production.

1.4.8 Simulation

Simulation is considered one of the pillars of Industry 4.0. In fact, it would not be possible to take advantage of enabling technologies without the use of appropriate simulation software.

In an increasingly competitive and complex business environment, virtual simulation has become extremely important, if not essential.

In general, simulation is the dynamic representation of a real system over a given period of time that allows the performance of that system to be predicted, under certain constraints and conditions. Industry 4.0 simulation is nothing more than the use of 3D virtual tools that can create a reality that simulates the physical reality such as a product, material or production process. This reality is called digital twin because it represents the physical product in all its functional and design aspects. It is one of the most widely used techniques in the manufacturing sector because it allows for ex ante assessment of the complexity of systems, varying configurations even in progress, simulating changes in operational strategies, and verifying the effects at the organizational level. Through simulation, product development time and costs can be significantly reduced, facilitating the integration of skills and knowledge from different processes and avoiding the repetition of errors, thus facilitating the optimization of the production cycle.

Currently, 3D product simulations are already being used in the design phase, but in the future, they may be used more widely in plant operations as well. These simulations will leverage real-time data to mirror the physical world in a virtual model, which can include machines, products, and people, allowing operators to

test and optimize machine settings for the next product online in the virtual world before the physical changeover, reducing setup time and increasing quality.

1.4.8.1 Digital Twin

A digital twin is a virtual representation of a physical entity, living or nonliving, a person or even a complex system.

The digital component is somehow connected with the physical part, with which it can exchange data and information, in real time or at later times (asynchronously).

It can evolve to become a true digital replica of potential and actual physical resources (physical twin), processes, people, places, infrastructure, systems and devices that can be used for various purposes.

The main characteristics of the digital twin are:

1) The set of data and information in any way referable to the entities represented by the digital twin;

2) The connection between the elements of the physical component with the corresponding virtual part;

3) The possibility of ubiquitous access to data and information resources through the web, with possibilities for information search and analysis;

4) The exchange of data and information between the virtual (cybernetic) and physical components, with the use of sensors and actuators.

The virtual model allows certain operations to be performed remotely, since it can be analyzed anywhere, regardless of where its physical counterpart is located. We can therefore imagine scenarios in which a technical staff gives instructions to operators who need to intervene on a machine that is miles away, simply by analyzing its virtual twin.

Figure 1.6, "Digital Twin" Source: Industry.itismagazine.it

1.4.9 Industrial internet of things

The cyber physical system (CPS) fully embodies the Fourth Industrial Revolution's desire for interconnectivity and transparency, representing a means to connect integrated systems and provide them with access to a communication infrastructure: the Internet (Schneider, 2018). CPS further brings the physical and virtual worlds closer together by integrating the processing of complex information, coming from multiple connected physical elements.

The Internet of Things has been defined by Kevin Ashton (1999) as the extension of the Internet to the world of concrete objects and places and is a key part of the news surrounding IT. Each "thing" belonging to the Internet of Things is uniquely identified by an Internet address that can be accessed over the network, and is capable of interacting with connected information systems. In general, a distinction is made between the Internet of Things for consumers (IoT) and the Industrial Internet of Things (IIoT) for businesses. In the consumer-oriented concept, the focal points are people, home applications, electronic devices, cars, computers, and many other everyday objects. IIoT, on the other hand, creates opportunities for enterprises, manufacturing plants or entire sensor networks. The industrial internet of things also includes digital representations of products, processes, and manufacturing infrastructure, better visibility and knowledge of business operations, and opportune assets to integrate and connect machine sensors, middleware (set of intermediaries between applications and software),

transportation and security systems, software, cloud, and warehouse management tools.

Through CPS and IoT, production monitoring and control systems indeed become smart, as in addition to providing a graphical display of parameter data, they can now signal the potential risk (probability) of a failure or malfunction occurring and provide quality control performance during production, eliminating the need for inspection at the end of the process.

IoT technology exaggerates the concept of communication, extending it to the interaction between machines, operators, processes and sub-processes.

At the heart of IoT technology is the ability for each device belonging to the network to be uniquely identified by an IP address and to be able to exchange data with other devices or software automatically through communication standards and protocols.

2 THE EFFECT OF DIGITATION ON ENTERPRISE'S ORGANIZATION

2.1 THE BUSINESS TRANSFORMATION

With the term Industry 4.0, we intend to refer both to a set of new technologies and new production factors but also to new labor organizations that are bound to bring decisive changes to the way of production and to the relations between economic actors, including consumers, with relevant effects on the labor market and on the organization itself. Such a fusion of reality and the digital, creates the so-called smart factory, a factory in which the way of conceiving production changes, increasingly less standardized and increasingly faster and more personalized, able to meet the needs of each customer, considered no longer as a collection of people (mass production), but rather as an individual with specific needs.

Defining the topic of digital transformation, precisely and confidently, and the effects it will have at the economic and enterprise level within a five to ten years time horizon can be very complicated and rather uncertain. However, it can be predicted, although not exactly in numerical terms, that the impact it will have on the enterprise will affect any aspect of it, from production to organizational and strategic. Digital transformation is defined as "a process of change in key business factors, consciously decided and managed by management, brought about by the use of new digital technologies and services and the development of organizational

digital capability."[11] Venier, referring to certain aspects, emphasizes that the impact of digital is not limited to the production process alone but affects any aspect of the company. From the previous definition, we know that the company outlines a strategy, called digital strategy, which is anything but random. It must be planned and well mapped out by the company's managers who will have to consider which technologies are most appropriate for their business and, most importantly, predict their effects so as to implement the most effective solutions. The last element of the definition to be noted is digital organizational capability, which contains many typical aspects of organizational design such as the ability to assess the positive and negative effects of digital technologies, data management, top management awareness, the ability to integrate digital systems and applications, and the alignment between business and the IT function, all of which are outlining aspects of new organizational systems. However, changing business processes requires a different approach than the previous traditional approach, often making it necessary to rely on external management figures to bring innovations both in processes and in the culture of the company.

Digital transformation also makes it possible to establish effective relationships that can pass on knowledge and skills within the company's resources, leading to another

[11] *Venier F., Trieste, 2017. "Digital transformation and organizational capability: Italian companies and the challenge of change."*

major advantage of being able to use integration in processes to generate more interconnections.

2.1.1 From the traditional company to the new model

Companies are increasingly recognizing the growth opportunities offered by digitization and interconnectedness. Numerous studies have analyzed companies' attitudes toward digital transformation and the opportunities and obstacles associated with it. The latter are rarely limited to a lack of technologies or standards. In many cases, uncertain implementation of Industry 4.0 is due to rigid organizational structures and a conservative culture in which people lack the courage to do things differently. Successful implementation also requires an understanding of the organization and a widespread willingness to change among its members: Industry 4.0 is not just about connecting machines and products via the Internet. Industry 4.0 will inevitably lead to new types and modes of work. This will require changes in corporate structures and inter-firm relations. The ability to analyze corporate culture will be critical to success. Companies must understand what Industry 4.0 means to them and develop a corresponding implementation strategy. Industry 4.0 Maturity Index provides companies with a guide to achieve this transformation. The index was developed by the German Academy for Science and Engineering, together with German universities and industry partners. The index includes a six-stage maturity model, where achieving each stage brings

additional benefits. The goal is to generate knowledge from data to enable rapid decision-making and adaptation. In fact, many organizations lack a basic understanding of key aspects of Industry 4.0. For example, companies often mistakenly limit Industry 4.0 to digitization or complete automation. In addition, instead of pursuing a common goal, many actions have been implemented as stand-alone measures. This index can be used to develop a digital roadmap tailored to each company's needs to help it make the most of Industry 4.0. The index helps companies determine at what stage they are in their transformation to an agile, learning company. It assesses them from a technological, organizational and cultural perspective. This approach is based on a succession of stages. Because a company's end state will depend on its business strategy, each company must decide which stage represents the best balance of cost, capability, and benefit, taking-into-account how these requirements might change over time in response to changes in the business environment. Industry 4.0 involves a significant upgrade of a manufacturer's digital capabilities and will affect large parts of the organization. Because the process can take several years, it must be implemented so that positive impacts on profitability occur at each stage. The benefits must be visible at each stage of the process to support overall success. This approach allows for quick results while keeping an eye on the overall goal of the transformation.

The company does not have to follow a standard migration process to go from a traditional company to an Industry 4.0 model. In fact, each company differs from others as it has its own corporate culture, unique characteristics, which must be taken into account during the design and implementation phases of the Industry 4.0 paradigm. Although it is not possible to absolutely represent the path to be taken to implement a proper digitization process, some experts have defined the steps from which one can start to achieve it. There is no single modus operandi to follow, but this path guarantees the same revolution.

The path consists of six phases. Each phase builds on the previous one. Since many companies are still facing the challenge of creating the basic conditions for Industry 4.0, the path starts with digitization (even if digitization is not considered a real part of Industry 4.0)[12].

First phase: Computerization

Computerization forms the basis for digitization. At this stage, different information technologies are used in isolation. Computerization is already well advanced in most companies and is mainly used to perform repetitive tasks more efficiently. However, it is still possible to find many machines without a digital interface. This

[12] https://www.assemblymag.com/articles/94546-industry-40-maturity-index

is especially true for machines with long life cycles or those operated manually. In these cases, terminals are often the missing link between business applications and machines.

Second phase: connectivity

In this phase, the isolated implementation of information technology is replaced by connected components. Business applications are interconnected and reflect core business processes. Some parts of the operational technology (OT) system provide connectivity and interoperability, but full integration of the IT and OT layers has not yet occurred.

Internet Protocol (IP) is becoming increasingly popular and this is due to the fact that IPv6 allows much longer addresses than IPv4, all components can now be connected without the need to translate network addresses. This is a fundamental requirement for the Internet of Things. Connectivity means that, for example, once a design is created in engineering, its data can be transferred to production. Once a production step is completed, confirmation can be provided automatically and in real time via a manufacturing execution system (MES). It also enables manufacturers of production equipment to perform remote maintenance of their products via the Internet.

In most factories, assets are kept in production as long as they produce quality products. It is not uncommon to see machines over 50 years old still in use on the shop floor. Because IP allows standardized communication on the shop floor, these machines can be easily retrofitted with sensors so that they too can provide data.

Third phase: Visibility

Sensors allow processes to be monitored from start to finish with large amounts of data. The status and performance of equipment can be recorded in real time throughout the company and beyond, rather than just in individual areas. In this way, an up-to-date digital model of a factory can be maintained. (digital twin). This model can show what is happening in the company at any given time so that management decisions can be based on real data. It is a key building block for the next steps. To become an agile learning enterprise, comprehensive data capture across the enterprise is essential. This will help, for example, to quickly determine changes in delivery dates through key performance indicators and real-time dashboards. As a result, managers can adjust production planning and keep customers and suppliers informed.

This is an area where companies need to change their thinking. Instead of collecting data only to support a specific operation, companies need to maintain an up-to-date model of their entire business at all times. The integration of PLM, ERP and MES

systems provides a complete picture that creates visibility into the status quo. In addition, modular approaches and applications can help create a single source of truth.

Fourth phase: Transparency

The fourth phase is about understanding why something is happening and producing knowledge through root cause analysis. To identify and interpret interactions, the data must be analyzed by applying engineering knowledge, that is, by using new technologies that support the analysis of large volumes of data (big data). This term is used to describe a mass of data that can no longer be processed by traditional business analysis. Typically big data applications are implemented in parallel with business systems, such as ERP or MES. This can be useful, for example, to perform condition monitoring of machinery. Logged parameters are searched for events and mutual dependencies, which are then aggregated to reflect machine conditions. This information is necessary for predictive maintenance.

Fifth phase: Predictive capability

In this phase, the company uses data to help predict the future. It involves representing scenarios that can be evaluated in terms of the likelihood of their occurrence. As a result, companies can anticipate future developments and take appropriate countermeasures in time. Such countermeasures can still be performed

manually. Reducing unforeseen events caused by disruptions or variations in scheduling allows for more robust operations. For example, the system can warn of logistical problems, such as a carrier failure, before they even occur so that they can be prevented.

Sixth phase: Adaptability

Predictive capability is a fundamental requirement for automated actions and decision making. Continuous adaptability allows a company to delegate some decisions to IT systems so that it can respond quickly to changing business conditions. The degree of adaptability depends on the complexity of decisions and the cost-benefit ratio. It is often best to automate individual processes.

It is important to carefully consider the risks of automating business interactions with customers and suppliers, such as changing the sequence of planned orders due to anticipated machine failures. The goal of adaptability has been achieved when a company is able to use data from the digital twin to make thoughtful and timely decisions.

2.2 ORGANIZATIONAL AGILITY

Organizational agility consists of an enterprise's ability to change rapidly and adapt itself to dynamic changes in markets[13].

The agile organization should be seen as the end point for any company: it is not constrained in rigid structures and impositions but is the organization that best adapts to change and thus the almost inevitable solution to sustain the ongoing digital transformation. The term organizational agility also refers to all business, management, and organizational aspects of work; and in all of this, technology plays the role of facilitator and supporter by offering greater opportunities in successfully achieving the final goal. It is for this reason that people are beginning to talk about IT ambidexterity, an element that falls under organizational ambidexterity, to identify one of the key factors for organizational agility[14]

2.2.1 Organizational ambidexterity

When it comes to organizational ambidexterity, the first organizational element to consider is specialization, referring to the total performance of the activity and not

[13] *Venier F., Trieste, 2017. "Digital transformation and organizational capability: Italian companies and the challenge of change."*

[14] *Tushman, O'Reilly, 2006. "Ambidextrous Organizations: Managing Evolutionary and Revolutionary Change"*

to the individual task, which precisely is capable of enabling companies to achieve the agility aforementioned.

The concept of ambidexterity was first addressed in the 1990s by March, who defined organizational ambidexterity as the ability of the firm to enact two different processes simultaneously: exploitation and exploration[15].

Exploitation means that process that leads to improving the use of resources that already exist in the organization by methods already known, increasing the efficiency of these resources; that is, increasing efficiency and control. Exploration, on the other hand, means the process of discovering and learning how to combine and put together resources in new ways to create new opportunities for the company that result in new capabilities; that is, research, innovation and autonomy. Therefore, the combination and implementation of these two processes go to delineate organizational ambidexterity, that is, the ability of an organization to make better use of what it already has in terms of physical, financial, technological and human resources and at the same time the ability to succeed in adopting new strategies and tools in an effective and useful way.

Some research has shown that under conditions of market and technology uncertainty, ambidexterity has a positive effect on company performance,

[15] *March, James, G., 1991. "Exploration and Exploitation in Organizational Learning"*

especially for larger companies that can enjoy sufficient resources, especially technology resources. To achieve ambidexterity simultaneously, the company must implement a structural change that results in a different role of people within the company. Two different solutions are possible, leading to different results: structural and contextual ambidexterity. Structural ambidexterity treats development between innovation and efficiency separately with the creation of two independent units specializing in one aspect rather than another. Each unit has its own personnel however, they are united by a common strategic intent, set of values, and mechanisms aimed at leveraging shared assets. This structural choice can also be applied at an inter-organizational level, that is, efficiency and innovation can be managed outside the company through partnerships and communities thus making it easier to achieve positive performance that is complementary to intra-organizational performance. Contextual ambidexterity, on the other hand, is the behavioral capacity to simultaneously demonstrate alignment and adaptability across an entire business unit. It does not occur between separate units, but the balance between innovation and efficiency is achieved within a single business unit that must be characterized by interaction based on trust, flexibility, and discipline, and above all by an organizational context that supports people to make autonomous decisions about how to manage the alignment and adaptability trade-off.

The unit must respond efficiently to daily activities and, at the same time, adapt to changes in the environment in a way that is resilient over time. Contextual ambidexterity is fostered by a culture that promotes flexibility and control. Each person within a unit based on these two factors knows what he or she must do because of the clear and simple directions given to him or her and is incentivized to take' action to maintain this balance.

In conclusion, we can say that structural ambidexterity is a dual structure in which the two processes are kept separate; on the other hand, contextual ambidexterity is a multidimensional structure consisting of two different but closely related elements. The two approaches have been analyzed and thought of as separate solutions, however, some experts argue that all are potentially effective and the most appropriate choice is to combine them.

From studies conducted over the past two decades, it can be seen that there is no one-size-fits-all organizational approach for each company: the goal is to achieve ambidexterity, but how to get there may differ depending on the context in which a company finds itself. In a more dynamic reality that is subject to frequent and significant change, the simultaneous approach is the most appropriate, while if the context is more static, the sequential choice is best.

On the other hand, the contextual and structural approaches are influenced by time; in fact, in the case of companies that have just entered the market, the separation of innovation and efficiency is crucial to explore the surrounding environment, but when the presence in the industry is more established and relevant levels of innovations have been achieved, the combination of the two systems can offer many opportunities in terms of performance and survival in the market[16].

2.2.2 IT ambidexterity

The role of technology is crucial in creating an agile organization, particularly that played by digital platforms employed in business processes that enable the enterprise to monitor changes quickly, change strategy flexibly, and thus react more effectively to consumer demands. In addition, these platforms ensure the creation of partnerships along the supply chain to conquer new markets, but more importantly, they can also be applied in creating or improving internal relationships. By providing these opportunities inside and outside the enterprise, technology acts as an intermediary to achieve sustainable competitive advantage. As previously, also in this case, we can say that IT ambidexterity consisting of IT exploration and IT exploitation.

[16] *O'Reilly & Tushman, 2013. "Organizational ambidexterity: Past, present, and future"*

IT exploration comes to manifest itself as the allocation of resources and time to understand the potential of new technologies that can be incorporated into organizational systems and then for the identification of those best suited to the needs of the enterprise from which positive feedback on activities will be obtained; the presence and support of this capability enables the enterprise to conquer new markets more easily as new business models are associated with these technologies that guarantee entry into new markets and, therefore, new customers.

IT exploitation, on the other hand, consists of the ability to manage the technologies already in the company more efficiently, applying them to more activities and being able to combine the technology aspect with the business aspect so as to take full advantage of them[17].

Picking up on the structural and organizational issue of organizational ambidexterity, IT ambidexterity can also be thought of as a simultaneous development of its two distinguishing capabilities, exploration and exploitation, which in some realities can be carried out in separate units or by combining existing and new technological solutions in the same unit.

[17] *Lee & Sambamurthy et al., 2007-2015. "IT-Enabled Organizational Agility and Firms' Sustainable Competitive Advantage"*

An optimal choice might be to implement both processes, moving from a separation at the beginning to a final union. According to many experts, the best choice to achieve IT ambidexterity is to integrate R&D with IT through two different solutions: the use of teams in which IT figures and R&D figures are brought together or through specific teams from the two areas that maintain some autonomy in acting and interacting to carry out innovation and efficiency projects.

2.3 A NEW ORGANIZATION: COMBINATION OF TWO DIFFERENT APPROACHES

One of the aspects that is important to note regarding the impact of digital on the organization is the need to revise that classical structure that is now no longer effective in the digital reality. Companies will have to move away from the classical hierarchical system, based on a vertical structure, in which roles and skills are strictly sectoral and in which there is little flexibility in hierarchies and tasks in favor of more flexible structures, capable of creating collaborative networks in which the driving force of the organization is no longer the individual manager but is the team in its physical but also in its digital version. In the classical organization we are accustomed to, decision-making tasks have always been confined to the close circle of top managers, who tend to keep information to themselves and impose specific roles and tasks on their employees, without involving them in the most important decisions for the enterprise and without considering their opinions

and operational experience in a specific activity. In this reality, the approach most often employed in decision making has been the intuition of the people with the most experience in the field especially under conditions of scarce information.

Nowadays, instead, it is necessary for the leader to agree to change the way he/she makes decisions by relying on the instruments and data that are collected as well as on his or her instincts to derive answers that are better suited to the problem. The risk that arises from a refusal to adopt this method is that of being replaced by those who know how to use these tools to their advantage and by rivals more adept at extracting useful value. The right choice is to combine the two approaches: letting ideas be developed from the *bottom up* and coupling this with a *top-down* approach to approval or support for these proposals.

Finally, it must also be considered that digital transformation has contributed to greater involvement of employees in many aspects where their intervention was previously not expected.

The direct interaction of people with machines and devices equipped with artificial intelligence has enabled employees to have the tools and capabilities to independently make decisions, having as its main consequence a redefinition of organizational roles. All these aspects fostered by the use of technology contribute

to the empowerment of workers who become more responsible and autonomous for their actions.

2.3.1 Flexibility & autonomy of teams

The term flexibility is a key concept in Industry 4.0. One of the first forms of flexibility that come to manifest in the new digital organizations is that related to tasks; In fact, the worker is no longer strictly bound to his or her task, but on the basis of his or her skills can be involved in different activities that transform routine tasks into empowered roles. The new basic unit of the organization is no longer the individual worker but the team, which is defined as: "*a distinguishable set of two or more people who interact, dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission*"[18]. In teams, each individual must perform his or her tasks from the perspective of the role he or she has within the organization while, however, always taking into consideration the relationship he or she has with the team, so within them there must be the right balance between individuality of tasks and collectivity of relationships that is fundamental to the company's performance. Roles within the team are not fixed and this is what makes the team a manifestation of the flexibility of new organizations. They are built on the basis of the skills and knowledge of its members, created ad hoc of the needs

[18] *Salas, Dickinson, Converse, & Tannenbaum, 1992. "Toward an understanding of team performance and training"*

and goals to be achieved in which the rotation of roles gives them greater responsibility in terms of decision making. Underlying this is the idea that each person has power in the company, and increased involvement in all aspects of the worker is a source of benefit to the company itself.

Another concept to keep in mind is the concept of autonomy associated with individuals and teams, who due to their multidisciplinary skills are able to self-organize and manage projects themselves with authorities that are decentralized. In an autonomous business environment, people can easily change roles and activities by putting all their skills into practice, the internal climate is one of innovation and creativity, and the traditional division into departments characterized by hierarchies is replaced by these teams capable, also thanks to technology, of acting on par with or sometimes more efficiently than their managers. Individual workers find themselves with tools in their hands that support them in initiatives and decisions, this has effects on the manager who will see a reduction in the burden of decisions to be made and ensure greater transparency and agility of systems[19].

The team is created with the aim of bringing together the best talents inside but also outside the company without remaining anchored to the organizational reality but opening up to the ecosystem in which it is located; this approach leads to the

[19] *Ismail, 2014. "Exponential Organizations: Why new organizations are ten times better, faster, and cheaper than yours"*

creation of teams in which the members are distant from each other, often in different geographic locations but which remain connected thanks to technologies in a transparent way and eliminating any barriers to communication and relationships. The main reasons that may drive a company to create virtual teams are related to its desire to bring the worker closer to the customer, to cut costs and travel time, or to bring together people who do not want to relocate but whose contribution is crucial to a project. New social technologies ensure constant coordination and dialogue; however, they do not compensate for the lack of direct contact between people that can make a difference. Hence, it is that many companies are considering introducing virtual reality and augmented reality systems that create a three-dimensional prototype within the shared virtual space where people can work together even if not with a physical presence but with a perception of the physicality of the team.

2.4 THE NETWORK EFFECT

The network effect, or the net, that took hold in the third revolution with the spread of the Internet is seeing its fullest expression with digital transformation and the most sophisticated technologies of the moment. The extreme interconnection between machines and people and the presence of social technologies makes possible collaborative and sharing relationships with other companies and stakeholders. As already mentioned, the key aspect in all of this is played by the

IoT, which in addition to having strong implications for productivity, will also change the way people and, in particular, companies interact. All this, will completely change the boundaries and competition between companies thus leading to the emergence of new innovative realities that base their business models on the use of such technology. The IoT, therefore, will be increasingly responsible for the realization of digital ecosystems in which data fluidity between machines, people, and the company's internal and external physical systems will be ensured by efficient and positive business partners. The platform and connectivity generated by IoT technology create an environment that is proactive, innovative, and in which any good idea that comes from this attitude of openness can propel every constituent of the organization into action. From this, it can be understood how crucial it is for any organization today to leverage technologies to create forms of networking (collaboration). This choice to adopt technologies for communication purposes should not only be taken up by the most established companies in the market but should also be employed by younger companies that do not have large amounts of capital to invest in digital. This collaboration translates, according to leading experts into value for both parties involved and at the same time also for the economic contexts in which such collaboration takes place.

The network effect nowadays is mainly manifested through the creation of *communities and crowds*. Digital networking makes it possible to unite billions of

people scattered around the world through a common interest. If we consider the case of an organization, the community is made up of core team members, former members, partners, stakeholders and users contrasted with the crowd, which includes everything outside the community, which is very difficult to conquer but rich in greater opportunities and resources for the organization. These two structures are employed for the purpose of leveraging the surrounding ecosystem, which is now crossing even industry boundaries, to seek creativity and innovation. This birthed *crowdfunding*, which offers the possibility of finding funding through the network from small and large investors for one's ideas, as well as testing consumer interest in the product. The network of relationships that is created opens up the boundaries of the company and makes it more difficult to define who is part of the company and who is external, makes the crowd and community an extension of the companies, and helps fuel organizational agility and thus growth[20].

2.5 POLICIES & STRATEGIES

This new revolution in industry is having a profound impact on companies, gradually giving rise to business models, forcing them to implement effective strategies. Companies, however, are not the only players; an important role is also played by politics. Which, is required to take in and learn about this revolution in

[20] *Ismail, 2014. "Exponential Organizations: Why new organizations are ten times better, faster, and cheaper than yours"*

order to implement appropriate measures that can take advantage of the benefits that digitization brings both socially and economically.

In the following sections we will go into more detail about the policies and incentives that have been adopted in Europe and Italy.

2.5.1 Digitising European industry strategy (DEIS)

In 2016, the European Commission presented the project known as: Digitising European Industry Strategy (DEIS). The goal of this project is to ensure that all European companies can adapt their business models to the new industrial revolution. The key element of this project is Digital Innovation Hubs (DIHs), a support structure for small and medium-sized enterprises (SMEs), apt to increase their competitiveness through the adoption of the latest digital innovations. The Hub acts as a remote counter that can provide businesses with various services including:

- access to digital technologies and skills;
- access to infrastructure to test technological innovations;
- training to develop new skills;
- financial consulting;
- market intelligence;
- networking opportunities.

Since this project started in 2013, the European Commission has invested about 110 million euros in setting up the HUBs by bringing in an initiative called Innovation for Manufacturing SMEs (I4MS), as a key activity of the project.

The goal is to promote manufacturing leadership through Hubs, that is, to foster collaboration through the transfer of Know-How between manufacturing SMEs, support the emergence of start-ups and mid-caps through the help of European HUBs, thus giving companies the opportunity to run experiments on their own digital innovations. This modus operandi creates an advantage for all players in the system, both technology providers and manufacturing companies can thus change their product-oriented business model into service-oriented business models. The I4MS is structured in several phases that pursue complementary goals.

The first phase, which began in 2013 and ended in 2017, was dedicated to the creation of well-functioning ecosystems around regional HUBs and covered four technology areas:

1) HPC cloud-based simulation services; 2) Advanced laser-based equipment evaluation; 3) Industrial robotics systems; and, finally 4) Intelligent fixtures.

The second phase, which began in the fall of 2015, had as its main objectives to organically grow existing ecosystems, extend their European dimension, and motivate the creation of new HUBs through a dedicated mentoring program. Access to EU funding has also become easier for companies, as administrative procedures have been simplified using the new HORIZON 2020 scheme, in which companies

can sign a light contract with one of the project beneficiaries, rather than entering into a direct and more complex contract with the European Commission.

The third phase, which began in fall 2017, includes four new actions for innovation. An important role for DIHs to play during this process is to increase the skills of business leaders, especially in start-ups and mid-caps, regarding the opportunities that digitization offers for their company. DIHs are tasked with providing staff in manufacturing companies with the skills needed to use digital technology to improve products, services, processes, business models and working conditions.

Following the successful implementation and impact of previous phases of I4MS, the European Commission intends to further invest HORIZON 2020 resources in this initiative. This will strengthen European small and medium-sized enterprises by helping them adopt innovative business models and also by connecting them with actors in the system that can provide access to finance or advanced training to retrain workers.

The fourth phase of I4MS will enable European manufacturing SMEs to access €35 million to accelerate the adoption of digital technologies. Now in its final step, the project aims to accelerate the adoption of digital technologies in processes across Europe, with the goal of extending transformative impact to lagging companies, regions, and sectors and supporting cost-effective, customized small-scale manufacturing based on secure digital technologies.

Phase 4 of the program was launched on June 1, 2020, by the European Commission, announcing the opening of funding calls by the end of 2020 for application experiments targeting Industry 4.0 technologies, with a strong focus on manufacturing SMEs.

During this Phase 4, the I4MS initiative will work to consolidate previous work and go further by improving the support strategy for Digital Innovation Hubs (DIHs) and EC-funded innovation actions, helping to define their value propositions in order to leverage further investment at regional and national levels.

In conclusion, we can say that I4MS opens new opportunities for manufacturing SMEs in their digital transformation journey, enabling them to test innovative digital technologies, receive funding and technological and business support from cutting-edge research centers in Europe.

Figure 2.1, "DEIS: The fourth phase" Source: European Commission

2.5.2 Digital single market

To boost growth, employment, investment and innovation, the European Community in 2016 also launched the Digital Single Market project. Citizens and businesses will finally be able to benefit from the entire European digital marketplace, thanks to the removal of obstacles that have for too long prevented free and safe use of the Internet. Recently, only a tiny portion of small and medium-sized enterprises in the EU (about 7%) were establishing business relationships on foreign soil. This only underscored and confirmed the nationalist trend of online markets.

The European Union's investment plan for the Digital Single Market includes the allocation of 50 billion euros, useful to pursue the following objectives:

- promoting e-commerce;
- adapt European copyright rules to the digital age;
- update European rules regarding audiovisuals;
- strengthening ENISA, the European Union's cybersecurity agency;
- ensure the best possible internet technology for all EU citizens;
- adapt privacy rules to the digital world;
- helping large and small businesses, researchers, citizens and public administrations make the most of new technologies[21].

[21] *https://ec.europa.eu*

Equally relevant among Europe's innovation initiatives is certainly the birth of the European Open Science Cloud, a digital portal through which research centers and universities across Europe will be able to communicate with each other easily to exchange scientific data. In this way, "knowledge" circulates faster and more freely thanks to the simultaneous participation of experts from different fields of science and academia.

2.5.3 eCommerce

By the term eCommerce we mean the process of buying and selling goods or services through the transmission of electronic data using the Internet and the World Wide Web (WWW). Thanks to new technologies, and in particular the World Wide Web, nowadays even a modestly sized company can, with a modest investment, operate in a global market simply by setting up a virtual store.

A concrete example of this commerce, is represented by Amazon, which started as a small retailer and then became one among, if not the largest, multinational corporation in the world. Choosing to interact with online users allows, in fact, to reduce operating costs, but above all allows you to expand the visibility of your business and attract more potential customers than a traditional store. In addition, by adopting good web marketing strategies, it is possible to target promotional messages to a well-defined target of customers, thus enabling excellent turnover results even for those dealing with niche products. There are different types of

eCommerce depending on the transaction mode, such as: Business to Business (B2B), Business to Consumer(B2C), Consumer to Business (C2B), Peer to Peer (P2P) and others.

The most important problematic associated with e-commerce, and so with Internet, in the security associate with online payments, and so the probability to be "mugged". To the current day, the most common methods that can lead to this problem are bank transfer, cash on delivery, and credit card payment. Initially, the transfer of information and personal data between seller and customer was done in plain text. This posed a huge security problem, as the transferred data were susceptible to being intercepted and then used by third parties for transactions outside the current business practice. Today, this data transfer practice has been abandoned, in favor of more secure practices that guarantee greater confidentiality of personal information and thus ensure the goodness of transactions.

E-commerce market turnover is expected to reach 740.20 billion euros in 2022, and revenues are also expected to register an annual growth rate of 12.50%, for an expected market volume of 1,054.00 billion euros by 2025. Overall, European e-commerce experienced a growth in B2C turnover in 2021, despite some countries reporting lower e-commerce sales due to the lessening of Covid-19 pandemic measures. As has been the trend for quite some time, Eastern Europe has experienced higher growth rates in B2C e-commerce sales than many Western European countries, however Western Europe still holds the largest share of total

turnover at 63% compared to Eastern Europe's 2%. This share of turnover is reflected in the E-GDP of the regions, as Western Europe remains the highest. Despite the appearence that Northern Europe lags behind in the share of total European turnover, the e-commerce markets are robust and over 4% of total GDP can be attributed to e-commerce. Although the digital economy in Eastern Europe is continuing its growth trend, there is much ground to be covered if the region hopes to compete with Western and Southern European markets.

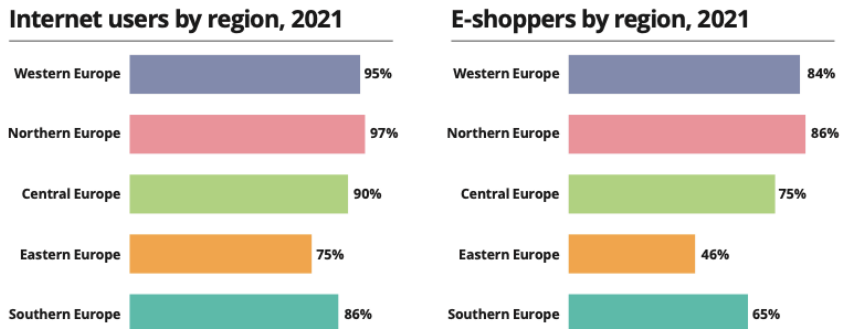

Figure 2.2, "eCommerce comparison by regions" Source: Eurostat

2.5.4 The Italian case

It is necessary to point out that following the 2008 financial crisis, the Italian economy has suffered severely especially in the manufacturing sector within which it figured as one of the major powers. For these reasons, the tool of digital transformation represents a real and concrete advantage to be grasped and implemented in order to restore the economy of companies affected by the crisis.

However, difficulties are present in the implementation of enterprise digitization. Within the Italian industrial sector there is a lack of large enterprises, or rather there are very few, and especially ICT enterprises that can drive technological development and change. In fact, the Italian industrial sector is characterized by the strong presence of small and medium-sized enterprises, this implies that there is a scarcity of financial resources and at the same time difficulties in raising the necessary financing for this purpose.

For this reason, in September 2016, the "National Industry 4.0 Plan" was presented by former Prime Minister Matteo Renzi and then Minister of Economic Development Carlo Calenda. The main objectives pursued by this Plan are to: 1) innovate and fortify the opportunities arising from Industry 4.0; 2) encourage and support financing. The purpose of these objectives is to make productivity more adaptable, allow for better quality products, increase production, and finally enable the process of getting the final product to market faster, consequently increasing competition within the Italian industrial landscape. In order to meet these goals, 3 different guidelines have been set; of which two are key guidelines while the last one is accompanying.

The first referred to Innovative Investments, has as its main objective to encourage:

- Private investments in the renewal of the " machine park " within enterprises (through the measure of *super depreciation*);

- Investments with greater transformative content using digital technologies and the use of a range of capital goods in the 4.0 perspective (through the measure of *hyper depreciation*);
- Business spending on research and development;
- Corporate finance to support the investments of the Industry 4.0 Plan.

The second, however, concerns skills. Industry 4.0, as previously mentioned, also affects the cultural context and, as a consequence changes the labor market considerably, primarily involving people and workers. This is why the aspiration for continuous upgrading of businesses is to be considered optimal in function of the acquisition of the new skills deemed indispensable by digitalization.

For this reason, the Industry 4.0 Plan provides a whole series of incentives oriented in this direction by providing training courses at schools and universities, the creation of competence centers and the establishment of digital innovation centers, creating a system aimed at incentivizing and supporting the demand for common innovation through assessment and support activities for companies.

These guidelines should be coordinated with the so-called accompanying guidelines, which aim to achieve goals that go hand in hand with the objectives of the competitiveness, productivity and sustainability of the entire system. In the first year of application, i.e. 2017, the guidelines of the Industry 4.0 Plan have had positive feedback regarding the country's economy and, in fact, the data reported by the Ministry of Economic Affairs show an increase in investment of 9% on an

annual basis (which in the case of machinery and other equipment rises to 11.5%), research and development spending of between 10% and 15% and improved access to the Guarantee Fund. Although, the estimates are stimulating the country continue to adopt a whole series of reforms aimed at ensuring innovative progress by seizing all the opportunities offered, so as to make Italy increasingly competitive.

3 THE IMPACT OF DIGITAL TRANSFORMATION ON JOB SKILLS

3.1 INTEGRATION WITH HUMAN CAPITAL

The digital transformation of enterprises is not only about the relevant innovative technologies, but also about the human component that plays a central role. This is true both for the transformation phase and for the phase of monitoring business goals; in fact, technology is not yet able to replace distinctive human characteristics, such as empathy or critical sense, and may never be able to do so.

The goal, in order to be able to take advantage of all the benefits that Industry 4.0 has to offer, is to have awareness of the changes that digital transformation entails within companies and have the skills and means to cope with them. The company is composed of the combination of assets, but most importantly also of human resources, the management of which is one of the most critical points. There is a need, therefore, for companies to innovate in all aspects through the adoption of new and different patterns of organization. Continuous training remains a key factor in improving a company's ability to adapt to constant external stimuli and pressures, enabling it to anticipate new needs and revolutions, which occur frequently in the digital world. The introduction of these innovative technologies has changed the way operators work, for whom training courses and seminars to enable them to adapt to the new work tasks become necessary. Changes due to digital technologies will alter the previous view of the worker, who will no longer have to perform

standard, repetitive tasks. This implies a reduction in the importance of so-called *hard skills*, i.e., technical skills related to know-how, and conversely an increase in *soft skills*, i.e., capabilities that are "*totally independent of professional knowledge, such as the ability to work in a team, to communicate, to analyze and solve problems, to empathy, emotional intelligence and so on."* Therefore, as time goes on, companies will require special skills such as those of problem solving, decision making and flexibility. Today there has developed the completely misleading idea that the digital transformation process will be able to almost completely replace the human component from enterprises. Instead, the real goal is to optimize productivity through the proper use of physical and digital systems. Of course, this requires managing the trade-off between obsolete skills and those, instead, that are needed.

3.2 HOW WORK & WORKERS CHANGE WITH INDUSTRY 4.0

Industry 4.0 will potentially change the traditional idea of work, and this implies a major impact on the labor market, the organization of the labor market, and also on the workers operating in it. Most aspects affecting the worker are in the process of change, from modification of directional power, the distinction between time devoted to work and time off, the level of duties and education required, up to the

structure of pay[22]. Companies' adoption of machinery almost always changes the actions performed by humans in their work. However, the impact that automation has on jobs is not the same in all, but changes according to the characteristics of the industry, some of which require activities that can be easily performed by machines, such as processing data or performing physical work, while others that a machine can hardly develop and require human intervention, such as knowing how to relate to third parties, understanding the mood of those in front and behaving accordingly. Generalizing, we can say that, a predictable environment with standard activities is easily automated compared to a changing environment or one for which activities with some logical reasoning are required. With integrated automation, employees are expected to be more autonomous than in the past, to be able to work in teams, and to cover different roles with a problem-solving approach. The company now needs an individual who is competent to deal with difficulties that may arise from machinery by having to be able to solve hypothetical defects in equipment.

With Industry 4.0, the concept of rigid locations and schedules is beginning to disappear. In fact, it is not strange, in these realities, to see that the worker is able to spend more time outside of the work context because of the management, intervention and monitoring possibilities that process automation provides.

[22] *Avogaro M., 2019. "The Highest Skilled Workers of Industry 4.0: New Forms of Work Organization for New Professions. A Comparative Study, E-Journal of International and Comparative Labour Studies*

We are facing an increasingly malleable and fluid world of work, marked by the possibility of managing one's tasks remotely (*smart working*), which in time is likely to become the routine. It is therefore easy to foresee how the figure of the worker in these contexts is of extreme importance. The worker is required to have additional knowledge and skills, so investing in training is crucial as employees work with highly specialized machinery.

However, the presence of complex technologies in digital factories requires a reconfiguration of the engineering activity as well, in fact the 'engineer must go on site to the various departments and, like any other corporate figure, must have the ability to interact with colleagues to compare their knowledge with respect to advances and transformations.

In conclusion, this process of Industry 4.0 will only be able to express its full potential if there is a different, but equally important, contribution that the two generations (junior and senior), are able to make throughout the business environment. In this way, the experience gained by senior workers and the greater familiarity and propensity for technology of junior employees will combine in a winning way.

3.2.1 Skills of the worker 4.0

Soft skills, or soft competencies, are those skills that relate to the personal sphere of the individual, such as attitude in the work environment and knowledge in the field of interpersonal relationships. Generally speaking, soft skills, constitute the alter ego of hard skills, or the qualities that are easily quantifiable and measurable. In a dynamic, and constantly evolving society such as the one in which we live, it is easy to see how soft skills represent a characteristic that is increasingly in demand and valued by businesses.

The paradigm shift brought about by Industry 4.0 affects all aspects related to the organization as well as knowledge sharing, work models and continuing education, which to date has taken on the role of the driving force behind the change. The latter is considered a driver of business development, an innovation strategy and an indispensable tool of learning organizations, i.e., those organizations in which training and continuous learning are the basis on which any business strategy for creating value and maintaining competitiveness rests. Human capital is the essential element of any organization and is the impetus for the famous "creative destruction," capable of bringing disruptive innovations that revolutionize production processes while ensuring increased performance.

The World Economic Forum has identified the 10soft skills that are most in demand by entrepreneurs to date:

1. *Problem Solving*: is a type of thinking and concerns the ability to reach a desired condition, starting from given conditions. Problem solving is only one part of the process of solving a problem; in fact, the entire procedure also includes the activities of *problem finding* and *problem shaping*, which both precede it. In an increasingly complicated economic situation such as the one in which we live, which requires continuous adaptation to changing conditions, the ability to be able to cope with critical situations and identify a solution quickly therefore becomes crucial.

2. *Critical Thinking*: is a type of thinking that aims to reach a judgment through mental processes of analysis and evaluation and includes activities of reflection on tangible and non-tangible topics. Critical thinking is based on observation, experience, reasoning, and communication. Its ultimate goal is based on the attempt to go beyond the vision and perspective of the individual subject; indeed, its fundamental characteristics are clarity, accuracy, precision and evidence.

3. *Creativity*: The ability to innovate is fundamental to creating added value. Creativity means thinking outside the box, coming up with new and alternative solutions. The ability to think outside the box is rewarding in the era of global competition. It requires courage since it is not for everyone to change a business

structure that has been working in a certain way for years and is still bringing results. It turns out to be a key factor because in today's modern world, keeping up, innovating and thinking outside the box means staying a step ahead of all your competitors.

4. *People management*: This is a skill that requires firmness, authority and emotional intelligence in addition to the ability to make decisions. Knowing how to lead a team by valuing and motivating people is definitely one of the most complicated activities especially when the team of people to be managed and motivated is located in different work environments as in the case of smart working and remote working.

5. *Teamwork*: It is the ability to relate to others, to be able to express oneself while also being able to listen to what others think, and to build lasting relationships where empathy and customer orientation in external communication are crucial to maintaining a healthy working environment within the company. Knowing how to work in a team involves being able to organize one's work with that of

others and being able to prioritize and make course changes if necessary, so coordination of themselves and others is the key word when it comes to this aspect.

6. *Emotional intelligence*: This is the ability to recognize, use, understand and consciously manage one's own and others' emotions. Those who possess it are able

to choose the right time and attitude to say or do something, proving to be of fundamental importance in maintaining balance within an organization especially at the most critical times.

7. *Decision making*: It is necessary to be able to share and listen, but at the right time also to be able to decide on the direction in which to go. In crisis situations it is even more difficult and at the same time of crucial importance. It is a good part of a manager's job to be able to listen to everyone but then decide independently.

8. *Service orientation*: it is the ability to know how to make oneself useful, showing oneself caring, attentive and cooperative toward the needs of those who work alongside us.

9. *Negotiation*: It is a strategic activity for the economic and relational well-being of the company and the people who work in it; in fact, it has an effect on the added value of a business and the profit produced. At the same time, it also affects reputation and one's bargaining power as the company relates to other organizations.

10. *Cognitive Flexibility*: This is an executive function that comes into play when there is a need for timely responses to unusual situations. Specifically referred to is response flexibility, which is the ability to adopt different behaviors in relation to changes in rules or task type. Those who possess this skill know how to adapt to the

work environment and to new things. The labor market changes rapidly, and organizations that wish to remain at the top and competitive must of necessity have employees who are willing to change roles and tasks; these changes can also be sudden and abrupt, so people who are inclined to learn new skills when their hard skills become obsolete are needed.

3.2.2 The role of the manager 4.0

Ongoing change affects any aspect of a company across the board, and as it is managed and coordinated by the manager figure, it is critical to understand what will happen to his or her role. In the era we are in, full of upheaval, people are in a state of fear and confusion toward the future. They cannot understand how their role in the labor market will change, and they need someone who can guide and motivate them to change, because without a culture aimed at change, it cannot be expected to happen. Thus, it is that the old image of the distant manager, not communicating with employees, not open to change and welcoming their employees' ideas and proposals is no longer effective; new leadership skills are needed. The figure of the manager in the context of industry 4.0, is undergoing a transformation: "he is no longer seen as the person to whom one must be accountable for his actions since he holds a high position regardless of his skills,

but he is a person who manifests his authority because of what he knows and the aspects of which he is an expert"[23].

To identify what these new skills are that are needed to cope with change, some experts have conducted research thanks to which they came with the conclusion that the skills that managers must have are:

- *Jumping into the breach*: The leader must be at the forefront of the transformation process therefore, he must use his experience and knowledge to motivate and support people toward change. The manager must be a motivator, inspirer and encourager;

- *Investing in people*: The leader must understand the talents and skills of each of his or her employees and must invest effort in bringing these people forward, making sure that their skills and competencies increase while at the same time trying to keep these talents within his or her organization;

- *Focus on important goals*: The leader must generate energy and action by imposing high goals on his or her employees because they will be more motivated and feel more responsible for having contributed to the growth and formation of the company;

- *Leave no one behind*: The leader must be able to listen to and interact with his or her employees and must accompany them toward change by listening to their needs

[23] *Ismail, 2014. "Exponential Organizations: Why new organizations are ten times better, faster, and cheaper than yours"*

and fears, involving them fully in company issues and problems even at times of greatest anxiety and stress;

- Personal Commitment: Managers must have a constant, daily relationship and dialogue with their workers, they must understand their needs and help them and make them feel good in the new organizational reality, and they must take personal action to develop their roles.

Most of these actions consist of elements that underlie a relationship of involvement and collaboration between the leader and the workforce. This involvement makes each person himself a leader and responsible for his group and company, so it is important that each individual be fully involved and active and thus practice what is called "followership." The follower, that is, the supporter or follower of the leader, must develop his or her ability to self-manage and actively engage in what he or she does, being autonomous and taking responsibility for his or her own actions, thus completing the other half of the leadership equation represented by the leader[24].

In conclusion, we can say that the essential and irreplaceable characteristic of managers regardless of their hard skills and abilities is the capacity to remain human and generate empathy.

[24] *McFarland, V., 2015. "Leading and Building Effective Teams"*

3.2.3 Human resources management

The organizational challenges businesses are facing due to the ongoing technological transformation are also critical for an important part of the organization that has seen rapid development over the past decade, HR (Human Resources). HR has always seen a great deal of effort on the part of professionals, in developing tools, including technological tools, that are very sophisticated and appropriate for the assessment and development of a workforce that keeps pace with changes in the organization and the industry.

However, although there has been a process of development and change in recent years in the techniques adopted by HRM, still there are solutions that are too outdated and not suitable for a generation of digital workers or organizations based on increasingly agile logics. There must be a greater openness to using new technologies to one's advantage by going beyond the limits imposed by the tradition of hiring staff only with a view to increasing one's personal workforce without considering what is called the on-demand workforce, that is, the figure of the freelance worker who makes his or her knowledge and experience available temporarily to a company without being directly hired by it.

The use of wearables and IoT means that the company is able to collect a great deal of data and information about people that proves to be critical to the company itself and to the ecosystem in which it finds itself. HR will need to equip itself with skills beyond its knowledge, in analytics first and foremost for understanding this data

and extracting useful information, IT and digital to know how to best use the new devices while maintaining its role as a psychologist and consultant. HR in its new role must leverage these resources to come to the aid of workers by creating training projects suitable for developing the skills required by the organization, reorganizing spaces in a more creative and productive way.

3.2.4 Outlook for the labor market & employment

With general automation, the digitization of work, and the introduction of robotics to replace tasks previously performed by blue-collar workers, the question arises as to whether machines are destined to replace human labor or whether the future of work will depend on achieving a balance between new generations of machines and human capabilities. Aspects to reflect on are job creation and transformation, job elimination as a result of automation processes, job relocation, and the pursuit of high levels of flexibility. On the one hand, it is stated that the adoption of robots increasingly programmed by computerized systems will have the effect of increasing demand related to workers with specific professional knowledge and adequately trained, but at the same time, however, labor experts point to the future risk of a drastic reduction in all those activities that require the performance of repetitive and manual work. This causes considerable concern among those workers who see the change as a threat to keeping their jobs. On the other hand, however, it is the same technological innovations that can be used to enrich the role and tasks

of the operator, demanding greater autonomy and more knowledge. In fact, the presence of highly skilled technicians employed in management and control activities is certainly a key factor that ensures better performance for the company. The 4.0 system needs and will certainly need in the future professional figures called upon to preside over business processes, an interconnection of knowledge between the different technical areas involved, and a propensity for continuous learning. To enter the 4.0 world without the risk of falling behind the times, companies must equip themselves with the necessary skills, reformulating the various strategies and practices of selecting, hiring and developing human resources.

The moment machines replace humans in the factory there will be a high level of unemployment due to digitization, so-called *technological deflation*. There will be huge masses of people without jobs because their role in the enterprise has been taken over by a robot. However, this loss is not unidirectional, it will in fact be offset by new hires in areas of IT, R&D, data analysis, as well as hires in other roles that will be created due to increased production, again due to technological innovation, in particular new jobs will emerge. The jobs that will slowly be totally automated will be those with

less added value and more repetitive tasks such as loading and unloading machinery or handling materials. New hires, on the other hand, will be present in those sectors of machine and plant manufacturers, which will also have a need for new

professionals in the areas of service and customer support. Progress changes the way people work but does not cause the overall supply of labor to decline; in fact, overall unemployment in recent years cannot be linked to new discoveries in technology that have done anything other than provide a contribution to productive growth.

The reason for this depression is due to the economic crisis, which has reduced aggregate demand levels, causing production to contract, consequently reducing the jobs that companies need. Rising unemployment is a problem not only for those involved but for the entire economic fabric of the country-the fewer people working, in fact, the lower the aggregate demand for goods and services, going to trigger a vicious cycle that will lead to more layoffs and a huge drop in GDP with negative consequences for everyone, it is therefore in everyone's interest to provide for the creation of measures to combat unemployment.

Another key issue is worker protection in both personal and public spheres. In particular, in the face of the employment and re-employment challenge presented by the digital factory, certain institutions such as the Wages Guarantee Fund, solidarity contracts, but also the various subsidies, seem ill-suited. We should talk about forms of assistance such as social insurance, with three basic requirements such as the disbursement of an allowance sized to the last salary received by the person concerned, active support in the worker's search for a new job, and training

programs that allow him or her not to find himself or herself with a skill set that has become worthless.

All this is necessary because while it is clear that robots are and will increasingly replace the manual work done by humans, it is equally clear that there are and will be new and increasingly important jobs within the company. Therefore, as mentioned earlier, the worker in this era must be proactive; that is, he or she must study, train, and keep up with the times more than ever before; in this way he or she will not only work less from a physical standpoint but will be sure to find work within a business context, who will probably also be better paid given his new knowledge.

3.3 ARTIFICIAL INTELLIGENCE (A.I.)

The term Artificial Intelligence (AI-Artificial Intelligence) was introduced in 1956 by computer scientist John McCarthy to describe the discipline that attempts to make machines (hardware systems or software systems) capable of reproducing human behavior and acting rationally through computer algorithms that process information from the external environment. Weak AI aims to make machines capable of performing complex operations by simulating human intelligence without, however, being able to reproduce human cognitive processes.

Strong AI, on the other hand, aims to realize a machine capable of performing complex operations by reproducing a cognitive process equal to or greater than that

of the human mind, consequently making the machine an autonomous intelligent entity independent of humans, operating on the basis of self-learning processes.

Artificial intelligence (AI) denotes those systems, which can also be adopted in the manufacturing context, that are capable of producing results, which could unquestionably be considered the fruit of human intelligence.

However, the perspective in which AI will be used turns out to be entirely new. If up to now robots and advanced automation technologies have been used to speed up operations, relative to fixed and established routines and scenarios, in the years to come artificial intelligence will allow processes and machinery to be automated to respond to unfamiliar or unexpected situations, making it possible to make decisions intelligently.

In this way, robots, devices, and machines will no longer represent the spasmodic quest to achieve human skill, but will be repositories of higher-level skills and capabilities[25].

Artificial intelligence will also enable machines to become self-optimized systems that adjust their parameters in real time, continuously analyzing and learning from current and historical data.

Finally, investing in artificial intelligence allows for a thorough assessment of what the limitations and weaknesses of human resources are, in order to use the

[25] *Guszcza, J., 2017. "Cognitive collaboration: Why humans and computers think better together"*

technology for compensatory and non-destructive purposes. Robots equipped with ultra-sensitive sensors, capable of sensing light, sound, smell and temperature, which humans, by their nature, are unable to pick up, allow the realization of an even deeper concept of the Internet of Things, the Internet of Abilities (IoA)[26].

3.3.1 The machine learning

Machine learning (ML) is a subset of artificial intelligence (AI) that deals with creating systems that learn or improve performance based on the data they use. The terms machine learning and AI are often used together and interchangeably, but they do not mean the same thing. An important distinction is that although everything related to machine learning falls under artificial intelligence, AI does not include machine learning alone. Currently, machine learning is used everywhere. When we interact with banks, shop online, or use social media, machine learning algorithms are used to make our experience efficient, easy, and safe.

Algorithms are the engines that power machine learning. The two main types of machine learning algorithms currently used are: *supervised machine learning and unsupervised learning*. The difference between these two types is defined by how each algorithm learns data to make predictions.

[26] *Kazutoshi M., Hiroshi O., 2017. "Interatomic potential construction with self-learning and adaptive database"*

The enormous potential of machine learning can help companies turn the amount of data currently available into business value. However, inefficient workflows can prevent companies from fully exploiting this potential.

To be successful at the enterprise level, it must be included in a comprehensive platform that helps organizations streamline operations and implement models at scale. The right solution will enable companies to centralize all data science activities in a collaborative platform and accelerate the use and management of open source tools, frameworks and infrastructure.

3.3.1.1 Customer segmentation & customer churn rate

The most effective marketing strategy has always been to offer the right product to the right person at the right time.

Not so long ago, marketers relied on intuition to perform customer segmentation, dividing customers into groups for targeted campaigns.

Today, machine learning enables data scientists to use clustering and classification algorithms to divide customers into groups based on specific characteristics. These groups consider customer differences along with multiple dimensions, such as demographics, browsing behavior, and affinity. Linking these characteristics to buying behavior patterns allows data-savvy companies to launch customized marketing campaigns that are more effective than generic sales incentive campaigns.

As the data available to companies increases and algorithms become more sophisticated, personalization capabilities will increase and allow companies to get closer and closer to their ideal customer segment.

Acquiring new customers takes more time and money than keeping existing customers satisfied and loyal. Creating a model for calculating customer churn rates helps companies identify customers who are likely to stop interacting with them and the reasons for abandonment. In fact, the churn rate is the percentage of customers or subscribers who stop using the services offered by a company over a period of time.

An effective model uses machine learning algorithms to provide comprehensive insights: from the churn risk scores of individual customers, the main factors of churn, ranked in order of importance. These results are critical to the development of an algorithm-based retention strategy.

This knowledge, helps companies optimize discount offers, email campaigns and other targeted marketing initiatives that keep high-value customers buying and returning to make additional purchases.

Consumers have more choices than ever before and can instantly compare prices across a wide range of channels. Dynamic pricing, also known as demand-driven pricing, allows companies to stay current with rapidly changing market dynamics. It allows organizations to price items flexibly based on factors such as the target

customer's level of interest, demand at the time of purchase, and whether the customer was interested in a marketing campaign.

This level of business agility requires a reliable machine learning strategy and a large amount of data to understand how customers' willingness to pay for a good or service changes in different situations

3.3.2 The predictive maintenance

Artificial intelligence is also being adopted in predictive maintenance, a type of preventive maintenance that is performed on machinery or tools following the identification of one or more parameters that are measured and controlled using appropriate mathematical models. The purpose is to prevent possible failures before they happen by estimating the likelihood that any component will fail based on its use and distributed experience.

Artificial intelligence has proven to be key to implementing these kinds of services. A concrete example of predictive maintenance comes from Greenbyte, a renewable energy company that has combined statistical models, artificial neural networks, and machine learning to identify component failures in wind turbines before they occur.

3.3.3 The potential of artificial intelligence to increase productivity & profit

The life cycle of a product is characterized by four stages, namely introduction, development, maturity and decline. The peak of productivity and profit is reached in the maturity stage. Each organization is characterized by a core business that contributes most to profit generation. Before it reaches the maximum point on the maturity curve and stops providing the company with its competitive advantage, the business model must be renewed. The introduction of a new technology is what allows a new business to enter the value chain[27]. The greatest benefit, in terms of added value, comes from being able to delegate those low-value activities to intelligent systems, allowing humans to concentrate and be more productive in the highest value activity, the so-called *core activities*. In doing so, companies will need to define a plan for transforming their business model to seize these opportunities and, at the same time, invest in some strategic areas.

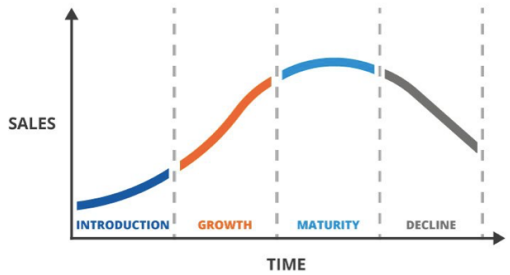

Figure 3.1," Product Life Cycle", Source: www.twi-global.com

[27] *Mckinsey Global Institute, 2017. "Artificial Intelligence the next Digital Frontier"*

Despite the challenges posed by the implementation of artificial intelligence, companies should adopt models based on AI technologies to greatly improve their position in their respective markets. Leveraging these tools can also give a company a competitive advantage by using it to enhance core business functions. To successfully maximize the benefits of artificial intelligence, the best stands to follow are:

Rely on new talent: To successfully use artificial intelligence, it is necessary to hire new talent, both technical and managerial. This is because new technologies require new people with vertical skills and expertise to help integrate the technology into the existing business mix.

Establish a strong digital base: artificial intelligence works best when you have access to high-level information. A company's digital base, however, is not just limited to data but includes all digital tools and resources, along with their respective uses.

Focus on growth, not cost reduction: some companies see AI as a means to reduce costs, but it can do much more. Many retailers use AI to expand their markets, which translates into growth. When used throughout a company's technology stack, artificial intelligence can really make a difference when it comes to sales. This new use of technology could only result in an expansion of AI's market share.

Be willing to change business goals: the moment you think you want to implement artificial intelligence systems in your enterprise you must be aware of and ready to make changes to your long-term goals. Migrating to an alternative business model may result in new sources of revenue, which is always a good thing.

3.3.4 The impact of artificial intelligence on economy

For business competitiveness, the use of Artificial Intelligence has become a key element. the McKinsey Global Institute (MGI) predicts that these technologies will drive an increase in global economic activity of about $13 trillion, with growth of about 1.2 percent of GDP per year. Europe, and Italy, appear to be lagging behind in the adoption of these technologies, widening the gap that already exists in the digital sphere with the American and Chinese giants.

Estimates made for the European continent state that thanks to Artificial Intelligence, the continent could see its GDP grow by about 2.7 trillion (+19%) by 2030, with positive effects on employment as well.

MGI has identified seven strands to study in order to analyze the impact of AI: of which 3 concern the direct impact on production and 4 analyze cross-cutting dimensions.

Regarding the impact on production, we have:

1) *Augmentation:* It concerns the two classical parameters for analyzing an economy, capital and labor augmentation. Surveys conducted by MGI in 2016 and 2017 found that investments in artificial intelligence tools occupied 10 to 20 percent of budgets dedicated to digital investments, assuming a gradual increase in this type of investment. If the predictions come true, MGI expects that many jobs will open up both to build the infrastructure needed to implement AI solutions and to monitor their operations to ensure full utilization. According to MGI, AI will lead to an increase in both capital and labor, but in both cases, investment must be made: regarding the former by acquiring the technologies, regarding the latter by training personnel for the new jobs.

2) *Substitution:* Based on studies done in past years, MGI, simulating a scenario of medium automation, believed that about 15 percent of the current time worked by humans could be replaced by automated systems by 2030; with this new study, assuming scenarios of massive automation through the pervasive introduction of AI technologies, it believes that this 15 percent could increase by 2 or 3 percentage points.

The technological challenge of AI could create new business models that could take market share away from companies based on more traditional models; here, for example, the concept of "substitution" is not of humans for systems, but of humans for more humans.

3) *Product and service innovation and extension:* This third effect is brought about by investments in AI that are not exclusively aimed at replacing manual labor to increase the effectiveness of capital investment, but by investments that enable the extension of companies' portfolios by creating new and innovative products and services through these technologies. The development of innovative products creates demand for these products with an increase in the available market. But again, as in the previous case, it must be remembered that not all of the new value created by firms is "new" to the economy as a whole: in fact, a considerable part of the gains from innovation comes from competition that shifts market share from one entity to another.

Instead, with regard to cross-cutting dimensions:

4) *Global data flows and connectedness:* Economies are not isolated; they interact in a global marketplace and generate flows of goods and assets that cross borders. Today MGI estimates that digital flows, by 2030, will contribute 7 percent to global GDP growth; considering that 20 percent of these flows can be traced to AI technologies, MGI infers that these will contribute 1.5 percent to GDP.

5) *Wealth creation & reinvestment:* As AI contributes to the increased productivity of economies, the increased output from efficiency gains and innovations can be passed on to workers in the form of wages and to entrepreneurs and businesses in

the form of profits. The result is a virtuous circle that, by increasing consumption, contributes to the growth of the economy. While this has been true for the previous two revolutions, it is now strongly challenged by a level of consumption that is straining our planet's resources. Not to mention the fact that over the past 30 years the gap between rich and poor has been widening dangerously, bringing many members of the middle class into the second category.

6) *Transition & implementation costs:* During the transition to artificial intelligence, companies will have to bear the costs associated with restructuring their organizations and, of course, all those associated with the acquisition and implementation of new technologies.

7) *Negative externalities:* As we have seen, the impact on employment is important and especially unlikely to be simultaneous negative and positive effects. The impacts on employment will involve costs to society as a whole because of the need for social safety nets to support workers ousted from the labor force as well as retraining courses will be needed for these workers.

In conclusion, we should make sure that this change in the way of working happens in all areas of business by investing in advanced digital skills and fostering innovation and the emergence of dedicated start-ups. All companies must

understand the exceptional opportunity that digital change is capable of generating, and they will need to plan for a transformation of business processes, keeping in mind investments and fundamental technological, organizational and management changes.

3.3.5 The future of artificial intelligence

Artificial intelligence has already changed the world. It has changed the way we interact with our devices, people and organizations.

It is still early days, but already a large segment of society, expects AI-driven interactions.

Within narrower domains and more controlled environments, artificial intelligence has already had a huge impact, and that impact will continue to expand as limitations are overcome.

Consider, for example, the deployment of robots in Amazon's warehouses.

These warehouses are organized around productivity that includes a tightly controlled warehouse environment. Despite the limitations, it is clear that robots on the factory floor are changing the economics of manufacturing and that impact will continue to grow as AI advances.

4 THE IMPACT OF COVID 19 & THE RUSSIA-UKRAINE WAR

4.1 COVID 19 PANDEMIC

Around the fall of 2019, health authorities in the city of Wuhan in China found the first cases of patients showing symptoms of a "pneumonia of unknown cause." The spread of the disease was first reported by Chinese authorities to the World Health Organization on December 31, 2019.

To this day, the origin is still uncertain. The strain responsible for the pandemic was identified in early January 2020 and officially named Severe Acute Respiratory Syndrome Coronavirus 2, abbreviated SARS-CoV-2. On February 11, 2020, WHO announced that the respiratory disease caused by the new coronavirus was named COVID-19.

On March 11, 2020, WHO, after assessing the severity levels and global spread of SARS-CoV-2 infection, declared that the outbreak of COVID-19 can be considered a pandemic. On January 30, 2020, after the second meeting of the Safety Committee, the WHO Director-General had already declared a Public Health Emergency of International Concern (PHEIC), as enshrined in the International Health Regulations (IHR, 2005). Public Health Emergency of International Concern is defined as: "an extraordinary event that may pose a health threat to other member states through the spread of a disease and potentially require an

internationally coordinated response."[28] This implies a severe, sudden, unusual or unexpected event; involves public health fallout beyond the national border of the affected state; and may require immediate international action.

From this "world crisis" situation, the response was a comprehensive and timely vaccine campaign. In fact, virologists around the world first tried and then succeeded in sequencing the virus and finding vaccines that could protect the world's population. We can say that vaccines are practically mandatory and have proved indispensable in curbing the virus attack.

There have been many variants of Covid, in fact to this day we are living with a variant named Omicron. The latter, compared to the previous circulating variants, seems to be less likely to lead to a serious clinical outcome requiring hospitalization or hospitalization in intensive care, however, it is able to evade the protective effects of antibodies elicited by vaccination or natural infection; in other words, it is less severe from the point of view of virulence of the virus but at the same time it is much more contagious. As a result, there has been an increase in the number of people who are positive for the virus.

In these pandemic years there have been times of complete crisis politically, socially, health-wise, and economically that have caused unimaginable damage, not only of lives, in virtually every part of the world. Nowadays, the situation, although

[28] *https://www.who.int/news-room/emergencies-international-health-regulations-and-emergency-committees*

it seems to be recovering, is not the best, plus what the future holds for us is increasingly uncertain. Therefore, the world, first of all China and America, followed later by Europe and then also of Italy has had to and is still finding a way to live with the virus that concerns all issues: the health, political, social and economic.

4.1.1 Economic crises brought up by Covid 19

The year 2020 was unprecedented. The Covid-19 Pandemic had devastating effects, not only from a social and health perspective but also from an economic perspective. The health crisis has put a strain on businesses around the world, compromising their business continuity and disrupting both short- and medium-term strategic plans. This health crisis, in addition to all the issues directly related to the virus itself, has generated a cascade effect that has triggered the collapse of demand, unavailability of raw materials, inability to have personnel in attendance, change in consumer purchasing habits, and so many other drastic effects on the world economy.

As a result, most enterprises have suffered a slowdown in business operations and a significant drop in turnover.

Among the economies of European countries, Italy's has been the most affected by the Pandemic. In 2020, in fact, Italian GDP contracted by 8.9 percent, compared with a European average contraction of 6.2%. The uncertainty related to the virus

trend, has led to a not insignificant setback for the competitiveness of European and Italian companies, affecting their business models, organizational models and investment priorities.

During the Pandemic, Industry 4.0 projects, did not slow down, but even accelerated, devoting on average more than one-third of their budgets to such projects. Companies, that had invested in digital technologies earlier, successfully making the transition to the Industry 4.0 paradigm, benefited greatly, while those that were lagging behind the digital transformation encountered great difficulties in ensuring business continuity for their business. However, the emergent context has made these companies more aware of the importance of digital as an indispensable condition for them to survive and compete once they return to normality.

4.1.2 Impact of Covid 19 on industry 4.0

The Covid-19 pandemic has had devastating effects in every sector, and it is in this context of uncertainty that digital technologies have been a lifeline for businesses, proving essential to their survival and ensuring business continuity of production facilities and logistics chains. Never more than at this time of health crisis have 4.0 technologies played a key role in ensuring an effective response to the challenges posed by the pandemic and in addressing the need for greater flexibility in business processes. Covid-19 has been an accelerator of digital transformation.

There are several areas where 4.0 technologies have enabled companies to address the new normal. A prime example is the application of IoT technologies to ensure that minimum safety distances are maintained between operators within factories and to track and monitor movements in case some employees are positive for the virus. One solution has been the combined use of IoT and wearable technologies to provide operators with devices equipped with trackers and sensors that can measure distance to other devices and send alerts if the imposed limits are exceeded.

Many companies, in order to meet the financial difficulties of customers, have begun to charge their machinery on the basis of actual use and no longer on the basis of a predefined fee, thanks precisely to the use of IoT sensors capable of monitoring the actual use of the machinery on the basis of which the fee is updated. Moreover, again thanks to this technology, it has been possible to monitor consumer behavior and offer personalized services, enabling so-called "Smart Products," which can store data, communicate and interact in real time within the ecosystem in which they are deployed and provide important information about consumer habits that can then be used in the design phase.

Another example of the application of 4.0 technologies to address the healthcare crisis concerns simulation tools, particularly the Digital Twin, which is the virtual representation of a production system that can simulate a wide variety of scenarios in real time thanks to data acquired from connected IoT devices, without the need to intervene on the actual physical system.

Another case is given by the increasing use of smart-working in companies, which has ensured continuity in all business activities, thanks to the 'use of tools such as Teams, Zoom, Cisco, i.e., platforms with which you can have real meetings in real time and at the same time carry out your task inside your homes.

Augmented Reality has made it possible to overcome the physical limitations that have emerged with the health care crisis; operators wearing smart glasses are able to initiate a video call with a remotely connected technician who can support them in solving a given operational problem. Another area where these technologies have proven useful is in the area of body temperature sensing, which is achieved through scanners that, through visors with integrated sensors, are able to detect in real time and at a safe distance the body temperature of moving subjects within a given environment. Big Data analytics have made it possible to estimate the impact of a disaster in a preemptive manner, thus enabling companies to be prepared and minimize the risks of business continuity disruption.

Finally, as previously mentioned, probably the most crucial aspect on which companies have focused most attention has been business continuity. On this front, the Cloud has been an excellent ally in responding, quickly and effectively, to the uncertain environment that companies have been facing. Its most important features are flexibility, scalability and oblique access. The latter feature at this point in history is extremely important as it ensures the ability to connect to enterprise platforms from anywhere.

Another important feature of the Cloud is that of time-to-market: the big difference from custom services is precisely that of having services available that are ready-made, thus all those services that fall into the SaaS category, which can be easily accessed because they are well-established services. In fact, from a technological point of view, the Cloud market is quite mature and manages to provide a variety of standard services, but also to meet the customized needs of companies with a short time to market. The Cloud makes it possible to reduce the
costs related to IT infrastructure and its obsolescence, but also those of a strategic nature for the creation of new services. Many companies have been able to implement services for digital payments thanks to the Cloud infrastructure, which has enabled them to respond to this new market need by providing a new service[29].

4.1.3 Digital in the days of Covid 19

Digital solutions have been the most important tool for overcoming the crisis triggered by Covid-19 and boosting enterprise competitiveness. Many companies have appreciated the benefits brought by digital and want to translate the procedures developed during the Pandemic into established practices once they return to normal. In addition to reinforcing the value of Industry 4.0, the pandemic has highlighted the limitations of current implementations made by organizations,

[29] *Cloud Transformation Observatory, 2020. "Cloud to ensure business continuity in an emergency context: how the sensitivity of companies to the Cloud is changing."*

making gaps and opportunities related to digital that were already present before the emergency erupted even more apparent. Therefore, a significant acceleration of the digitization process of European and particularly Italian companies is desirable in order not to succumb and to be able to relaunch their competitiveness in the markets once they return to normal. The pandemic has radically changed the way of approaching Industry 4.0: before, it was sought only for competitive advantage; today, it is purely and simply for dependence on it.

4.1.4 Next generation EU

In order to recover from the Covid-19 pandemic and try to overcome the difficulties that this brought both in economic and social terms, an unprecedented response was given by the EU by means of the 2021-2027 long-term budget together with a temporary recovery instrument called Next Generation EU. It consists of €1.211 trillion in current prices (€1.074 trillion in 2018 prices), combined with €806.9 billion (€750 billion in 2018 prices) of Next Generation EU.

The Multiannual Financial Framework has undergone significant changes also in terms of the shares dedicated to the main policy areas, adjusting to the changing situations and needs of the European Union over the years. What is evident from the Figure 4.1 here below is that the more we move towards recent times the greater the convergence of the shares addressed to the different policy areas covered by the MFF, in particular common agricultural policy, economic social and territorial

cohesion and new and reinforced priorities, which for the first time in the long-term budget have the largest share (31.9%).

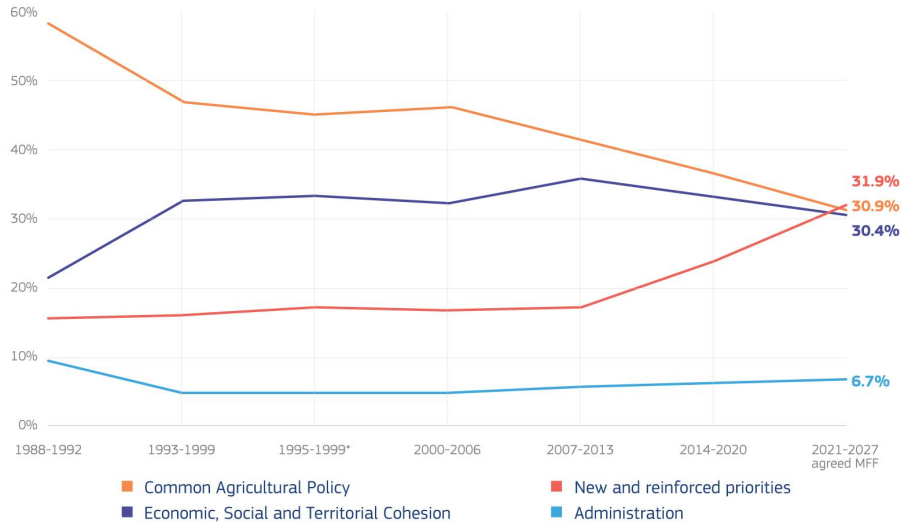

Figure 4.1" Shares of main policy areas of the multiannual financial frameworks over the years"; Source: European Commission.

In addition to address the crisis brought by the pandemic, the 2021-2027 MFF aims to support a transition towards a more sustainable Europe by supporting its economic recovery and building a greener, more digital and more resilient EUROPE, with the auxiliary support provided by the Next Generation EU. For example, among the most outstanding objectives it is worth mentioning that more 50% of the total amount will support the modernization of the EU and it will be addressed to research and innovation, fair climate, digital transitions and recovery and resilience. Besides, 30% of the EU budget will be spent to fight climate change,

biodiversity protection and gender-related issues and 20% of Next Generation EU will be invested in the digital transformation.

The funds needed for the Next Generation EU will be raised between mid-2021 and 2026 by borrowing on the capital markets (issuing of bonds) and are expected to be repaid through future EU budgets or by the member states concerned, by 2058. The EU will be able to borrow on advantageous conditions given its high credit rating. These advantages will be transmitted directly to the Member States when providing them loans or to the Union budget as low interest rate payments on amounts they borrow to finance their recovery spending. Moreover, in order to help repay the borrowing for the funding of Next Generation EU, new own resources are introduced so as to complement Member States' contributions to the EU budget. The first new own resource is a new contribution based on non- recycled plastic packaging waste. Further new sources of revenue could include one based on a carbon border adjustment mechanism and a digital levy and another based on a financial contribution linked to the corporate sector (or a new common corporate tax base).

4.1.4.1 The centerpiece of Next Generation EU: The recovery & resilience facility

The centerpiece of Next Generation EU is the Recovery and Resilience Facility (RRF) to which the majority of the funds are addressed. Its goal is to support

reforms and investments in the EU Member States with a total value of €723.8 billion in current prices. This instrument is composed of grants (up to €338 billion) and loans (up to €385.8 billion) to be given to member states. Grants will be repaid by the EU budget and they are divided among EU countries according to several allocation criteria, including GDP per capita, population, unemployment levels and the impact of the Covid crisis. Moreover, later on, after assessing the loss in real GDP over 2020 and cumulatively over 2020-2021, another part of the allocation will be determined. On the other hand, loans will be repaid by the borrowing member states. Figure 6.2 shows the several programs in which the Next Generation EU money will be invested through the abovementioned grants and loans. In order to receive the aid and benefit from the RRF, EU countries must submit "Recovery and Resilience Plans" in which they must explain how the money will be spent. These plans will then be assessed by the Commission and finally approved by the EU Council. Money will be disbursed upon the achievement of targets; however, the EU pays up to 13% in advance to make the recovery start. The RRF is a temporary recovery instrument consisting of large-scale financial support through which Next Generation EU will reinforce the following six pillars: green transition, digital transformation, economic cohesion, productivity and competitiveness, social and territorial cohesion, health, economic, social and institutional resilience, as well as policies for the next generation. As stated by the President of the EU Commission, Ursula von der Leyen, at the State of the Union in 2020 "... we choose

to not only repair and recover for the here and now, but to shape a better way of living for the world of tomorrow. This is Next Generation EU."

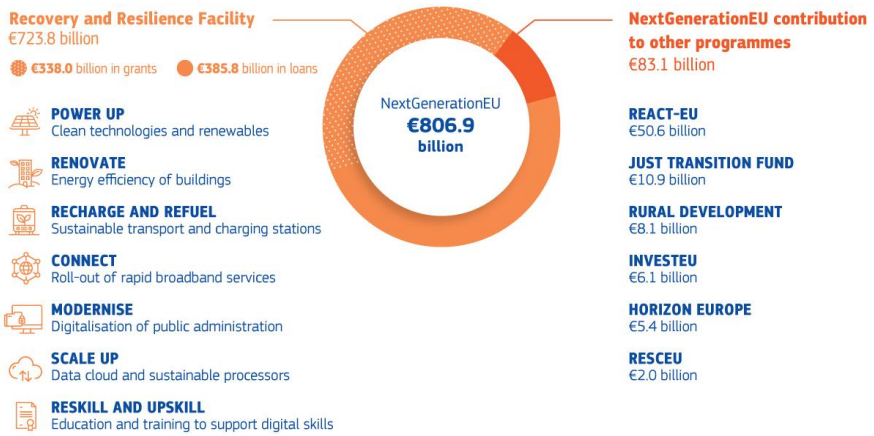

Figure: 4.2, "NextGenerationEU and Recovery and Resilience Facility"; Source: European Commission.

By recalling these words, it seems clear that the pandemic crisis that Europe, as well as the rest of the world, had to face has put the basis for a different and quite innovative fiscal policy adopted by the European Union aimed at not only mitigating the economic and social effects of the pandemic, but also at making European economies resilient, more sustainable and better prepared for both challenges and opportunities of the green and digital transitions. A policy also addressed towards a stronger cooperation to reach the target of climate neutrality by 2050 and a digital transition, both creating jobs and fostering growth.

The NGEU is an innovation. It does not impose austerity measures, which would be counterproductive, however the Stability and Growth Pact discipline will have to be reinstated at a later date. Instead, it includes policy reform conditionality as a core feature that each nation must decide on, albeit in accordance with the EU's country-specific recommendations and subject to Commission and Council rubberstamping. It also involves some debt mutualisation, as it will be financed by debt issued by the Commission in the name of the EU, which will be serviced by additional EU budget resources until 2058.

It should be emphasized, however, that the political decision to establish the NGEU stated upfront that it was "an unusual response to transitory but extreme circumstances" and that "the powers provided to the Commission to borrow are explicitly limited in size, duration, and scope"[30].

The formation of NGEU could be a significant step forward in the building of a European macroeconomic policy. On the one hand, funding will be provided based on need and the economic damage that each country has suffered as a result of the crisis by distributing resources to individuals. The recovery fund represents a substantial and unexpected acceleration in the European Union's fiscal unification process. The EU will generate a considerable stock of common debt for the first

[30] *LIoveras Soler, Josep, M., 2021." The Next Generation EU: Opportunity and risk"*

time in its history, which will be repaid by the collection of new common resources. Furthermore, mobilizing these funds will enable EU institutions to adopt a common macroeconomic strategy by subsidizing economic recovery in Member States in accordance with the political objectives that they will determine. Clearly, the EU is doing something unprecedented, whose legality has been questioned under the existing EU Treaties: exercising some form of budgetary power.

The NGEU is both a high-risk and high-opportunity operation. The euro is still a work in progress, as it has yet to bring about convergence or complete its institutional and political structures. The current crises have exposed both of these flaws, but the NGEU may be able to help with their resolution. Furthermore, if the NGEU fails, the EU may be unprepared or unwilling to respond adequately in the future.

Transformation, or change, is required for a long-term, inclusive, and resilient recovery, particularly in the weakest economies. Transformation is required everywhere in terms of ecological and digital concerns. The Commission and Council, which must approve and monitor progress, will make the final decision on the adequacy of the reform substance in each national plan. This crucial aspect of the NGEU, however, may remain elusive and difficult to assess and track. Political willpower and thorough monitoring will be required, and peer pressure, including from the "frugals," may help.

4.1.5 The transition plan 4.0

Italy is a beneficiary of most of the resources provided by the NGEU, and in order to benefit from them, the Italian government developed and submitted to the European Commission the National Recovery and Resilience Plan, which is a detailed account of the reforms and investments that are intended to be undertaken to revive the Italian economy after the economic crisis caused by the Covid 19 pandemic. The resources provided to support the Plan amount to 248 billion euros, of which 191.5 come from NGEU funds. The plan is divided into six missions, which are:

1) *Digitalization, Innovation, Competitiveness and Culture:* It aims at the digital transition of the public administration and the production system, especially Small and Medium Enterprises. It supports the development of ultra-wideband networks nationwide in order to facilitate digital transformation. It also aims to digitally boost tourism and culture, two extremely important sectors for the Italian economy. The resources earmarked for this mission are about 50 billion euros, 41 of which are financed by European funds;

2) *Green Revolution and Ecological Transition:* It provides for investment in R&D in renewable energy, interventions to develop sustainable agriculture and better waste management. It also aims to prevent hydrogeological disruption, to safeguard

and promote land biodiversity, and to ensure the sustainable and efficient management of water resources. The resources allocated to this mission are about 68.96 billion euros, 59.3 of which are financed by European funds;

3) *Infrastructure for sustainable mobility:* It provides for investments aimed at optimizing high-speed rail throughout the country and also air traffic having sustainability as one of the main objectives. The resources allocated to this mission are about 31.4 billion euros, 25.1 of which are financed with European funds;

4) *Education and Research:* To fill the gaps in the supply of education services in Italy, increasing the number of teachers in schools and promoting access to university for more students. The resources allocated to this mission are about 31.9 billion euros, 30.9 of which are financed with European funds;

5) *Inclusion and Cohesion:* It aims to strengthen labor policies, focusing on the dual system and female entrepreneurship. The resources allocated to this mission are about 22.4 billion euros, of which 19.8 are financed with European funds;

6) *Health:* strengthening prevention and care on the ground and modernizing the technological equipment of the National Health Service (NHS). The resources allocated to this mission are about 18.5 billion euros, of which 15.6 are financed with European funds.

Going to look at these 6 missions in detail, it is easy to see that they are almost entirely made up of money from the NGEU; therefore, it is essential that Italy comply with the requirements put in place so as to have access to these funds for the implementation of this recovery plan. All of the Plan's initiatives act within a time horizon ending in 2026. The government estimates that the planned investments will have a significant impact on national GDP, which experts say will grow by about 16%[31].

4.2 RUSSIA-UKRAINE WAR

On February 24, 2022, the military offensive by the Armed Forces of the Russian Federation began, having as its main objective the invasion of Ukrainian territory and thus marking an abrupt escalation of the Russian-Ukrainian crisis that has been ongoing since 2014[32]. The armed intervention was preceded by a prolonged border massing of Russian forces that began in the spring of 2021, motivated by Russian President Vladimir Putin based on fears of Ukrainian membership in NATO and followed by military exercises. A few days before the invasion, Russia recognized the independence of two self-proclaimed states in the Donbass region within Ukraine's borders, the Doneck People's Republic and the Lugansk People's Republic, and on February 20 sent its armed forces to garrison their territory. The

[31] *National Recovery and Resilience Plan, 2021*

[32] *The war in Ukraine as of March 25: Kyiv's defenders launch counterattacks, in El País, Gruppo PRISA, 25 marzo 2022*

next day, the Federation Council unanimously authorized President Vladimir Putin to use military force outside the border.

The war that broke out between Russia and Ukraine has its roots in a long diplomatic and military crisis between the two countries. Russia's geographical situation, with no natural borders except for the Arctic and the Pacific Ocean, has allowed it to develop a foreign policy based on state expansion in every direction for many centuries, which has fueled a desire over the years to regain the sphere of influence lost with the dissolution of the Soviet Union and to secure strategic positions such as Crimea, which overlooks the Black Sea.

The Ukrainian revolution of 2014, which ended on February 23 with the transition from a pro-Russian to a pro-Western executive, had led to two key facts: Ukraine's rapprochement with Western countries (EU, NATO) through increasingly close military cooperation and, beginning on February 28, 2014, the military occupation of Crimea initially by unidentified forces and the rapid annexation of the peninsula to Russia that was followed by the armed secession of the Donbass region and numerous clashes in eastern Ukraine between Russian-speaking and Ukrainian communities.

As of today, June 2022, we have reached more than 3 months of war (more than 180 days) and in addition to counting an indecent number of casualties, the war has only continued to worsen both socio-politically and economically. The situation between the two presidents of the respective nations is at an all-time low, with

Moscow opening up to negotiations, being aware of its advantageous position, and at the same time President Zelensky opposing these and interacting with the Russian president.

4.2.1 The NATO's choice

Following the Russian invasion of Ukraine, NATO held three extraordinary meetings within a few weeks. Alliance leaders called Russia's war against Ukraine the "most serious threat to Euro-Atlantic security in decades" and condemned the invasion in the strongest terms. They stressed that Russia must immediately stop the invasion and withdraw its forces from Ukraine. The allies reiterated their determination to counter Russia's attempts to destroy the foundations of international security and stability and to defend the 30 allies and "every inch of allied territory." It also reiterated that it was united and resolute in opposing Russian aggression and stressed its firm commitment to Article 5, the Alliance's collective defense clause. The Alliance also condemned Russia's decision to recognize the separatist regions of eastern Ukraine and stressed that it stands by the Ukrainian people and their legitimate and democratically elected president, parliament and government. The allies called on Russia to engage constructively in credible negotiations. NATO also reaffirmed its commitment to the open-door policy, which is precisely why in December 2021, Moscow had submitted demands to the United States and NATO itself in the form of draft security pacts, asking to withdraw troops

from Eastern Europe and to cease the open-door policy for future members, including Ukraine, but without any results. NATO has repeatedly stressed its role as a defensive alliance and that it is not seeking war with Russia. It has ruled out imposing a no-fly zone over Ukraine, which would risk escalating the crisis into a broader European conflict involving allies, or even escalating into a third world war, although experts believe the latter is unlikely, and has also reiterated that it will not deploy forces to Ukraine. At the same time, he warned Russia that it must stop with the nuclear threat and that any use of chemical weapons will have far-reaching consequences. Thus, the strategy has been "a careful balance between its defensive mission, its credibility and the need to avoid escalation." The alliance has repeatedly expressed support for the delivery of weapons and military equipment to Ukraine by individual allies; in fact, allies such as the United Kingdom, the United States, Canada and other EU member states have provided Ukraine with weapons and equipment. It also pledged to strengthen practical support to regional partners, including Georgia and Bosnia and Herzegovina but, also to increase practical and political cooperation with Asia-Pacific partners (Australia, Japan, South Korea, New Zealand) on issues such as countering disinformation and cyber threats. The ministers agreed that NATO's next Strategic Concept (scheduled for adoption at the Madrid Summit in June 2022) should define the guidelines for the alliance's future relationship with Russia. Ukraine's ability to contain Russian aggression will determine the security environment for years to come. At the

Madrid summit in June 2022, NATO recognized and offered an updated support package. The volume and speed with which more sophisticated weapons systems are provided to Ukraine in the coming weeks will be decisive in preventing Russia from overcoming the country's defenses. It is up to individual allies to ensure this help as of now. Special financial assistance will be needed for long-term training and modernization of Ukrainian forces, effectively bringing them up to NATO standards. This is necessary because Ukrainian weapons stocks composed of Soviet-standard equipment are depleted and the availability of such weapons outside Ukraine is limited. Concrete decisions will be more important than any new organizational chart. Russia is using brutal force to achieve its imperialist goals. Although weakened, the remains capable of inflicting heavy damage on others. Only strong deterrence and credible force can stop it. Counterintuitively, preparing for a possible war with Russia is the best approach to preventing it, this at least according to experts.

The collective West (and particularly NATO) can count on its likely ability to contain an aggressive Russia, at least in the long run. But defeating the Ukrainian aggressor is the indispensable goal in this context, because it would severely limit Russia's ability to attack other countries, give time to increase collective defense, and consolidate international unity against aggression. These, at least, are the key decisions that the Madrid Summit provided as a necessary strategy in the short to medium term.

4.2.2 The social-political impact of the war

The course of the war indicates that Russia is unable to achieve anything substantial from military action against Ukraine. What Russia expects to achieve with the current attack was regime change. Putin aimed to expel President Vladimir Zelensky from power and install a pro-Russian government. But Ukraine's unexpected military resistance ruined Putin's plans. Against Russia's expectations, the Ukrainians managed to hold on to the capital, Kiev. The Russian strategy was to capture Kiev and pressure Zelensky to step down from power or accept conditions imposed by Russia.

This war had a critical impact on world politics, for in addition to the energy crisis, negative impacts on the global economy and food security, it created major challenges to the current world order based on American hegemony and also to the security and stability of Europe. The security of the states that were part of the former USSR is at risk due to Russia's expansionist plans and aggressive military moves. Putin's plans to rebuild Russia and revive its superpower status may be perceived as existential threats to these states[33].

Russia accuses the United States and Western European countries of wanting to manipulate Ukraine and Georgia against it. With the extension of membership to the Baltic republics, NATO has already virtually caught up with Russia, and if

[33] *Kappeler, A., 2022. "Russians and Ukrainians, unequal brothers, from the Middle Ages to our days"*

Ukraine were to join NATO as well, the Western military alliance could move much closer to the Russian border, something Moscow has always feared.

Russian President Vladimir Putin has made some moves for his country's security and regional interests in view of Ukraine's new NATO membership. In fact, in December 2021, Russia had submitted to the United States and NATO some written demands that they described as essential for the future security of the country; the demands were: (a) Ukraine's perennial exclusion from joining NATO, (b) NATO's reduction of its forces in Eastern European countries, and (c) the 2015 ceasefire in Ukraine must be implemented. The demands were not accepted by NATO and the United States. Subsequently, Putin declared his current "special military operations" to "demilitarize and de-nazify" Ukraine, to stop the genocide and atrocities perpetrated for eight years by the Ukrainian military against the ethnic Russian population in the Donbas region, and to free Ukrainians from the oppressive Zelensky government.

Putin, in his 22 years in power in Russia, has always had NATO expansion as his main concern. After the serious setbacks suffered from his move to capture Kiev and expel President Zelensky, Putin now postulates that the main goal of military action is the liberation of the Donbas.

Demilitarizing Ukraine and making it a neutral state was another of Russia's goals in sending its troops to Ukraine. Russia aggressively insisted on this demand in

mediations to stop the war and withdraw. In the latest peace talks held on March 29, 2022, Ukraine proposed four points in response to Russian demands:

1) Ukraine would become a non-bloc and non-nuclear state without foreign military bases on its territory;

2) Strict and legally binding guarantees are required from the United Kingdom, the United States, France, China, Turkey, Canada, Italy, Poland and Israel that would protect Ukraine in case of external attack;

3) In the event of a threat to Ukraine's security, the guarantor states should hold consultations and intervene in Ukraine's defense within three days;

4) Ukraine would be allowed to join the EU;

Regarding the status of Crimea, Ukraine proposes a 15-year time period to discuss and resolve the dispute. But Russia is not ready for any discussion on Crimea. As for the Donbas, Ukraine demands the withdrawal of Russian troops from its territory as a precondition for any discussion with the rebels. The Russian demand for demilitarization, according to them, is an absurd demand that cannot be considered.

This war has destabilized the security structure of Europe and in addition, has caused large-scale human casualties, infrastructure damage, economic misery and human exodus. The chances for a quick resolution of the crisis are limited, given the complexity of the issues involved. Certainly, Ukraine's intention to join NATO

and the EU are Russia's immediate concerns. Russia demands assurances from NATO that Ukraine and Georgia will not be admitted to it.

In conclusion, it is clear that the demands of both sides are difficult to meet in the current situation. The status of Crimea and the Donbas would remain a major obstacle. Both of these areas are an integral part of Ukraine, as stipulated in the 1997 border agreement between Russia and Ukraine but, Russia is using its military force to force Ukraine to accept Crimea as part of Russia and Donbas as an independent territory. It is impossible for Ukraine to accept both demands. In this situation, an effective and lasting cease-fire agreement between Russia and Ukraine based on these assumptions is far-fetched: In the meantime, the war continues, casualties increase, the politics of the two states involved are increasingly in crisis, world geopolitical relations are at an all-time low, and the economy, especially the European economy, collapses. All this, of course always, in a scenario of a global pandemic.

4.2.3 The economic impact of the war

Before I go to analyze the economic impact that the war brought I wanted to explain why I felt it was appropriate in a paper on industry 4.0 to talk about this. It is undeniable how this war brought and is still bringing very high damage socially, politically, and economically, but while Covid-19 had a direct economic impact that resulted in part in increased implementation and development of industry 4.0, this

certainly did not happen with the advent of the war. So, to the unobservant eye it would appear that there is no correlation between the impact of the war and Industry 4.0. Instead, I believe it has had a fundamental impact, because it is well known that Europe, and Italy in particular, is totally dependent from the point of view of gas and electricity supply precisely on Russia, and so it is inevitable that this whole situation has only slowed down the advent of Industry 4.0 and put the whole industry even more in crisis. Having said that I will now go on to explain the economic impact that the war is taking with itself.

4.2.3.1 EU energy independence

The blockades caused by Covid (including those still ongoing in large cities in China), Putin's war, and the general increase in almost all commodities and energy costs have already driven the global economy into stagflation and will drive many economies into recession.

But the economic consequences of the war will not be the same for everyone; they will affect the U.S. and China little, while they will have a strong impact in Europe and particularly for some countries such as Italy. Estimates of global macroeconomic variables promised a rebound after the two-year pandemic, with a readjustment to late 2019 levels. But the warning coming from the Organization for Economic Cooperation and Development (OECD), is that in addition to a humanitarian crisis associated with high numbers of refugees fleeing Ukraine, the

consequences will be quite significant in economic terms, affecting world GDP and inflation. The OECD report points out that although Russia and Ukraine are relatively small in terms of economic output, they are still large producer and exporter countries of food, mineral and especially energy commodities. The shock in particular is occurring in the oil, gas and grain markets, with prices reaching unprecedented heights. For this reason, since the outbreak of the war, estimates of world GDP growth have been revised downward, with inflation likely to stand out by rising approximately 2.5%, and it has also been estimated that Global economic growth will be more than 1 percentage point lower than before the start of the conflict in Ukraine.

Since the beginning of the invasion, there has been a sharp worldwide increase in the prices of key commodities and especially fuels. Concerns about the security of energy and food supplies have increased both in the EU and globally. Reducing energy dependence on Russia is one of the key points emphasized by the Paris-based international organization: policymakers especially in Europe will have to substantially revise their energy-themed policies, putting in place incentives to support the long-awaited green transition.

Since the second half of 2021, there has been a sharp spike in energy prices in the EU and around the world. Fuel prices have risen further as a result of Russia's unprovoked and unjustified aggression against Ukraine, which has also raised

concerns about the security of energy supply in the EU. Russia's decision to suspend gas supplies to several member states has further affected the situation.

With the Versailles Declaration, the leaders of the 27 EU member states agreed in March 2022 to free the EU from dependence on Russian fossil fuels as quickly as possible. At the March European Council discussed measures to mitigate the impact of high energy prices and secure energy supplies.

On May 30 and 31, 2022, the European Council agreed to ban nearly 90 percent of all Russian oil imports by the end of 2022, with a temporary exception for crude oil supplied by pipeline.

Taking-into-account the different energy mixes and different conditions and circumstances of member states, EU leaders called for:

1) Further diversify energy sources and supply routes;

2) Accelerate the deployment of renewable energy;

3) Further improve energy efficiency;

4) Improve gas and electricity grid interconnections.

On June 3, 2022, the Council adopted the sixth sanctions package against Russia, which includes the oil import ban agreed by EU leaders in May 2022.

On July 26, 2022, EU energy ministers reached a political agreement on a voluntary reduction of natural gas demand by 15 percent next winter. They also discussed national contingency measures and plans, as well as further short-term actions to strengthen the EU's security of energy supply. On August 5, 2022, the Council

adopted by written procedure the regulation on reducing gas demand by 15 percent. The adoption follows the political agreement reached in July, and the regulation will be published in the Official Journal on August 8 and enter into force the following day.

The EU is a net importer of energy. In 2020, 58% of the EU's available energy was produced outside EU member states.

The graph shows the "energy dependency rate" of each EU member state and the EU average, highlighting the extent to which individual countries and the EU as a whole depend on imports to meet energy needs.

In 2020, the dependency rate for the EU as a whole was 57.5%. The dependency rate varied widely across member states: 10.5% for Estonia, 63.7% for Germany, 73.4% for Italy, 81.4% for Greece and more than 97% for Malta.

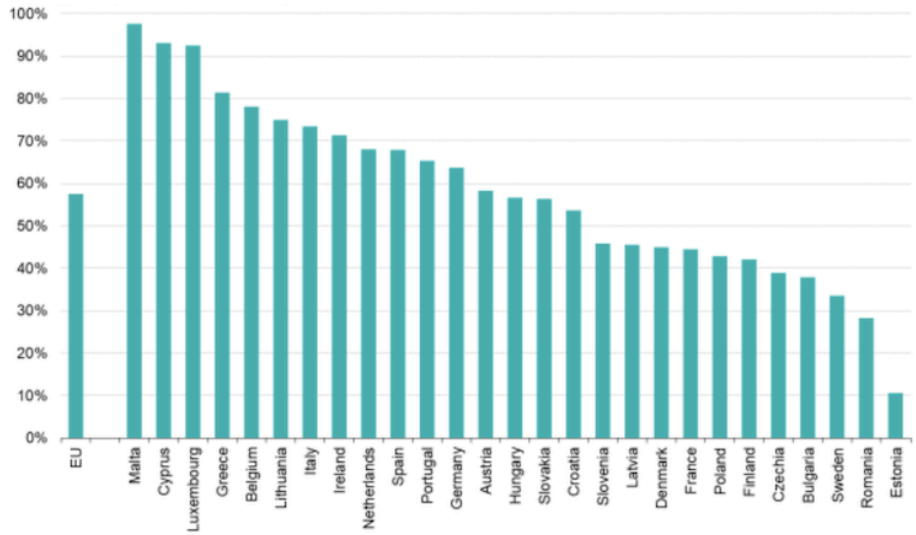

Figure 4.3, "Energy import dependency, UE 2020", Source: Eurostat

4.2.3.2 Food markets

Russian military aggression against Ukraine also has a direct impact on global food security and food affordability.

Thanks to the Common Agricultural Policy (CAP), the availability of food, feed and fertilizer is not of particular concern in the EU. The EU is largely self-sufficient and its single market is expected to live up to its role by absorbing shocks, ensuring food security for EU citizens, and providing income support for European farmers.

However, reduced imports of corn, wheat, oil, and rapeseed and sunflower meal from Ukraine are mainly affecting feed prices and the EU food industry. In light of high market prices and inflationary trends due to the war in Ukraine, the main concern in the EU continues to be affordability.

At the European Council meeting on June 23 and 24, 2022, EU leaders stressed that Russia is solely responsible for the global food crisis and urged it to immediately stop targeting agricultural facilities and allow the export of Ukrainian grains[34].

EU leaders also discussed food security and food affordability at the extraordinary meeting of the European Council held on May 30-31, 2022, at which they strongly condemned Russia's destruction and misappropriation of Ukrainian agricultural production and called on Russia to:

1) End attacks on Ukraine's transportation infrastructure;

2) lift the blockade of Ukrainian ports on the Black Sea;

3) allow food exports, particularly from Odessa.

EU agriculture and fisheries ministers recalled the importance of effective international coordination measures to ensure a comprehensive food security response. They stressed that the ability to transfer stored grain out of Ukraine before the next harvest is a necessity both for Ukrainians and for easing tensions on international markets.

4.2.3.3 Mobility of people & goods

The invasion of Ukraine has also had a significant impact on the mobility of people and goods in the EU in all modes of transport. imports of goods and the massive

[34] *https://www.consilium.europa.eu/it/infographics/how-the-eu-is-helping-address-the-global-food-crisis/*

influx of Ukrainian refugees to EU countries have led to additional operational challenges.

Regarding solidarity with Ukrainian refugees, member states have implemented a number of measures, such as establishing transportation and information hubs at major border crossings and facilitating the transportation of humanitarian aid.

At the June Council meeting, EU ministers expressed full support for the Commission's initiatives regarding:

1) The provision of "solidarity corridors" to optimize supply chains and controls between Ukraine and the EU and create new transport routes;

2) A contingency plan to strengthen transportation resilience in times of crisis;

The Council adopted a draft mandate authorizing the Commission to negotiate an agreement for the temporary liberalization of certain road freight operations between the EU and Ukraine and Moldova.

5 AN OUTSTANDING CASE: AMAZON, THE WAREHOUSE OF THE FUTURE

5.1 EVOLUTION OF AMAZON

Amazon.com, Inc. is a U.S. electronic commerce company, headquartered in Seattle in Washington state and founded in 1994 by Jeff Bezos. It is the largest Internet company in the world.

Bezos had immediately realized the immense potential represented by the Internet and 'eCommerce, so he decided to leave his employment to devote himself completely to his project: The creation of an "Everything Store," a virtual store that would act as an intermediary between customers and manufacturers and allow the exchange of all kinds of goods. Given the difficulty of setting up a real "whole store" from the start, he began by drawing up a list of products that he thought were most suitable for online sale, later narrowing it down to just five product categories, namely those he felt had the most potential: CDs, videotapes, books, software, and hardware. His final choice, as we know, fell on books, and in 1995, together with his wife and some software experts, he officially started the business, setting up the first company office in his garage. He believed that the key aspects on which to

build the business were freedom and variety of choice for customers; two extremely important aspects for the company also in the future.

The particular Business model set up included gaining a substantial market share for the first five years as the primary goal, even at the cost of profit generation. Indeed, Amazon would continue to operate at a loss until 2002, which is one of the reasons why it was so complicated in the beginning to attract investors. For this reason, in 1997, in an effort to strengthen the Amazon brand globally and improve its perception in the minds of consumers, Bezos considered it appropriate to proceed with the initial public offering (IPO) of the company, a move that proved successful, as it raised $54 million and increased annual sales by 900%[35].

During the early 2000s, the company found itself in the midst of the crisis related to the dot.com bubble, and the value of its stock fell from $107 to $7 per share. However, Amazon was able to survive thanks to its solid business model and the farsighted vision of its CEO.

In November 2000, Marketplace was launched, through which third-party retailers had the possibility of using the site as a sales platform for their products; this service, although at first very undervalued turned out to be one of the most important "weapons" from a profit perspective and is still used today by more than

[35] *Stone, B., 2013. "The Everything Store: Jeff Bezos and the Age of Amazon"*

two million sellers. In 2003 Amazon reached its operating profit for the first time and has not stopped since then.

From 2000 to the present, Amazon has done nothing but grow at an almost unimaginable rate, has conquered vast segments of the market with increasing strength, and to this day has a presence in virtually every industry, even to the point of being present, in the United States, also as a drug retailer.

Since 2002, the company has dedicated itself to cloud computing through its Amazon Web Services (AWS). These are computing services such as storage space, databases, computing and processing power, and content distribution, based on a virtual infrastructure created by Amazon. Nowadays, some of the most well-known digital platforms such as Netflix, Instagram, and Spotify make or have made use of solutions offered by AWS.

In 2005, Amazon Prime was launched in the United States, which consists of the ability to have free and fast shipping for all orders placed on the site, provided that they subscribe to a particular "Premium" subscription. Thus, users who are willing to pay a certain monthly fee get these and other benefits in return, such as exclusive promotions, special discounts, or access to flash deals.

Moving closer to the present day, 2014 saw the introduction of Amazon Echo, which is a speaker equipped with voice recognition and supported by an artificial intelligence, called Alexa, capable of answering questions and conducting internet

searches, playing music, calling and texting, with the future goal of becoming the primary conduit for online shopping experiences.

The rapid growth of Amazon was causing a major disruption from traditional retailers. By 2019, Amazon had become the digital giant with over 280$ billion in revenue and 840,000 employees worldwide.

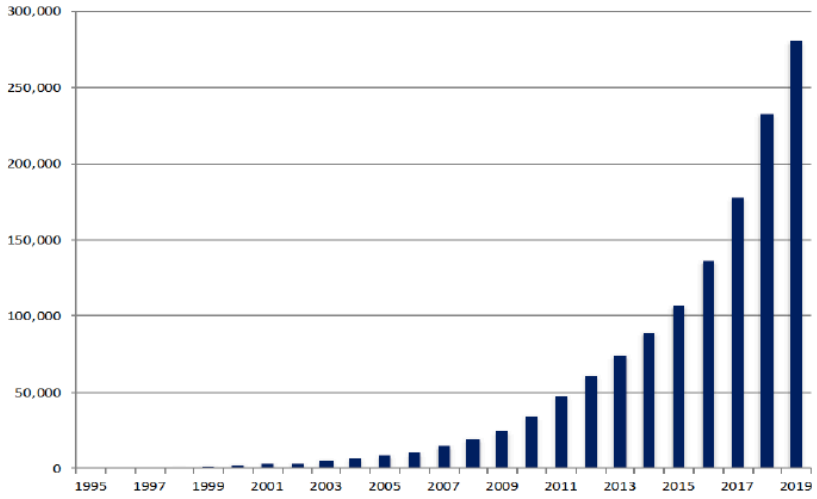

Figure 5.1, "Amazon's revenue from 1995-2018", Source: Amazon annual report, Harvard Business School (HBS)

The year 2020, if for everyone it was a year of only negative Covid-related challenges, for Amazon it was a bivalent year. On the one hand, the pandemic and the resulting look-downs caused an exponential increase in the online demand for its products, and this obviously from an economic point of view was a very positive impact; however, on the other hand, this exponential and sudden increase caused logistical problems, despite the fact that Amazon is exceptional in this aspect , and

this resulted in a greater delay in the delivery of products and in turn caused an advantage for its online competitors such as Walmart.

The products and services just mentioned are only a tiny part of the very wide range of items and possibilities that Amazon makes available to its customers, but they manage to give a good idea of how research, innovation and the ability to improve are the core values on which the entire company is based.

5.2 THE WAREHOUSE OF THE FUTURE

As mentioned above, in addition to its activities as a marketplace (intermediary for online sales), Amazon is involved in consumer technology (Amazon Basic), cloud computing (Amazon Web Services - AWS), entertainment (Prime Video), and logistics. The eCommerce sector is definitely one of the sectors that have most undergone immense growth since the revolutionary wave of 4.0 began: deliveries and the work related to them has grown significantly, and at the same time orders have shrunk in size becoming even individual. In this climate, the logistics sector has had to develop more and more modern solutions in order to adapt to market needs. Amazon's phenomenal sales growth and desire to maintain "the greatest selection on Earth" have led to an incredible increase in the diversity of product offerings. In addition to basic media products such as books and DVDs, for which Amazon's supply center network has been built and optimized, Amazon now offers product lines ranging from jewelry to large sporting goods. This diversity has

created challenges in figuring out how to efficiently store and process items through a fulfillment center. While basic media products tend to be uniform in size and received in standard quantities, the addition of product lines and new service offerings has meant that Stock Keeping Units (SKUs) arrive in a wide variety of sizes and quantities, ranging from a single unit to truckloads of a single SKU.

Autonomous robots bring significant benefits to a company such as: Reduction in costs due to labor, replacement for humans in case of staff shortages (see Covid case), increase in speed, productivity and accuracy. For a logistics robot to be useful, it must not only be capable of seeing, carrying, grasping, and locating objects, but it must also possess a mind that is capable of coordinating all of this.

Mick Mountz founded Kiva Systems in 2003 and in January 2004, in collaboration with co-founders Peter Wurman and Raffaello D'Andrea, designed a systematic e-commerce in a small distribution center in the Boston area, marking its beginning. This will involve a total change in the way goods and personnel move through the warehouse. Kiva Systems is a company that produces the best robots that automate the picking and packing process in large warehouses. The founder had advanced the idea that one of the main obstacles facing the logistics department is the low flexibility of the existing loading and unloading system and the high cost of order fulfillment. This problem prompted Mountz to create an order picking, packing, and transportation system capable of delivering any item to any operator at any time.

To realize his vision, Mountz came up with the idea that the use of automated robots capable of transporting goods from shelves to warehouse workers could improve the efficiency.

The automatic handling system designed by Kiva consists of two parts:

- Mobile shelves (Pods)
- Drive unit agent (DUA)

Mobile shelves (pods), are nothing more than stacks of trays stacked on top of each other, where each tray is in turn divided into containers.

The DUA, on the other hand, is a very reliable autonomous robot, capable of carrying even very high loads and reaching a speed of 5 km/h, and which orients itself thanks to an integrated GPS system specialized to interior spaces.

The task of DUAs is to transfer shelves from their storage locations to stations where an operator extracts the appropriate product from the container containing it. All activities performed by the robot such as picking, barcode scanning, and laser pointers identifying picking locations are managed by a central computer. The use of an automated picking system that relies on scanning each product greatly reduces picking errors, and consequently reduces the need for final quality control.

The MHS system is a program written entirely in the Java language, and was created through the use of various technologies employed from the field of artificial intelligence (AI) and the use of algorithms aimed at improving robot performance over time, while simultaneously deriving important parameters about the state and

health of the system. In addition to MHS, an event programming language was used to develop a simulation of a robot realization system, which is very useful for exploring algorithms and analyzing their impact on the system. The simulation includes detailed modeling of the robot motion, shelf geometry and manual operations and is performed by referring to simulated order data or actual customer data.

In 2012, Bezos purchased Kiva System for $775 million in order to make its distribution center (DC) as efficient as possible. In April 2015, Amazon renamed Kiva to Amazon Robotics. A year later, the famous orange-shelled robot (based on Kiva technology) was born and has now become a feature of all Amazon DCs. Amazon has activated more than 300,000 Kiva robots of which 100,000 are used in the 25 most advanced centers around the world. It has been analyzed and researched that Amazon's Kiva robot is a type of automation that can provide significant cost and time savings compared to an all-person workforce. The robots have reduced the company's operating expenses by about 20 percent, which means savings of about $22 million in logistics costs.

In addition, it was estimated that while in non-robotic warehouses the product cycle from user purchase to delivery takes 65 to 75 minutes, in those warehouses controlled by Kiva robots the cycle was reduced to 15 minutes. Other analyses performed indicate that the robotic warehouse can accommodate more inventory space, with a 50 percent increase in goods.

To further reduce costs and speed up logistics, Amazon has developed a new automation system for the final stage of delivery in a robotic lab located in an industrial park in North Redding, Massachusetts. Specifically, it has invested in drones that reach to the buyer's door.

5.2 "Amazon Robotics-Kiva", source: Amazon.com

5.2.1 Amazon warehouse operation

Now that we have defined how an Amazon warehouse is primarily composed and what is the ultimate goal that Bezos is inspired by, the last question that comes to mind is: How do such robots integrate with the entire operational process?

In Amazon's warehouses, items are not arranged precisely or neatly, but randomly. When goods arrive, employees pick up individual products and immediately place them in the first available space they find, regardless of location, and then thanks

to electronic equipment, they tell the business system the location of the product. Subsequently, robots (usually around 1,000 per warehouse) transport the shelves, up to 340 kg, following a virtual path composed of bar codes printed on the floor.

In this way it is the items, contained in the shelves, that move through the warehouse reaching the employees who simply have to pack the products they receive and proceed with the shipments. This is mainly aimed at: Reduce human error, in fact, the choice of the shelf and consequently of the product is made by the robot, and to considerably increase the speed of the entire warehouse, which therefore brings maximum efficiency as the final consequence. The Kiva's, patented by Amazon itself, are equipped with sensors that are useful in avoiding collisions and respecting rules of precedence against other robots. In addition to the reduction in shipping time, the use of this technology makes it possible to increase shelving per square meter, because the space needed for the movement of employees is eliminated, and to facilitate the work of employees who no longer have to move continuously within the warehouse.

Finally, it should be noted that the amazon warehouse is not so much developed by width but rather by height. This has speed as its main objective; that is, to make employees and robots travel less and also by taking advantage of the height there is less environmental impact, which is extremely important nowadays.

CONCLUSION

Industry 4.0 does not manifest itself simply as a change in the way of producing or in the resources that are used, but is a real cultural change that requires a rethinking in the way of doing business, in the organization of the company, in the production and management processes but also in the roles and responsibilities of the people who make up the organization.

The discussion in this paper aimed to outline what are the possible strategies that companies can adopt in order to integrate digitization in the most suitable way. The main aspect that I have grasped is the fact that the opportunities offered by this revolution can only be seized if a cultural change takes place in the company and in the entire economic system. This change is realized at the moment when the company is questioning itself, because if it wants to survive in the current economic and social environment, the only solution is to react to the market by being able to adapt in the best possible way: By being flexible and timely.

The fourth industrial revolution is changing the way production activity is carried out in the company; the traditional factory is taking on the connotations of a smart factory in which heavy, manual labor is being replaced by machines capable of performing tasks better, with fewer errors and faster; that in other words, they are able to perform and replace human work by being more efficient. The digital

technologies brought to the fore with Industry 4.0 in recent years are the foundation that supports this revolution. What is really a change from the past is the greater availability of the technologies in economic and physical terms. Their cost and wide diffusion in all countries thanks to IT ensure that they can be used by all economic entities, from the largest ones that thanks to their economic possibilities have always been able to enjoy the latest innovations, to small and medium-sized enterprises.

Digitization has also had its effects in business organization; in fact, new organizational types more suited to the new economic and social environment have been adopted. Organization 4.0 revises traditional canons and introduces new ones that bring the focus back to the figure of the person and the importance of his or her role in making a difference in the company. The company is no longer seen as closed in on itself, incapable of interacting with the environment, but is one that understands the opportunities that the ecosystem around it offers and takes' action to form a network of relationships in which it shares information and experiences that result in a logic "win-win" for all parties.

In the new organization, the role of the person could appear almost superfluous and at risk of "extinction. This is one of the most negative aspects that could manifest in the future. The trend that is rampant in society is the fear that by 2050 many jobs could be lost to machines; this idea should be countered, first and foremost by

governments, but also by companies that need to invest in people and their skills. This is only partly true; on the one hand it is true that technology is going to replace human work, but at the same time there will be an increasing need for skilled people who will be able to intervene in the process if there are problems with the technology. So, in all this it is essential that the government and companies help through training courses the workers to acquire the new skills required and at the same time that the worker be proactive and ready for change. The skills required in the new 4.0 organizations are varied and derive from different fields, on the one hand they are extremely specialized and technical (data analysts) but on the other hand they are also increasingly transversal in the digital sphere. They constitute the jobs of the future, that is, hybrid jobs, which require a starting base consisting of the first kind of skills and a completion given by digital, relational or communication skills. The development of these skills allows for an overcoming of the risks arising from robots and other machines in the company and ensures a greater involvement of the worker for his intellectual skills that can never be replaced by machines.

Another element that distinguishes the new digital organization is the different way of coordination of work and its resources. Two contrasting elements come into play in this issue: on the one hand, the greater control exercised by the manager over the work of workers through connection and analysis technologies such as wearable or

mobile devices, and on the other hand, the greater engagement of the worker in even the most important decision-making aspects ensured by the data available at all levels of the company that offer the worker greater autonomy and flexibility in his or her work. These two contrasting aspects define the new coordination of managements and roles within the company.

After analyzing the technologies and principles of Industry 4.0, the new organizational models and the new skills required of workers and managers, I thought it appropriate to analyze the current socio-political situation.

It is now since 2019 that we have been living with the pandemic and knows on the one hand, as is logical to expect, it has created irreparable damage to society socially, economically and politically; but on the other hand, this virus has done nothing but exponentially increase this process of digitization; especially in those countries, see Italy, that were far behind. This new mode of industry has led to the birth and, has seen its consecration during the pandemic, of smart working, a new mode of work that has proved essential for the survival of companies. Also for our future I believe, that this mode is essential as it impacts much less on the environment than actual in-person work. During these pandemic years, governments are adopting new plans to among cope with this crisis and to incentivize more and more this new type of industry because it fits perfectly with the claims that the pandemic has brought.

Next, I focused on analyzing, from a political and economic perspective, the war that broke out on February 24, 2022, and still exists between Russia and Ukraine. Although it does not seem directly related to the topic of Industry 4.0, I think it is essential to talk about it because the social, political and economic impact that this war is causing, not only to the two nations involved, but also to all of Europe is almost enormous. The effects that it is causing are enormous, and in the near future they will be even more so, and they range from the difficulties of finding food supplies (grain and cereals), to the massive increase in the price of gas and fossil fuels, and again the gigantic increase in the price of electricity. So, it is well understandable how this war is considerably slowing down digitization and putting even more of a crisis in the global scenario.

Finally, in the last chapter I wanted to talk about a worldwide example of a company that uses these new technologies extensively.

In particular, I talked about the Amazon case starting from its birth in 1994 and its overflowing economic and organizational evolution. Amazon represents a leading company in the industry, has a virtually worldwide presence, and is structured to be an everything store. Obviously, all of these characteristics have required an ever-increasing organization and ability to satisfy the customer, which for Amazon remains the priority, and therefore they have seen the implementation within their warehouses of these technologies.

Amazon's warehouse practically represents the future, which is what other medium-sized small businesses scattered around the world aspire to. Within it is a coexistence of machines (Robot-Kiva) and humans to make sure it is as efficient as possible. Their prerogative remains customer satisfaction, and behind that has come everything else; that is: speed of delivery, trying to make as little mistake as possible with orders, and so on. So, in order to succeed in this goal, Bezos has seen fit to introduce these new technologies and invest in research virtually continuously. In fact, it is almost certain that in the coming years we will see this colossus take on more and more market segments and continue its virtually endless process of digital transformation.

BIBLIOGRAPHY:

Acemoglu D. e Restrepo P., 2017. Robots and jobs: evidence from U.S. labor markets.Working Paper, Massachusetts Institute of Technology

Andriopoulos C. e Lewis M.W., 2009. Exploitatio-Exploration Tensions and Organizational Ambidexterity: managing paradoxes of innovation. Organization Science, 20(4), 696-717

Avanade, Successful digital transformations are Future Ready. Now., fonte https://www.avanade.com/-/media/asset/research/future-ready-now-executive- research.pdf, 2019;

Avogaro M., 2019. The Highest Skilled Workers of Industry 4.0: New Forms of Work Organization for New Professions. A Comparative Study, E-Journal of International and Comparative Labour Studies

Baldwin, R., & Wyplosz, C. (2019). The Economics of European Integration 6e. McGraw Hill.

Baumgarten J., Grant D., Keith D.B. e Laudico A.T., 2014. Designing the Organization for Digital: why you may be asking the wrong questions. SpencerStuart, Gennaio 27

Bharadwaj A., El Sawy O.A., Pavlou P.A. e Venkatraman N., 2013. Digital business strategy: toward a next generation of insights. MIS Quarterly, 37(2), 471-482

Bughin J. - Seong J. - James Manyika J. – Chui M. - Joshi R., Notes from 82
The AI frontier modeling the impact of AI on the world economy, McKinsey Global Institute, 2018;

Cisco, 2017. Annual Cybersecurity Report

Cloud Transformation Observatory, 2020. Cloud to ensure business continuity in an emergency context: how the sensitivity of companies to the Cloud is changing.

Cusumano M.A., 2015. How traditional firms must compete in the sharing economy. Communications of ACM, 58(1), 32-34

D'Apice, P. (2015). Cross-border flows operated through the EU budget: an overview. European Economy-Discussion Papers 2015-, (019).

Dawson A., Hirt M. e Scanlan J., 2016. The economic essentials of digital strategy. Working paper, McKinsey & Company

De La Boutetiere H. - Montagner A. – Reich A. , Unlocking success in digital transformations, McKinsey & Company, fonte https://www.mckinsey.com/business-functions/organization/our-insights/unlocking- success-in-digital-transformations, 2018;

Epstein J., 2017. Companies of the future: No CEO, no boss, managed by blockchain. VentureBeat, Aprile 23- www.venturebeat.com/category/entrepreneur/

European Commission, Brussels,2012. A European strategy for Key Enabling Technologies – A bridge to growth and jobs

A. Martin, 2019. Industry 4.0, Challenges and Opportunities for Made in Italy. Technologies. Scenarios. Success Cases

European Commission, Key lessons from national Industry 4.0 policy initiatives in Europe, fonte https://ec.europa.eu/growth/tools- databases/dem/monitor/sites/default/files/DTM_Policy%20initiative%20comparison%20v1.pdf, 2017

Executive Office of the President, 2016, Artificial Intelligence, Automation and the Economy. U.S. Government

Ghobakhloo, 2018. The future of manufacturing industry: a strategic roadmap toward Industry 4.0

Gilchrist A., 2016, Industry 4.0: The industrial Internet of things. New York, Apress, 2016

Guszcza, J., 2017. Cognitive collaboration: Why humans and computers think better together

Ismail, 2014. Exponential Organizations: Why new organizations are ten times better, faster, and cheaper than yours

Kappeler, A., 2022. Russians and Ukrainians, unequal brothers, from the Middle Ages to our days

Kazutoshi M., Hiroshi O., 2017. Interatomic potential construction with self-learning and adaptive database

Laurini and Murgante, 2008. L'informazione geografica a supporto della pianificazione territoriale

Lee & Sambamurthy et al., 2007-2015. IT-Enabled Organizational Agility and Firms' Sustainable Competitive Advantage

LIoveras Soler, Josep, M., 2021. The Next Generation EU: Opportunity and risk

Luca, D. (2021). Next Generation EU: has the Hamiltonian moment come for Europe

March, James, G., 1991. Exploration and Exploitation in Organizational Learning
Martin, A. 2019. Industry 4.0, Challenges and Opportunities for Made in Italy. Technologies. Scenarios. Success Cases

Strandhagen et al., 2017. The fit of Industry 4.0 applications in manufacturing logistics: a multiple case study

McFarland, V., 2015. Leading and Building Effective Teams

Mckinsey Global Institute, 2017. Artificial Intelligence the next Digital Frontier

OECD, Strengthening Active Labour Market Policies in Italy, 2019;

O'Reilly & Tushman, 2013. Organizational ambidexterity: Past, present, and future

Porter M. e Heppelmann J.E., 2014. How smart, connected products are transforming competition. Harvard Business Review, Novembre, 65-88

Pfeiffer S., 2015. Effects of Industry 4.0 on vocational education and training. Working Paper, Novembre, Institute of technology assessment

Picek, O. (2020). Spillover Effects From Next Generation EU. Intereconomics, 2020(5),

Rüßmann M., Lorenz M., Gerbert P., Waldner M., Justus J., Engel P., e Harnisch M., 2015. Industry 4.0: the future of productivity and growth in manufacturing industries. Report, Aprile 9, Boston Consulting Group

Rüttimann and Stöckli, 2016. Lean and Industry 4.0—Twins, Partners, or Contenders? A Due Clarification Regarding the Supposed Clash of Two Production Systems

Salas, Dickinson, Converse, & Tannenbaum, 1992. Toward an understanding of team performance and training

Sanders A., Elangeswaran C. e Wulfsberg J., 2016. Industry 4.0 implies lean manufacturing: research activities in Industry 4.0 function as enablers for lean manufacturing. Journal of Industrial Engineering and Management, 9(3), 811-833

Stone, B., 2013. The Everything Store: Jeff Bezos and the Age of Amazon

Strategic Policy Forum on Digital Enterprises, 2015. Digital transformation of European Industry and Enterprises. Report, European Commission

The war in Ukraine as of March 25: Kyiv's defenders launch counterattacks, in El País, Gruppo PRISA, 25 marzo 2022

Tushman, O'Reilly, 2006. Ambidextrous Organizations: Managing Evolutionary and Revolutionary Change

Venier F., Trieste, 2017. Digital transformation and organizational capability: Italian companies and the challenge of change.

World Economic Forum, 2015. Collaborative Innovation transforming business, driving growth. Report

World Economic Forum, 2016. The Future of Jobs- Employment, Skills and Workforce Strategy for the fourth industrial revolution. Global Challenge Insight Report

Wortmann F. e Flüchter K., 2015. Internet of things- Technology and Value Added, Springer.

SITOGRAPHY:

https://blogs.cisco.com/security/a-20-20-vision-for-cybersecurity;

https://ec.europa.eu

https://ec.europa.eu/eurostat

https://ec.europa.eu/eurostat/cache/infographs/energy/bloc-2c.html?lang=en

https://euromod- web.jrc.ec.europa.eu/overview/extended-functionalities

Schneider, 2018. " https://www.industry4business.it/risk-management/schneider-electric-a-sps-italia-2018-con-lindustry-4-0-di-ecostruxure/

https://www.argoconsult.it/la-logistica-4-0-di-amazon/

https://www.assemblymag.com/articles/94546-industry-40-maturity-index

https://www.bruegel.org/wp-content/uploads/2019/12/WP- ZSOLT-FINAL.pdf

https://www.consilium.europa.eu/en/policies/coronavirus/

https://www.consilium.europa.eu/it/policies/eu-response-ukraine-invasion/impact-of-russia-s-invasion-of-ukraine-on-the-markets-eu-response/

https://www.consilium.europa.eu/it/infographics/how-the-eu-is-helping-address-the-global-food-crisis/

https://www.europarl.europa.eu/RegData/etudes/ATAG/2022/729380/EPRS_ATA(2022)729380_EN.pdf

https://hbr.org/search?search_type=search-all&term=amazon%3A+case+of+study

https://www.automazione-plus.it

www.plm.automation.siemens.com;

www.ec.europa.eu/programmes/horizon2020/

www.manufacturing.gov

https://www.sciencedirect.com/science/article/pii/S2049080122007932

https://www.realta-aumentata.it/scienza-e-tecnologia.asp

https://www.who.int/news-room/emergencies-international-health-regulations-and-emergency-committees

ACKNOWLEDGEMENTS

First of all, I would like to thank my parents, my sister and my grandparents who allowed me to study and have a future full of opportunities. Special thanks to my lifelong friends who have been close to me in all the most important stages of my life. I would extend my thanks also to my classmates, especially Alessandro, Giacomo, Alice, Matteo and Leonardo who have always been so helpful and with whom we have shared these two years together. Finally, I would like to express my gratitude to Professor Giancarlo Vilella, who has been helpful, professional and friendly since the first interview regarding the project of this thesis.