



Ca' Foscari  
University  
of Venice

## Master's Degree in International Management

### Final Thesis

The impact of the Industry 4.0 on human resources:

An analysis of eight manufacturing companies in the Treviso area

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*Dedicated to the people of my life and  
to all who are at the heart of this journey*



## **Abstract**

In recent years, the Italian manufacturing sector has started to adopt new technologies entailed in the national industrial policy plan called “Industry 4.0”, that has opened many new opportunities, also for small companies to invest in new digital tools.

Initially, new Industry 4.0 technologies such as 3D printers, Cloud Computing, Cybersecurity, Big Data, the Internet of Things and other additive manufacturing tools, were used in order to improve the production processes of manufacturing companies, they enhanced productivity, flexibility, and the quality of the products. But then they were also implemented in other supportive activities by companies in the manufacturing sector.

The thesis is focused on the Veneto region manufacturing sector and its companies, which are mainly small and medium enterprises, that for some years have invested considerably in new technologies as a result of the financial and tax incentives included in the “Calenda Plan”, a program established in 2016 to incentivize the investments in new technologies. Investments in Industry 4.0 tools also have some challenging effects on the human resources, in particular on the small and medium sized firms.

In many cases, employees do not accept the implementation of new technologies which have an impact on their job tasks but, on the other hand, companies need workers with updated skills in order to exploit new technological tools.

The challenge facing by companies is to cover the skills gap created by the Fourth Industrial Revolution, in order to hire and train right people to manage new digital tools that require specific competencies, and to avoid unemployment caused by the substitution of human resources by machines.

Therefore, they should listen and involve their employees in this change. The research will focus on eight specific case studies of manufacturing companies in the Treviso province, specialized in the fashion and furniture industries, both of which are significant manufacturing sectors for the province economy.

Companies have invested in Industry 4.0 technologies which have had important effects on the management of human resources that required new and specific skills and competencies.



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## **Introduction**

Industry 4.0 is considered the Fourth Industrial Revolution that has led to a completely new way to do business and at the same time helps companies to improve their production processes (Zhou, 2016).

The revolution started in the early 2000s, but only in 2011, the term Industry 4.0 has been introduced after the Hannover exhibition in Germany. (Zhou et al.,2016).

The new system includes the integration and the automatization of the production process and the other secondary activities through the Industry 4.0 technologies that are formed by Cloud Computing, Big Data, 3D printing, additive manufacturing tools, Internet of Things, Cyber Security and many other important and secondary tools.

New technologies are essential in order to improve the production process, to increase productivity, flexibility of the production but also to boost the quality of the products, to remain competitive in the international markets and to reduce the numbers of errors.

The revolution has been disruptive for many reasons, that will be explained intensively during all three chapters of the thesis. But summarizing:

Firstly, because it completely changed internal communication, now all functions are integrated and they communicate through new digital tools, many new software is now involved, and companies are continually investing in that.

Secondly, new technological tools have automatized many activities causing an enormous impact on the human resources.

Before the implementation of new tools, the production was completely manual and managed by people that were used to doing hand tasks, after that, the production process is driven by integrated and interconnected machines and consequently human jobs changed.

Nowadays, people manage, activate, and control the operativity of machines and they usually perform digital tasks.

This is the disruptive impact of new tools on people, and it is also the focus of the thesis. The research question of the project is to investigate the key effects of new Industry 4.0 technologies on human resources, taking into consideration the manufacturing companies in the Treviso province.

Eight companies were interviewed in the manufacturing context of Treviso, notably four firms of the wood-furniture industry and the other ones in the fashion sector, in order to understand the main effects on human resources.

The research aim is to evaluate the consequences in a small province, Treviso, that it is very representative of the Italian system, because it is mainly characterised by small and medium sized manufacturing companies that are considered an excellence of Made in Italy, they exported their products all over the world where their quality and design are appreciated.

The selected two industries represent the “Italianness” because both the furniture and fashion sectors drive the Italian manufacturing turnover in particular in this province where two fundamental industrial districts were created, the Sportsystems and the Wood-furniture one.

Summarizing, the research will focus on:

In the first chapter, the general concept will be presented, explaining in depth the concept of Industry 4.0 and the technologies involved.

In addition, an important excursus on the other three industrial revolutions will be faced in order to understand better the main characteristics of the fourth one.

The chapter, then will focus on the effects of 4.0 technologies on human resources, delving into the various perspectives of main authors like Mcfee Acemoglu, Bongomin, Corazza, Coro, De Propris, Caruso and many others.

They also explain the different effects of technologies on various types of jobs and showing the main consequences on the skills required by the companies, that are constantly updated.

The first part will also focus on different effects on human resources in the various regions of the European context and at the end the role of universities is underlined.

At the beginning of the second chapter, there will be an explanation of the Italian manufacturing system, underlining essential data on the GDP, industries, in order to understand the context analysed.

The focus will be on the main technologies used in the Italian manufacturing context with an analysis on the digital tools preferred by Italian companies and also in-depth research of new technologies impacts on the Italian workforce.

In the second part of the chapter, the central point is, then, restricted to the Veneto region with a general analysis of the manufacturing system and then wide research on the implications of the Fourth Industrial Revolution on Veneto manufacturing companies.

The second section is very critical in order to bring in the third and last chapter that will be the focus of the thesis which will treat an empirical analysis on eight manufacturing companies in the province of Treviso.

Firstly, the main characteristics of the production context of the province are presented with also a specific focus on the two industries selected.

Secondly, the research will touch the methodologies used for the eight interviews and finally the results obtained by the eight interviews will be presented, focusing on the human resources consequences after the implementation of 4.0 technologies.



# **CHAPTER 1: The Industry 4.0 and the impact on human resources**

## **1.1 A review of the Industry 4.0 concept**

Few years ago, the term Industry 4.0 was introduced to indicate the Fourth Revolution and it refers to a complex and disruptive technological system that has an important impact on the industrial environment (Pereira et al., 2017).

This term appeared for the first time in a German article in 2011 published by the government in which they promoted an innovative business model to help companies to advance in the production processes (Zhou et al.,2016).

Industry 4.0 is a new trend in manufacturing that is characterized by the integration of a set of technologies that enable ecosystems of automated firms and integrated product-services, which has helped the manufacturing landscape to change as a result of many digital innovations that are very useful in order to simplify the production processes. (Santos et al.,2017).

The main transformations entailed new automation technologies, digital manufacturing technologies and network communication such as Internet of Things (IoT), Distributed and Decentralized Control, Embedded Systems, Cyber-Physical Systems (CPS), and Big Data in manufacturing companies.

The various technologies and their integration are representative of the concept of Industry 4.0., that will influence both products and processes, allowing efficiency and productivity improvements among companies (Santos et al.,2017), but on the other hand, new tools can also create new opportunities for companies to innovate their activities and also for the human resources that have to update their skills (Pereira et al.,2017).

The new integrated digital technologies enable many new facilitations for companies, they can easily exchange information among different parts of the manufacturing process, and in many cases, these tools are also able to also operate autonomously, reducing the human effort.

Many companies are becoming more and more “smart companies” that are really interconnected, they operate faster satisfying better the consumer demands and needs and new technologies really change the modus operandi of the organizations allowing companies to streamline many routine and repetitive activities which lock-in the growth of firms (Pereira et al., 2017).

If new digital technologies have really simplified and innovated the production processes of many companies, they have also been so disruptive that it was difficult to predict the consequences, indeed now companies are risking in order to invest in these technologies. In addition, the new technological improvements entailed in the industry 4.0 are more and more blurry, the boundaries between the digital and physical context are not defined.

## 1.2 A brief introduction to the Previous Industrial Revolutions

As mentioned in the previous part, the Fourth Revolution is very disruptive and different compared to other three industrial revolutions, for many reasons and it has characteristics that differentiate it from the previous ones.

The First Industrial Revolution increased the productivity and efficiency through the use of steam power.

The second allowed mass production thanks to the electricity while, the Third Industrial Revolution was characterized by a starting point in the production automation using electronics and technologies.

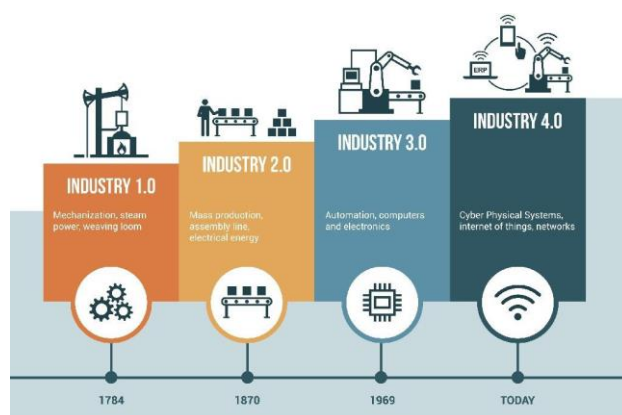


Figure 1 The four Industrial Revolutions

Source: Imphal Review

The Industrial Revolutions can be divided into four phases: (Simon, 2023 <https://sustainability-success.com/it/4-rivoluzioni-industriali-industria-1-2-3-4-0/>)

The First Industrial Revolution (Industry 1.0)

The Second Industrial Revolution (Industry 2.0)

The third industrial revolution (Industry 3.0)

The Fourth Industrial Revolution (Industry 4.0)

The First Industrial Revolution started in the 18th century, and it covered the period between 1760 and 1840, it was characterized by great transitions that completely revolutionized the economies existing in different continents, transforming most economies that still relied on agriculture and craftsmanship.

However, with the onset of this Industrial Revolution, economies began to rely on new manufacturing systems, large-scale industries, and mechanized production, especially, they started to use modern energy sources, new machines, and even new strategies to organize different departments in industries.

The First Industrial Revolution led their main effects on three different regions, that are the United States, Great Britain and continental Europe.

Many different sectors were hit by the First Industrial Revolution include the glass, mining, agricultural and textile industries, in fact, so much so that the mechanization of industries led to a great production for companies, eight times higher in volume than the previous production process.

The leading discover of the era was the power of steam, it was introduced in the industry, and it completely revolutionized the production process, indeed the strength of steam not only led to the production of higher volumes, but also led to a significant increase in human productivity.

On the human resources side, new machineries allow workers to become more efficient and productive, in truth companies improved notably their productivity and lower their costs. As a result, most small businesses, also in Italy, have grown and developed into large organizations that served more people.



The first revolution completely transformed the economy but on the other hand it led to some drawbacks, indeed, the demand for new machines was very high but impossible to completely satisfy forcing many companies started to exploit workers in order to produce more and more.

Workers were forced to work long hours and in unhealthy working conditions. However, in 1833, the United Kingdom was the first country to enact the “Factory Act” to ensure compliance with high standards in all workplaces. (Simon, 2023).

The Second Industrial Revolution (Industry 2.0) began in 1870 and it took root mainly in Germany, America and Great Britain, and it is also considered the “Technological revolution” because it focused mainly on the industrial processes using machines that were powered by electricity.

The electricity was already used in the production process, but it was only with the Second Industrial Revolution that electric machines were implemented, because they are more efficient and also less expensive because they operate without human effort.

It has started also a process machine automatization that required less and less human effort.

Industry 2.0 implemented not only a leaner mass production process, that was a consequence of the assembly line that operating through economies of scales, improving the quality and also the number of products manufactured, but also allows the improvement of the industrial culture.

For the first time, programs introduced rules and principles of lean manufacturing, resource allocation, just-in-time production strategies, and improved division of labour.

Finally, the technology systems used in the period also served as a model for Henry Ford in order to establish the famous “Assembly line”, because before the introduction of it, each station in a company would have assembled the entire automobile; however, Henry created a new system in which all vehicles would be produced step by step, allowing the production of cars and then of other products to become faster and cheaper.

The Second Industrial Revolution led to an important issue that was the deskilling of employees, who were assigned to simple and repetitive mansions. (Simon, 2023)

The Third Industrial Revolution is also called "Digital Revolution" starting in the 20th century, around the 1970s.

Simple but large computers were developed, which were characterized by good computing power.

In the period of Third Revolution, information technology (IT) and electronics were established into many production processes, promoting a more automated processes, that are still relevant nowadays.

In turn, this has led to higher production accuracy, higher speeds, better competences and some technologies have even replaced human labour in some production processes, starting to talk about the phenomenon of human resources substitution.

Furthermore, in the 1960s, the programmable logic controller (PLC) was introduced which increases the processes automation starting from electronics, moreover, many new softwares were implemented that improved the processes management such as inventory management, product monitoring, business resource planning, product flow planning, and shipping logistics.

The period has converted the existing analogy world into a modern digital world. (Simon, 2023)

The Fourth Industrial Revolution (Industry 4.0) is currently taking place in the modern world, indeed the major changes in this era have been evident since 2011. During this year a project was conducted in Germany, promoting computerisation in production and in this occasion, in the Hannover Fair, the term "Industry 4.0" was publicly launched.

The Industry 4.0 focuses on the use of communication and intelligent technologies that are implemented in the production processes in order to make them more efficient.

Therefore, the fourth industrial revolution has led to efficient networks of systems, also known as "cyber-physical production systems".

This cyber-physical production systems have allowed the introduction of intelligent companies, where the production process has become almost completely automated, and people and components started to communicate through a unique network.

Another important change of the period is working method, employees have started to learn how new technologies work and they also collaborate with them in their daily activities.

The manufacturing sector is becoming more and more digitalized after the introduction of Industry 4.0 technologies, allowing an easier exchange of information among employees. (Simon, 2023)

Nowadays, many of new technologies can self-organized logistics, predict failures, and perform different maintenance processes independently, they could also manage unexpected or changes in production, thus ensuring greater continuity in production processes.

In other words, there would be a disruptive change in the way goods are produced, served, refined and distributed.

Another important aspect of the Fourth Industrial Revolution is focus on sustainability and environmental issues.

Sustainable development is not only a necessity to be more ecological and preserve natural resources for future generations, but it is also an opportunity to improve the efficiency of production processes.

The implementation of Industry 4.0 has not been a smooth process, despite the many opportunities and advantages for businesses that this industrial revolution has brought, there have also been major challenges and obstacles.

Indeed, as more advances in technology are made, there is a greater need for more skilled employees.

The new workforce should have the "digital dexterity"; they should have a good competency of the production processes, as well as know how the digital tools and smart machines work. (Simon, 2023)

### **1.3 The different types of 4.0 technologies**

Despite the technological improvements ensured by the fourth revolution, the Industry 4.0 is driven by the technical integration of Cyber-Physical Systems into manufacturing processes and the use of the Internet of Things and Services in manufacturing processes (Giacomo Büchi et al, 2020).

As explained in the previous part, the Cyber-Physical Systems are processes that allow the interaction between the physical and the virtual environment, trying to control and coordinate operations in order to provide data.

These systems are fundamental in the production because they ensure the integration of production processes through the exchange of important data and, in this way, they enable a simplified and innovative production.

The combination between the Cyber-Physical systems and Internet, it is called “Internet of Things”.

When the Cyber-Physical Systems are used in the production and they relate to Internet systems, a Smart factory is created (Giacomo Büchi, et al., 2020).

The Internet of Things (IoT) is term that indicates the technologies based on the connection between physical things and the Internet, indeed the main aim of the new digital tools is not only the collection of data but also, to integrate and interconnect physical products with the information network, allowing the creation of Industry 4.0 companies, where the boundaries between the physical and digital world disappears.

In industries, IoT has been exploited in automation for lighting, heating, robotic vacuums, remote monitoring, and control of machines (Bongomin et al., 2020).

Flexibility, product customization, real-time dialogue between customers are the positive effects of the use of Internet of Thing technologies.

The typical IoT structure entails three layers: perception layers, network layers, and application layers (Bongomin et al., 2020).

The first level operates as sensors for data acquisition, second layer focuses on data transmission platform, and the last level is the application layer in which the smart environment is built.

In addition to these two fundamental technologies, there are many other technologies that are very relevant for the development of the Industry 4.0.

Firstly, the Big Data and Analytics technologies focus on the collection and analysis of data from different sources that go through the Internet and that describe, for example, market trends, consumer habits, brand reputation, the demand for goods.

From last years, Big Data are always more using for helping the management in the decision-making process indeed, companies can effectively extract economic value from

the acquisition and processing of large volumes and varieties of data, being able to identify possible future scenarios and actions to take (Alberto Cipriani et al., 2018).

New big data tools can have a huge room for growth, so, companies must develop the appropriate skills to customize the path, adapting it to their reality without losing valuable opportunities.

The recent improving in the performance of data mining and modelling software means that it is now possible to analyse vast quantities of digitised data as a basis for activities such as consumer profiling, behaviour modelling, movement tracking, interaction. (European Parliament, 2017).

The increase in the use of Big Data has led to data policies that are rules to regulate the public use of data.

Furthermore, 3D printing is a technology that can be used to physical objects based on the 3D CAD file.

The terms 3D printers and additive manufacturing are often used interchangeably because both focus on the creation of three-dimensional physical products from a digital model representing their design.

The three-dimensional products are usually more personalized and customized with determined characteristics that are not possible if traditional manufacturing techniques, are used.

The 3D technologies are very used in the first phase of the production process, the Research and Development, in which employees started to design the product and these products enable the save of materials and the reduction in prototype times and costs.

The innovation of 3D printing is not recent, but today the field of use of this technology is wider, since you can make larger objects in a wide range of materials (metal, ceramic, wax, polymers etc.) and the cost of the machines has been reduced. (Redazione Make Group, 2023 <https://www.make-consulting.it/industria-4-0-tecnologie-abilitanti/> ).

Additionally, the Cloud Computing is a service that can be used to have access to data remotely.

The development of Cloud Computing technologies has allowed the increase necessity for infrastructure that retain a large amount of data.

In the last years, the use of Cloud services is becoming more and more relevant, because through these services companies can easily access to data from all over the worlds, using applications like Dropbox, iCloud, Google Drive. (Redazione Make Group,2023)

Another crucial technology is the Cybersecurity systems that are aimed to ensure the right security to companies and protect the relevant information of a business (Bongomin et al., 2020).

The security tools are used to avoid the risk of hacking that is now very high because all parts of the companies are interconnected through Internet, so it is fundamental to protect industrial systems from possible attacks.

The term cybersecurity refers to the set of technologies aimed at protecting computer systems from attacks that can lead to the loss of relevant data and information, that are in many cases secret and private.

Robots are another type of technologies 4.0 which can produce goods and they can carry out also difficult tasks, such as they are useful in logistics department in order to reduce the human effort in the packaging process.

Virtual reality (VR) and Augmented reality (AR) are complementary technologies of industry 4.0.

The virtual reality technology can allow users to be transported into a virtual world through headset, instead the augmented reality has an illusion of layers of graphic information in order to increase the view of something (Bongomin et al.,2020).

Augmented reality is therefore an integration of the physical environment with the main goal of streamlining the user activity and enhancing interactions with the real world.

In addition, Artificial Intelligence is a program coded and designed machines in order to reproduce human reasoning ability. (Bongomin et al., 2020).

For the past few years, AI (Artificial Intelligence) has been applied in complex operations such as drilling fluid, underground mining, and maintenance, as well as monitoring of sophisticated manufacturing systems.

Another type of technology 4.0 is smart sensors that includes smart devices, they control objects such as water and flood levels (Bongomin et al., 2020).

Simulation is another technology used for analysing the behaviour of systems and it is applied in different industries due to its ability to improve components of manufacturing systems.

Simulations are used in production processes to analyse real-time data and they test and optimize processes before their physical production, reducing installation time and increasing product quality.

The simulation tools allow the real-time corrections in the production process of a given product without facing the huge costs sustained by the companies that correct the error at the end of the production process.

Companies implement new technologies in order to improve their production process, they are mainly used by manufacturing firms that have simplified their production, making it more flexible and improving the quality of their products and they can easily reduce the number of errors in the production process.

Technologies are mainly used by the manufacturing companies through all the production process and then also the services companies have started to adopt Industry 4.0 technologies in order to simplify other relevant activities related to the organization.

#### **1.4 Drivers of Industry 4.0**

The Industry 4.0 is driven by four main pillars: (Lisa De Propris et al., 2020).

First, new technologies are deeply implemented in the production processes, they allow a great improvement of both the productivity and the flexibility of the production process.

Furthermore, the Fourth Industrial Revolution emphasizes a new phenomenon that is the “Servitisation”, companies not only produce goods, but they complement the offer with new services which increase the consumer’s satisfaction.

Thirdly, some of new technologies ensure a better production cost, they also allow the production of more personalized, customised, innovative products, in many cases there is also a co-production of the good between the company and the customer.

The last driver is the sustainability, which cover a priority role in the fourth revolution, because new digital technologies enable a more sustainable production, reducing the level of energy or water consumed, material used, and the level of waste produced.

Th drivers allow to understand that new technologies completely change the configuration of a company, the disruption of these tools alters the processes of value creation modifying the priorities of companies.

If a company is able to do this step, it can earn a successful competitive advantage against its competitors (De Propris et al., 2020).

### **1.5 The consequences of the Industry 4.0 on the workforce**

As seen previously, the Fourth Revolution has been disrupted and revolutionary for many reasons.

The last Industrial Revolution caused both economic and social opportunities but also challenges and changes are involved.

Many firms are not prepared for this revolution, they lack a digital strategy that allow them to facilitate the implementation of new technologies (Raj et al.,2020).

The main risk concerns workers because the relationship between workers and machines is becoming completely new and uncertain.

Digital tools can take decisions in place of human beings that are in many cases less important in the process. (Schafer,2018).

Due to the radical revolution, human resources have undergone important effects, they are called to change their skills to adapt to this new system.

As emerged in many studies (Assolombarda, MCfee, frey et al.) as well as changing their skills, workers risk to lose their workplace due to the substitution of human resources with machines.



### *1.5.1 Human resources change due to Industry 4.0 technologies*

The change of the workforce dynamics is caused by new radical trends such as the digital revolution, the globalisation, the transition of green economy. (ASSOLOMBARDA, 2021).

The main cause of the workforce transformation is the digital revolution process that we will explain throughout all the theses.

Other important trends which have an important impact on the workforce are mainly: the globalization, many companies have decided to offshore part of their production to low-cost countries where low skilled workforce is an economic advantage and on the other hand, they keep in-house other primary activities that are carried out by more skilled workers. (Assolombarda, 2021)

The delocalization process creates a skills gap, many operators are now risking their workplace in advanced economies because workforce is becoming too expensive.

The sustainability is another fundamental trend, which favours the development of new jobs related to the green economy, new figures are necessary to face this change.

The sustainability process is also related with the digital revolution, in fact companies invest in new technologies with also the aim to waste in the production processes.

Companies introduce new machines, software, cloud spaces in order to decrease the paper used in their work activities, at the same times, new machines can also monitor the amount of energy and water waste in the production process.

The evolving and complex relationship between technology and employment is relevant, indeed if in the past century the technological evolution has coincided with a rapid development of the economy and the employment, now this is very uncertain (Assolomabarda, 2021).

### *1.5.2 Different perspectives on the topic*

As explained beforehand, the Fourth Revolution has important implications for workforce.

In the literature, many different perspectives are established, in fact from on hand, many studies showed the negative impacts on human resources such as the unemployment (Barbieri, MCfee et al., Caruso et al., Fareri et al., and many others) while other research (Piva et al., Benešová et al., Fareri et al., Frey et al., and many others) also include the positive part of this process which allow change in the workforce competencies and their growth.

From the point of view of Barbieri, 4.0 technologies born to be labour-saving, so they substitute humans in the tasks and jobs, for this reason, now, the qualitative aspect of the human jobs is becoming relevant (Barbieri et al., 2019).

Part of the literature affirms that the introduction of new technologies entailed a threat for the workforce because despite the increase in the productivity, others remained very vulnerable after the implementation of these tools and they are even substituted (Fareri et al., 2020).

In addition, there is the problem of the “bad jobs” in which these technologies entailed an increase in the low skills workers (Fareri et al., 2020).

From the research of Fray, has emerged that 47% of the jobs are at the risk of computerisation.

The theory shows that the workers who are most at risk, are in transportation and logistics occupations, administrative roles, production jobs and in the service occupations. (Frey et al., 2017).

On the other hand, the computerisation has an important effect to low-skilled roles, in particular workers will be assigned to more creative and social tasks, acquiring new important cognitive skills (Frey et al., 2017).

On the Assolombardo research, came out that some intermediate professions are particularly affected by all indicators of technical progress.

In fact, while highly qualified professions are not hit by automation because they are characterized by few routine activities, the lowest routine professions are more likely to be automatized. (Assolombardo, 2021).

On the other hand, Caruso pointed out that technological innovation not only substitutes low skilled employees, but it can also reach important outcomes such as reducing the workforce and wages (Caruso, 2017).

For this author, the industry 4.0 has not reached what was planned since the main effects of new digital tools should have been positive for the productivity, future work and for the economy.

Some productive objects have been reached such as the increase and the improvement of the productivity, the level of quality of product are continually increasing thanks to these tools but on the other hand important drawback related to the unemployment was underestimated when these tools were introduced. (Janis, 2018)

This Fourth Revolution is creating a disequilibrium in the workforce between the demand and the supply, in the form of a skills gap, new technologies require new skills that many workers in this moment do not possess.

The problem of skills gap has enormous consequences for companies which have difficulties to hire people with right skills. (World Economic Forum,2016)

The temporary situation of skills gap creates also unemployment which is not only a considerable cost for the economy but also a social issue.

In many cases, the situation is only transitory but if not fixed, it can create large negative effects (Pittarello et al.,2020).

The phenomenon of skills gap issue is not only present for the hiring process but also for people already hired.

The concept of on the job “skills gap” refers to the employees that are over or under prepared for their tasks (vertical gap) or workers that have different skills than requested (horizontal mismatch). (McGuinness et al., 2016).

The issue can create a situation in which employees don't exploit really their skills or a context where workers possessed skills for their jobs but are not updated to the new process of digitalization.

For example, in a very dynamic labour environment, an ‘on- the- job’ skill mismatch might be limited, firms pass on individuals the cost of training in order to possess the right skills for the new job.

In an active context, education and training are essential to stay ahead.

Nowadays, from research of PwC, has arisen that people invest more and more in a individual, they try to stay ahead by improving their skills, competencies with many programs because it is always more important to create an own brand.

Companies hire people based on their skills so investing on personal training make the difference when you are looking for a job. (World economic Forum, 2016).

On the other hand, in a more static context in which companies have more obligations towards employees, they try to fix the skills gap with many training programs, in order to ensure updated abilities to employees.

Generally, firms are in front line to solve the skills gap, but the effort is insufficient, if it is not accompanied with a public intervention in order to solve the problem in the short-term and to guarantee the long-term development of the economy and society (World Economic Forum, 2016).

According to the McKinsey Global Institute (2017), skills imbalance creates a disequilibrium, that by 2030 will substitute more than 30% of the labour force that are not able to update their competencies to the new situation.

In order to resist in the uncertain and unpredictable labour market, people try to possess their personal skills in order to have a value-added in the workplace, they also try to be more flexible, and they should have desire to always learn new things and skills.

People are now more aware of their competencies and skills and also looking for a workplace that allow them to obtain more flexibility and autonomy.

Furthermore, new tools help workers in carrying out their tasks and have more autonomy in the decision-making process (World Economic Forum, 2016).

Many workers are now updating their skills but at the same time, the unemployment is still a consequence of the Fourth Revolution.

Many studies such as the Caruso one underlined the underestimation of the unemployment after the implementation of new technologies in a company, that frequently do not require human presence. (Caruso,2017).

But on the other hand, from many studies and also from the interviews done, has emerged that machines improve the productivity, but even today human resources remain fundamental in the process.

### *1.5.3 The Industry 4.0 technologies impact on different types of jobs*

The effect on human resources after the introduction of new Industry 4.0 technologies are more or less positive in relation to the types of technologies introduced and also to the different jobs.

In the World Economic Forum Report, the Artificial Intelligence will have a negative impact on employment but on the other hand, new technologies such as Big Data, Internet of Things and Robots could entail a more positive impact on job creation.

In addition, professions in the Architecture, Engineering and Mathematics fields could have a relevant increase, by contrast jobs in the production and in the administrative fields are more subjected to a decline.

Unfortunately, the decrease in the production roles is due to development of labour-substituting technologies such as additive manufacturing and 3D printers that can substitute manual task of operators (WEF, 2016)

The impact on other job families is mixed, for instance, maintenance roles can grow especially in eco-green professions such as the installation, repair and maintenance of new plants and systems.

Sales roles are very hit by new technologies as a result of new software introduced such as smart inventory management while, the demand remains stable for the financial and management role in which new skills are requested in the upcoming years.

In future years, the labour demand for the Computer and Mathematical roles will have a boost due to the growth of Big Data Analysis tools.

Roles that are most negatively affected by new technologies are in the administrative professions, which can be substituted by new software which reduce the number of activities that were usually carried out by clerks. (WEF, 2016).

Instead of the dramatic prediction of 2 million of jobs lost, many new roles are continually emerging. (WEF,2016).

As just showed, at the level of professional groups, losses will be concentrated in the administrative and production areas with about 4.8 and 1.6 million places destroyed respectively.

However, the risky jobs are compensated with more specialized tasks that will be required to manage new machines, so it is not really true that the production jobs disappear, but they are changing with new task and activities.

According to the research of World Economic Forum (2016), they will partially compensate the losses with more hiring in financial area, management, computer science and engineering jobs that are more and more required by the companies.

According to some reports (WEF, Caruso and may others), many jobs will be lost and replaced by machines, but at least twice as many jobs will be created that are more suitable for this new system.

Summarising, there will be an increase in the high-skilled roles that are still unable to cover the job losses in the other roles such as in the administration or in the production. It is necessary an upskills and a reskill of the existing workforce in order to avoid additional job losses. (Siegel, et al., 2018).

By contrast, new roles are emerging in the labour market thanks to the space leave by latest technologies which are important drivers for the innovation of a company, in particular two figures emerge, the first data analysts who expect to be very important for companies because they will help them analyse data generated by the technological disruptions. (WEF,2016)

The second role is the specialized sale representative because companies need to promote their products to customers.

Other important new figures need to be mentioned such as new types of human resources and organizational development specialists, engineering figures such as materials, biochemicals, and robotics, regulatory and government relations specialists and commercial and industrial designers (WEF,2016)

The new technological revolution is not only modifying the types of professions but also the employees' skills requested, new digital tools can substitute specific tasks of workers

rather than completely eliminate some job positions and this led to the fundamental role of employees' retraining.

Even jobs which are less directly affected by technological change should require to update their competencies. (OECD, 2019)

Skills change rapidly in line with the disruption of the adoption of new technologies.

In general, problem-solving skills are the most required by companies together with social skills and creative skills.

Other than the technical competencies that are different for each job, the social skills are more and more relevant because people should be able to have always more connection with other people.

The effect of the disruption of new technologies led to a transformation of the workforce, changing the skills required and focusing on the importance of training, that we will treat in the next parts of the thesis.

In several manufacturing sectors, there would be an increase in the level of employment that it is not followed by an improvement in the skills level (Fareri et al. 2020).

The most important investment in the future will be the retraining of employees that entails an increase in the request of certain basic, cognitive and cross-functional skills. (WEF, 2016).

The cross-functional abilities are developed inside the company through the internal training, the cognitive one is related with the educational background and the basic skills can be implemented through the basic education carrier.

It is also fundamental to exchange skills among different roles, for example skills requested for the sales roles can be also important for other roles, people who acquire different skills can give an added value to the company, for their flexibility and their adaptability to new and uncertain situations.

Companies can obtain important outcomes from the introduction of these new tools, if they are able to reorganize the activities and to update the workers skills through the training, these tools allow companies to reduce the physical risk at work for the workers, and an increase specialization of them.

From the OECD research is emerged that low skilled employees are more likely to be replaced by automation than highly educated ones (OECD, 2019).

This is the same results emerged by the research of the World Economic Forum in 2016. In addition, the OECD study showed that the substitutability of jobs is lower in tasks that require high educational background (OECD, 2019).

The research agrees with the Frey and Osborne research, in respect to the fact that the automatability is higher in jobs with a high share of tasks that are related to exchanging information, selling or using hands.

The evidence from the task-based literature argues that so-called routine tasks are subject to automation, whereas interactive or cognitive tasks are less likely to be substituted by machines and computers (ACEMOGLU et al., 2011).

On the other hand, only 9% of all American workers are at risk of unemployment due to the Fourth Industrial Revolution, in contrast with the Frey and Osborne research which showed that 47% of the American jobs are at risk of automatization.

Even in jobs that are at high risk of substitution due to the new technologies, it is necessary to take into account the numerous variations of tasks because also in these high-risk jobs, workers are very irreplaceable due to the fact that they perform not only routine tasks but also other supportive activities (OECD, 2019).

Two important cases have been presented in the research to prove the results.

The first is that according to Frey and Osborne research, people that performs jobs in “Bookkeeping, Accounting, and Auditing Clerks have a risk of automation about 98% but, only 24% of all employees can perform their job without face-to-face interactions”, so people carry out other important activities that make them very irreplaceable.

The second example is related to “Retail Salesperson” that according to Frey and Osborne face an automation potential of 92% but despite this only 4% of retail salespersons perform their jobs without face-to-face interactions.



Figure 3. Share of Workers with High Automatability by OECD Countries

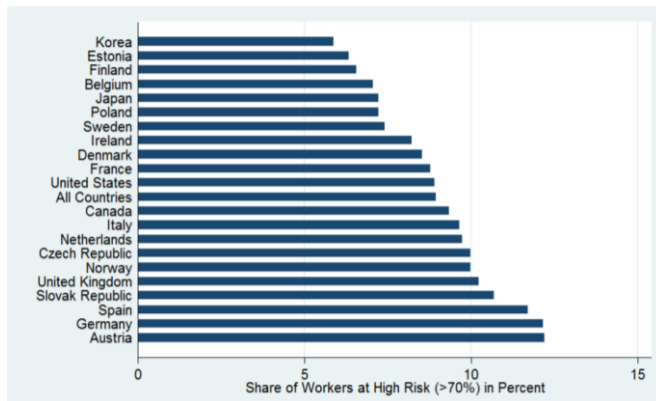


Figure 2 Share of Workers with high Automatability By OECD Countries

Source: Authors' calculation based on the Survey of Adult Skills (PIAAC) (2012)

The figure shows the percentage of workers at risk of automation that belongs to the OECD Countries, and it has emerged that the Austria has the highest percentage (12%) and the Korea the lowest one, but the interest of this research is the Italy that has a percentage of about 9%.

Analysing the figure, it has emerged that countries that have lower percentage of workers at risk, usually focus more on interactive tasks. For instance, jobs in Italy and Germany show low degrees of communication, they are more at risk of automation whereas jobs in the US and UK are more communicative, and these allow workers to resist to the job losses.

Another important consideration showed in the OECD research is that in general, the automation of jobs tends to decrease with high level of education and high income, so the category most hit remain the low skilled and low-income individuals.

The study found that Industry 4.0 is eliminating or completing change certain tasks rather than completely delate the occupations, while it is also true that new technologies create new jobs.

The risk of automatability is lower than Frey and Osborne had previously studied but the automatability change with the level of education and also with the types of jobs, as a result low-skilled workers are the most at risk, but on the other hand, companies can

invest on their retraining of these workers in order to give them new skills that allow them to resist at the automation process and also be more productive in the production process. The results are far from what was expected at the beginning, because workers do not have flexibility and autonomy in the decision making, the processes are not becoming horizontal but on the contrary, jobs are becoming more precarious and less paid (OECD, 2019) as expected by Caruso provisions that underlined the fact that new technologies have disruptive effects that are in many cases completely unexpected.

The most negative part of this Fourth Revolution is the consequence on the employment and the risk of automation for jobs (Caruso,2017).

#### *1.5.4 The effect of Industry 4.0 technologies on the European Regional area*

The Fourth Revolution has an important effect also on different types of European Regions, with different consequences on human resources (De Propriis, 2019).

The globalisation and the technological progress have completely changed the composition of the European workforce with an increase in the high-skilled workers and a decrease in the middle skilled workers.

In addition to the automation of the jobs, the European market is suffering a strong offshoring strategy accomplished by companies which decided to displace the production to low costs countries creating a strong risk for a manufacturing region like the European one.

These two issues presented raising concerns to the competitiveness for the European market.

On the other hand, the adoption of new digital tools has led to a more “smart factories” that need smart workers who are workers entailed in new digital production processes. (Barzotto et al.,2018).

European regions are facing a skills gap indeed, from research of Cedefop’s European Skills and Jobs (ESJ) Survey, on average, 45% of EU adult employees across eight macro groups of job tasks (elementary occupation, plant and machine operators, skilled agricultural workers, service and sales, clerical support, technicians and associate

professionals, professionals, and managers) believe that several of their skills will become outdated in the next 5 years. (European Commission, 2016)

The skills gap is a problem for the regional development because their composition can create economic growth. (Cedefop, 2016).

Skills and competencies are fundamental for sustaining an additive competitive advantage for firms that can collaborate and absorb knowledge from other firms.

The industry 4.0 requires a mix of technical and experiences skills in order to accomplish new digital jobs. As seen previously, the disruption of tools requires to manage unpredictable, uncertain and complex situations in which the technical skills are not enough, but they must be related with problem solving skills. (M. Schafer et al., 2018).

From one hand, the European market has suffered the phenomenon of globalization in which many companies have decided to offshore the production causing a lot of problems in the growth of GDP and creating a period of economic stagnation.

In contrast, the globalization has had also positive effects, many companies have enlarged their boundaries, investing also in completely international supply chains and trading their products in many other international markets.

On the other hand, the European Regions are characterized by the presence of small and medium enterprises in many different territories that operate in the local territories.

Small and medium firms are mainly present in Italy, Germany and other European territories.

They are in many cases, manufacturing or service companies that are family-based facing difficulty to adapt to the global context and also to the digital revolution because they do not possess the right financial, human and cultural resources in order to face important changes.

Many small Italian companies mainly in the Veneto context export the majority of their products so they are slowly entering in the globalization process.

Regarding the digital revolution, the small and medium Italian companies rank far away compared to Northern European Regions, indeed Veneto is in 101st place out of 242 European regions for innovation capacity, according to the report Ambrosetti Innosystem Index 2023.

Hovedstaden Regions is far away from the Italian one, and it is a region of Denmark that ranks first in their innovation process, followed by Ile de France and Stockholm.

The Veneto also lags behind to the other Italian "top of the class".

Lombardy led among the regions of Italy, and it is 31st European place.

They follow Emilia Romagna (52nd), the Autonomous Province of Trento (63rd), Piedmont (92nd) and Lazio (98th). (VenetoEconomia, 2023)

While Italian regions are far behind in innovation compared to other European regions, much has been done compared to previous years.

In fact, the 2016 "Calenda Plan", also known as the Industry 4.0 Plan, has relaunched the use of these new technologies for small and medium-sized Italian companies, helping them to invest more and more in innovation and new technologies that can keep them competitive at European and global level.

New incentives are mainly used by the manufacturing companies that are the core of Italian industrial tradition.

The plan ensures important financial incentives to the companies in order to innovate and it is mainly aimed to small companies that have difficulty to access to the credit compared to the multinational companies that have many available funds.

They are trying to innovate their production processes in order to become more competitive and productive, they also improve the quality on their products, and they are faster in the production also increasing the number of products sold.

For example, in the Veneto region is characterized by small and medium enterprises, the incentives for the innovation of companies have important positive effects on companies. Indeed, many companies have risen their investment on new technologies that are finalized to the readaptation of the manufacturing system.

All provinces of the Region have improved the investment on technologies, as evident from the table, an important data for a country like Italy that for their characteristics is always far behind the other nations for the investments in innovation.

PROVINCE	2019		2020		2021	
	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters	Adopters
BELLUNO	58,8	41,3	47,3	52,7	40,2	59,8
PADOVA	50	50	49,3	50,7	40,7	59,3
ROVIGO	68,5	31,5	51,3	48,7	55,8	44,2
TREVISO	57,3	42,7	49,3	50,7	44,2	55,8
VENEZIA	59,6	40,4	56,9	43,1	47,8	55,2
VICENZA	54,6	45,4	42,4	57,6	39,1	60,9

Figure 3 Percentage of companies that invest on technologies in the Veneto provinces

Source: Rielaboration of Unioncamere data

Moreover, the plan ensures also incentives to the formation of workers.

(Tasich, 2018 [https://blog.osservatori.net/it\\_it/piano-impresa-4-0-principi-iniziative](https://blog.osservatori.net/it_it/piano-impresa-4-0-principi-iniziative))

Finally, new technologies can improve the regional productivity of the European firms, but this must be accomplished with an upskill of the workers that should have new skills to manage new tools, the “smart workers”.

According also with the Assolombardo research is emerged the relevance, nowadays, of the mix skills, not only new technical and scientific competencies are required from workers but also complementary skills such as cognitive, social skills are becoming more and more relevant to face the skills gap in Italy but also in the European labour market.

### 1.5.5 The role of Universities in the Fourth Industrial Revolution

In order to build the suitable skills for the industry 4.0 plan, the higher educational institutions have to play a crucial role (Bongomin et al.,2020).

The role of the universities should be to prepare students to this complex, uncertain and new labour market giving them the right competencies required by the firms.

Not only the universities are fundamental institutions in which new figures can be introduced to the companies but also firm can invest in training and retraining of their

employees in order to ensure them the right skills in a place where new technologies have a crucial role.

In order to close the skills gap, new curricula can be implemented to adjust and renew the old ones in particular many universities courses can be updated in order to meet the technological progress that require new figures inside the company.

The revolution in the education system is called Education 4.0 where there is a combination between new technologies and the education system, in order to develop the right skills for the workforce of the Industry 4.0. (Chiam et al., 2019).

It is evident that investing only in new digital tools does not ensure a better performance or a competitive advantage for firms, but it is necessary that employees must be trained. For years, companies started to focus on the training of their employees because it has been recognized the central importance of employees.

Companies are better able to manage this fourth revolution, if their employees are continuously improving and renovating their skills.

From a study of Anastasia, has emerged that the introduction of new technologies led to lack of right technical competencies that, maybe the technical institutes are able to cover in order to manage new tools. (Anastasia, 2021).

But one other the hand, universities compared to the technical institutes can give to the students the right managerial competencies in order to bring new and innovative ideas and vision in the companies in which young people enter.

This is what is often missing in small realities, they can looking for people that possess the right technical competencies, but they do not focus on investing in new resources that are able to manage changes, they do not have yet the culture for the change.



# **CHAPTER 2: The Impact of Industry 4.0 on the manufacturing system: A focus on the human resources in the Veneto Region**

## **2.1 A brief introduction to the Italian manufacturing context**

The focus on the thesis will be the impact of new Industry 4.0 technologies on the human resources in the manufacturing context of the Veneto territory.

For this reason, it must be fundamental to have an introduction on the Italian manufacturing system and after starting to explain specifically the Veneto manufacturing system.

The Italian Industrial System is characterized by about 4.4 million of non-agricultural companies that cover more than 17.4 million of workers.

More than 60% of companies have maximum one employee and the other one third of companies are defined as micro-enterprises because they employ only 2-9 workers.

The Italian manufacturing context is characterized mainly by small and medium enterprises.

The small companies usually employ maximum between 10 to 49 workers and are 200.000 thousand while those medium and large are 28.000 thousand, that is less than 0.7%: the medium one, represented more than a third of employment and more than half of the value added produced in the territory. (ISTAT, Rapporto sulle Imprese, 2021)

In the European context, the Italian industrial system has reached the largest number of enterprises.

Indeed, in 2018 the Italian companies are the 16% of European one, compared with 12.6% in France and 11.5-11.7% in Germany and Spain.

The high percentage of companies is balanced with a reduced size of companies; indeed, the Italian industrial system has in general small and medium enterprises, around 4 employees in Italy against about 12 in Germany.

In Italy, the manufacturing sector is fundamental because, it generates the 16% of the Italian Gross Domestic Product with 245 billion of euros.



The most important Italian manufacturing chains are those of metallurgy (38 billion of value added) machinery (34 billion) and food industry (30 billion). (The Ambrosetti House, 2022)

Italy is a global manufacturing power: the country is sixth in the world and second in Europe after Germany for manufacturing trade surplus, with a trade surplus of more than 113 billion euros corresponding to 6% of Italian GDP. (The Ambrosetti House, 2022).

The relevance of the Italian manufacturing is seen also at the industrial districts level, in fact through an analysis of European context, three of the first- five super specialized province are Italian, between which Bergamo, Brescia and Vicenza. (The Ambrosetti House, 2022).

Despite the numerous results achieved, Italy from many years, is experiencing a significant decline in the level of productivity.

In order to change this direction, it is fundamental to understand the causes of the negative trend, that are deduced by “the Energies of the system”, that is the efficiency with which input of capital and job are used together. (The Ambrosetti House, 2022).

The multifactor productivity (the Energies of the system) determines the growth coming from the ecosystem: such as the managerial ability, formation, allocation human resources, sustainability, digitalization and the efficiency of the public administration in supporting the enterprises.

The GDP components have two adverse effects, one is that components have helped Italy to increase its GDP during recent years, at the same level of the other European countries but at the same time, the aspects of the Energies of the System have had a negative impact on the Italian growth in these years.

Indeed, Italy is demonstrating is inadequacy to face changes that are required by global and dynamic market.

In 2008, the Italian productive system was hit by a huge economic and financial crisis that have reduced the number of companies and completely changed the Italian manufacturing system.

The main consequence was the reduction of bank lending that has led to a decrease in the level of investment of companies due to the fact that Italian small and medium enterprises have always relied on banks for having access to funds. (ISTAT, Rapporto sulle Imprese,2021)

The main problem of the Italian productive system is the lack of growth in the productivity due to factors such as the structure of companies, the lack on investment in R&D, the infrastructural gap. (Cassa Depositi e Prestiti, 2018)

The double crises that Italy has faced due to the pandemic have further damaged the level of employment and investments.

On the other hand, the diffusion of new technologies and the change in production processes, can improve the Italian situation rising their productivity.

As seen previously, the Calenda Plan has allowed companies to invest in new Industry 4.0 technologies in order to improve their production process and streamline the supply chain making it more flexible. (Cassa Depositi e Prestiti, 2018).

In addition, companies mainly the small ones have not taken into consideration the importance of the training of their workers in order to give them the right tools to face this new system.

One of the most important factors of new technological revolution is the update of the competencies that are required by companies in order to implement digital tools, because these are the reasons why the productivity of Italian companies remains stable and doesn't grow. (ISTAT, 2021).

Thanks to the policies of the government that have incentivized both the level of employment and investment, Italy is slowly improving their productivity.

The Fourth Revolution have important economic and social effects that can completely change also the mindset and the corporate culture, companies now have more possibility to really innovate their activities from all points of view.

Companies, now focus more on the employment of young people, they are willing to innovate and change the traditional concept of Italian company.

The Italian companies are starting to have the right tools to face these crises and to respond with new innovative strategies.

Companies are now completely changing their traditional way to manage a firm because they are transforming together with the society, in particular there is a strong generational change which affect many companies where children take the place of parents in the leadership of the company with positive effects on a new era. (ISTAT, Rapporto sulle Imprese, 2021)

Young people are more aware of the importance of the sustainability and innovation in all processes, there is also an increase in the number of women in companies.

## **2.2 Italian companies invest on Industry 4.0 technologies**

Until few years ago, Italian manufacturing companies are taillight in the investment on Research and Development, because unfortunately government didn't invest many resources on new technologies, this has led to a miss in the more technological intensive activities that are those required high-skilled workers.

After the last crises, the R&D expenses have grown considerably thanks to the strong fiscal incentives that government adopted through the Calenda Plan and PNRR.

In general, the R&D expenses are however below the average, only one fifth compared the German and French funds.

The Italian companies are lagging compared to the other European competitors, but they are more and more investing in new technologies in order to remain competitive in the European market. (Chiaversio, 2018)

Few years ago, the Industry 4.0 becomes important also in the Italian scenario. (Istat, Rapporto sulle Imprese, 2021).

For resisting in the market, companies must invest on innovation and the plan of Industry 4.0 can help them to achieve this goal.

For Italian companies, it is very difficult and risky to invest radically on these technologies but on the other hand, it will be very profitable to gradually implement new digital tools because they can increase the economic value of the company and also their productivity. (Cassa Depositi e Prestiti, 2018)

New investments are very expensive, and companies can balance the potential benefits with the costs associated with the implementation of these new technologies.

It is not only an entrepreneurial assessment of risks, but also a cultural obstacle, especially for small and very small businesses (Cassa Depositi e Prestiti, 2018).

In some cases, Italy is investing more in certain technologies such as Cloud and Internet of Things compared to Germany, France and Spain thanks to ad hoc policies which are

aimed to increase the investment in specific technologies compared to other ones. (Istat, Rapporto sulle Imprese, 2021).

In most cases, Italian companies are in line with the other European countries regarding the Artificial Intelligence and Robot investments.

On the other hands, Italian firms are completely lagging behind for the use of Big Data technologies because companies don't possess the right competencies to analysis the right data in order to possess information that allow companies to make some market previsions. (Istat, Rapporto sulle Imprese, 2021).

AI technologies used by the Italian companies belongs to the "Intelligent Manufacturing" system that is, the use of these new technologies in the production processes in order to optimize the production, make it more flexible and efficient.

From the research of Ambrosetti "The European House", has emerged that among the new "Intelligent Manufacturing" there are four categories of technologies that include: Robotics, Artificial Intelligence, Internet of Things and Cloud Computing.

The Robotics technologies are more and more popular in Italian companies, they are not only useful for streamline the production process but also to manage the logistics and quality control.

Italy plays a leader role in the robotics fields, with an export of 462 million of stocks and this makes Italy the third country by numbers of robots sold, behind only at Germany, and Japan. (Nicola Sandre, 2021)

Robots are not only more and more relevant in the production processes but also in the routine activities that are usually manage by workers.

They can carry out many tasks from the extraction to the elaboration of many data, for this reason now the scenario is changing, the automation is now also involving the workers.

Internet of Things technologies have allowed the communication and the dialogue between human and machines by creating a data stream (Ambrosetti the European House, 2022).

There is an exponential growth of the industrial devices connected through the network, from 800 million to 11 billion.

These technologies are able to monitor the quality, to intervene in case of malfunction of machinery in order to minimise the costs of maintenance.

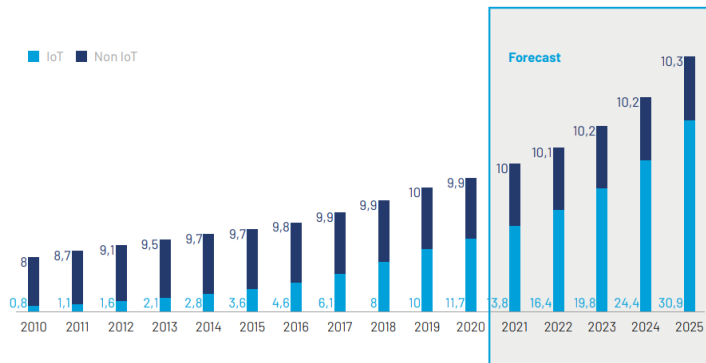


Figure 4 Industrial devices connected to IOT

Source: rielaboration of Ambrosetti from Bloomberg data

The Artificial Intelligence is fundamental, because has allowed companies to have more and more devices and sensors that are installed to production machinery, and they transmit real-time data.

It is forecasted a 422 billion of market for AI technologies because they are becoming fundamental in all phases of the production processes not only in the production but also in the logistics, quality, maintenance, prices. (Ambrosetti the European House, 2022).

All these technologies can have a huge potential to exploit but they must be supported by the correct strategy that should be directed to the innovation.

The last technologies are the Cloud Computing tools that are fundamental in order to have storage services that enable companies the simplification of businesses processes.

The technologies are evolving rapidly in the Italian contexts, with a growth of 59%. (Ambrosetti the European House, 2022).

From the Istat report on the companies, emerged that in the three-year period 2016-2018, 46.8% of companies had made investments in digital technologies, 22.1% with medium or high intensity.

Last data give an idea on the importance of the investments in new digital tools but also on the level of imbalances between different sectors regarding the level of investments. (Istat, Rapporto sulle Imprese, 2021).

At one extreme, in the field of ICT services 73.7% of companies invested in this area and about half with high intensity.

These are followed, with a spread of more than 60% of companies that invest in technologies which belongs to Finance and Insurance, professional, scientific and technical activities and those of Health and social assistance. (Istat, Rapporto sulle Imprese, 2021).

At the other extreme, the activities of Accommodation and Catering, Real Estate and Other services to the person have the lowest percentage of investments in new technologies, about 30%.

Indeed, many new technologies are adopted by companies, in particular Italian companies tend to prefer using technologies like additive printing, 3D printers because they are used to simplify and streamline the production process, they allow companies to lower costs and to improve the productivity, this is because the DNA of the Italian companies is characterized by small and medium enterprises that are manufacturing ones.

In contrast, other new technologies such as the virtual reality and the Internet of Things are still unknown among the Italian companies, as the implementation of them could be radical for companies that should change their technological systems and also, they should think to new business model that include these disruptive technologies.

For facing the shift, companies should rely more on skills and competencies that come from universities and R&D institutions, otherwise companies are not able to understand real potential of these tools. (Istat, Rapporto sulle Imprese, 2021).

The “Intelligent Manufacturing” has specific benefits for companies that are:

First, it allows companies to benefit of more productive flexibility, as presented above, they are better able to satisfy the customer needs that are always more fragmented, and this is possible thanks to flexible production lines and a deeper interaction with the customers that are based on a more accurate data analysis (De Propris, 2019)

The Intelligent Manufacturing is also the answer of a more and more fast market that is based on the efficient production criteria of the “Just in Time”, which is very relevant in the Italian manufacturing context in which many companies produce high-specialized products.

The product life cycle is getting smaller and smaller, companies should introduce new products and services in a limited period in order to remain competitive in the market and to satisfy the customer wants (Ambrosetti “The European House”, Philipp Morris Italia, 2022).

Furthermore, the integration is one most innovative process of the Industry 4.0, that allow companies to connect different processes that before were isolated, making the production process more efficient.

### **2.3 Human Resources on the Italian manufacturing system**

The recruitment of human capital is one the most important factor that describe the positive growth of companies.

For example, in the three-years period 2016-2018, the 58% of Italian companies have hired new employees. (Istat, Rapporto sulle Imprese, 2021).

Considering the contractual types, between the enterprises that in three years 2016-2018 have acquired resources, 70.1% employed permanent staff while 53.8% temporary staff.

From the same Report on companies, drawn up by Istat, emerged that the most important issue in the recruitment of new people in Italy, is the very high labour cost.

Companies spend many resources in the taxation of the wages and this slow down the level of wages in Italy, that is one of worst nations for the wage level.

Another big contemporary issue presented by the 21% of the companies interviewed is the difficulty of finding staff with the required technical skills, and the 30% of them said it is even more complex to find people that have high values.

Most companies have hired people through informal channels, one third through internal information (collection of curricula and database), mainly they hired workers in the Education and Health sectors, and more than 40% in Finance, ICT Services. The other companies focus on private work agencies, and 22.9% active search through ads on the media, on their website, on portals.

New technological tools are fundamental in order to hire people in professional activities, finance, industry and, above all, in the ICT services, characterized by high professional mobility.

More modest are the shares of companies that have acquired new resources through collaboration with authorised intermediaries like entities local authorities, schools and public universities.

Among the various functions of a company, production is the most attractive for new hiring (50.5%), followed by sales (28.6%), the area that includes R&D and Informatics (18.1% of enterprises) and, with percentages between 10%, Human Resources and Management and Finance.

Manufacturing companies are looking for operators that manage the new Industry 4.0 machines.

In recent years, companies have started to understand the importance of incentives, for example ensuring the flexible hours, smart working are now very appreciated by the employees in order to find a balance between the work life and the private life.

It is a more relevant practice after the Covid period, where people have understood the importance of slowing down the frenetic pace of everyday life. (Istat, Rapporto sulle Imprese, 2021).

The ability of enterprises to retain or attract qualified personnel is closely linked to the ability of the same to innovate.

Companies which understand the needs of their employees, will benefit of more positive and efficient workers.

After important crises faced by the Italian workers, they are now more aware of what kind of workers they want to be and looking for realities that are in line with their values of life.

The attention of companies to human resources is closely connected and related with their awareness and ability to use the opportunities offered by technology.



Another important factor for a company's competitive growth is the training because it provides an important occasion to grow and learning new skills. (Istat, Rapporto sulle Imprese, 2021).

Indeed, in 2018, 38% of companies that have more than 10 employees tried to train their personnel, the percentage increase with the size of companies, in particular more than 80% in larger companies, with 250 employees and more, while the percentage drops to 18.4% in small and micro enterprises.

In many cases, training is useful to improve the technical skills of employees, and it is particular important with the rise of Industry 4.0 technologies. (Filippetti, 2019)

The phenomenon of technological transition is more pronounced for companies that have large dimensions. Indeed, the 74% of companies that have more than 350 employees adopted more technological solutions, the percentage is lower to 20.5% among micro-enterprises between 3 and 9 employees. (Istat, Rapporto sulle Imprese, 2021).

Employees of companies active in technological-digital transition processes are mostly hired in the North-West (40.8%) and North-East (26.6%), while one in five works in the Centre (20.6%) and just over one in ten in the Mezzogiorno (12.0%).

In the Italian manufacturing context, the relationship between the adoption of new technologies and the increase of the employment seems to be positive, the demand for highly specialized profiles has improved over the years, in particular figures with technical and scientific competencies (Corò et al., 2021).

In contrast with other research, from a study of Anastasia et al, emerged that the introduction of new technologies does not have a negative impact on the employment but on the contrary, it has a positive effect on the number of low-skilled workers.

The phenomenon is particularly evident in the textile industry, where the increase in the share of routine labour is accompanied by a reduction in skilled workers.

However, in the more fashionable sectors, part of the mechanical work is still necessary to maintain skilled workers with manufacturing skills, which are necessary to create value linked to the artisanal and symbolic aspects of production.

Always taking into account the production sector, our analysis highlights that, even in the most capital-intensive sectors, the adoption of Industry 4.0 technologies is associated with the increase of routine work.

Therefore, intelligent technologies seem to be absorbing production capacities which were previously reserved for more skilled jobs, thus reducing its role in the company (Anastasia et al.,2021).

The research of Pittarello (2020), showed that in the Italian labour market, companies hired more medium-skilled workers compared to high-skilled and low skilled ones.

Another important theme in the Italian system is the mismatch between the supply and demand of skills in all those areas which have been affected by the introduction of new technologies.

One of the biggest challenges is the lack of skills which are necessary, that can lead to decrease in global competitiveness.

The major gap is caused both by the lack of graduates in STEM (Science, Technology, Engineering and Mathematics) subjects and graduates in professional institutes and also because of poor training of already workers. (Ambrosetti the European House, 2022).

The comparison between Germany and Italy, gives an idea of this lag, indeed Italy has only 15% of young people that are enrolled in engineering courses while in Germany more than 20% of students attend these universities' courses.

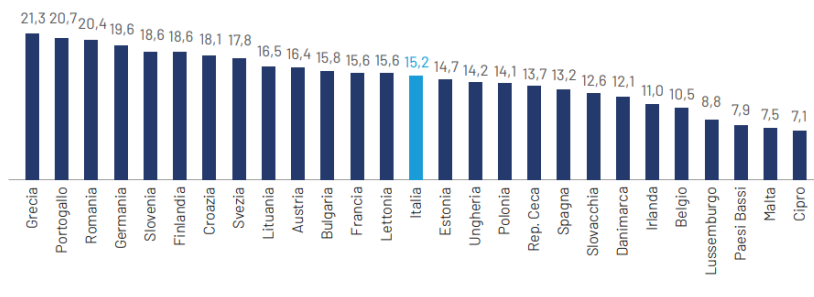
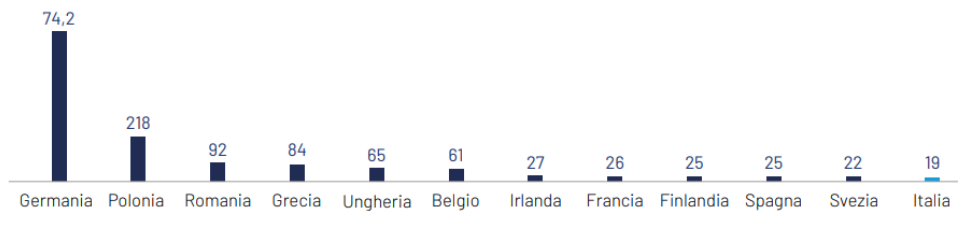


Figure 5 Students enrolled in engineering courses in Europe

Source: Ambrosetti,2022

The same situation is for the graduates in professional institutes, indeed Italy has only 19.000 enrolled in these institutes while Germany has more than 740.000. (Ambrosetti the European House, 2022).



*Figure 6 Students enrolled in professional institutes in Europe.*

*Source: Ambrosetti, 2022*

From one hand, the technical institutes allow companies to easily obtain technical figures which are now fundamental to manage new technologies that require certain skills belong only to specific graduates can possess.

On the other side, STEM graduates allow can lead to companies' new managerial skills strategical ideas in order useful for companies to innovate their activities.

As explained previously, not only the Italian companies do not possess the right people to face this revolution, but they also do no invest in employees.

Regarding training for workers, Italy confirmed its position behind the other European countries.

Italy is the latest country for investing in digital human capital, compared other European countries such as Germany, Netherlands, Portugal, Spain, France.

The gap of digital competencies is not only in the number of workers that other countries employed but it is also a gender gap, because unfortunately, in Italy only 17% of the woman are involved in digital jobs.

Apart from the gender gap, there is also a territorial gap among the northern and southern regions, indeed the former are increasing more their digital competencies compared to the latter one.

The disruption of new technologies requires to find a new balance between technology and workers; indeed 840.000 workers of manufacturing sector are at risk, and they need the right competencies in order to continue and update their job. (Ambrosetti the European House, 2022).

In Italy, new hard and soft skills are always more important to develop with the aim to implement new intelligent technologies.

Skills that are related to the Data Scientist, Artificial Intelligence are more and more required by companies in order to manage new tools.

From research of Ambrosetti that involved more than 150 companies, is revealed that more than 87% of Italian companies want to invest on technologies of Industry 4.0 and they also said that the first obstacle to the implementation of these technologies is the lack of the right competencies, followed by the lack of the right business culture and then the lack on integration of the workforce with these technologies. (Ambrosetti the European House, 2022).

The lack of the competencies is not limited to the digital competencies, but it is also extended to the management skills.

Competencies should be passed through all levels of companies in order to have an overall qualified workforce starting from lower levels inside the companies. (Ambrosetti the European House, 2022).

The introduction of these competencies has to begin not only through the recruitment of young people but also through the reskill of the existence workforce.

In Italy, after the pandemic period it was introduced by the European Union the PNRR: *“The National Recovery and Resilience Plan (PNRR) is the programme by which the government intends to manage the funds of the Next Generation Eu. In other words, the economic recovery instrument introduced by the European Union to remedy the losses caused by the pandemic”* (<https://www.mise.gov.it/it/pnrr>).

The plan includes also many funds for the implementation of the Industry 4.0 objectives, the programme can help them to develop the right skills by accelerating the training and the education of young people and also by streamlining the production processes. (Ambrosetti the European House, 2022).

Besides the important issue of the skills gap, companies have difficulties to face this revolution because they lack the right business culture that means, they are not prepared to face an innovative system.

Many small and medium Italian enterprises have important difficulties to introduce new technologies because they find the resistance of people inside the company, it is more difficult to change instead of remaining in the same routine even if these technologies simplify their tasks. (Valerio De Molli, 2023)

Therefore, companies and regions confirmed the lack of Italian educational system in the developing of new competencies. They have found three factors in which Italy has to start rebuilding their educational system in order to be more competitive:

- The first is fragmentation in the governance of Italian competencies, in fact the policy makers should have the same vision but, in many cases, this is not the real situation because actors are not coordinated in their job, creating a retreat in the technological development. (Ambrosetti the European House, 2022).

There is a lack of collaboration between the ministerial institutions, among who elaborate the industrial policies and who formulate the educational policies.

In addition of this central mismatch, there is also a disequilibrium between the central and local actors and between the public and private sector.

As there would be a strong action to eliminate administrative inefficiencies to develop key skills to cope with the technological revolution.

- The second aspect, as seen before, is the strong mismatch between the demand and supply of competencies because in Italy, there is a lack of graduates in STEM and in professional institutes. Moreover, in many cases, the educational path is not in line with companies requests that want more and more multi-disciplinary competencies (Ambrosetti “The European House”, 2022).

After the analysis of the main aspects, emerged that Italy has a huge potential to grow thanks to its network of small and medium enterprises that are considered very innovative but alongside this can be accompanied to a great willingness to change, to innovate, to exploit the disruption of these new technologies.

Small and medium firms are not an issue but a resource, they represent Made in Italy, they produce products that are highly specialized, exported and appreciated all over the world.

New technologies can only help companies to improve the quality of their products, if they are willing to accept new changes.

In according to the research of Ambrosetti there is the launch of the “The New Deal of Competencies” that is aimed to promote the diffusion of new competencies in order to satisfy the company’s needs.

Regarding new deal, the main proposals include:

Firstly, “Restoring the centrality of technical and scientific education”, because companies in the manufacturing and agricultural sectors are completely unfulfilled about the educational paths and carriers in Italy, that at the moment do not satisfy companies requests, in particular for the secondary and post- secondary education.

There is still a gap between the German and Italian technical education in which Italy should train forty times the current number of graduates to reach German levels.

In addition, a huge underdevelopment of the digital competencies persists, in fact from the results of the Desi index of 2022, shows that Italy ranks third last in the digitalization of human capital compared to the other European countries.

After considering all the aspects, new possible solutions can include a better coordination mechanism between universities and technical institutes and companies, it will be important to organize more and more meeting between companies and universities in order to promote the inclusion of new young figured on companies.

In addition, it will be necessary to provide specific tools for encouraging the diffusion of digital skills among women and men through specific training courses in order to update the skills.

At the end, improving the university orientation, to bring students closer to work and to promote new courses related to the new professional 4.0 (Ambrosetti,2022).

The second proposal is “Encouraging the training”, because in a dynamic and uncertain world, it is mandatory for the workers to update continually their skills through the training.

Nowadays, it is significant to stimulate the training of the workforce and a possible solution it will be, creating master ad-hoc in order to facilitate the coordination between companies and universities and foster the entry of young people in companies.

In addition, strengthen mechanisms to encourage the participation of workers in training courses will be a necessity.

The last request of this New Deal is to “Define quantitative targets on Industry 4.0”, that are related with the qualitative ones, they include the reduction of at least a third of the gap with Germany for ITS enrolled. Furthermore, increase the number of students enrolled in engineering courses by at least 85 thousand people, because it is important to be in line with the other European countries.

## **2.4 The manufacturing system in Veneto Region**

Having analysed the national context for the development of Industry 4.0 technologies and their impact on human resources, the focus will be on Veneto region to better understand the characteristics of its technological evolution.

The section will accompany to the introduction of next chapter, which will treat the interviews of local companies on the Treviso Province.

The companies in Veneto area, are characterized by a huge presence of micro and small enterprises that in many cases are also managed by families. (ISTAT, Report Veneto, 2019).

Therefore, companies in Veneto are not only micro and small enterprises, but they are also family-owned companies. In 2018 firms with 3 and more employees controlled by a family are about 81 thousand, 77.7 percent of the total (ISTAT report on Veneto, 2019).

In the Istat report of Veneto companies 2019, is highlighted that 75% of companies in the territory belong to the micro categories with on average 3-9 employees, instead the small one is the 20% of the total companies and usually employ 10-49 workers. (ISTAT, Report Veneto, 2019).

On the other hand, the medium and large companies are less relevant in the manufacturing context of Veneto, they cover only the 3% of the total companies of the region.

Veneto regions include a higher percentage of services companies rather than the manufacturing ones due to the “tertiarization” process, which has allowed companies to focus more on service industries.

The tertiarization is particularly evident in the Venice province where the presence of services companies counts the highest percentage and minimum number of manufacturing industries (20%) are involved; on the other hand, the Treviso and Vicenza provinces recorded the highest number of industrial companies (40%).

The prevalence of manufacturing companies in Treviso area has allowed the focus on two manufacturing sectors for the case studies.

In Veneto, more than 24.000 companies belong to the industrial sector and the majority of them are in the manufacturing sector, only a residual part is active in the extraction sector.

Specifically, a relevant percentage of companies, more than 11.000, operate in the construction field.

The most important sector is the service one, indeed the tourism is the main force of the Gross Domestic Product of the Region, that cover the 15% of the companies in the region.

The main objectives of the companies in the region, are to strength their competitive position, they would grow on the Italian market but also at the same time they would find new international markets where operate.

Firms have very high percentage of products exported; small and medium companies usually export the majority of their goods in international markets because Italian products are very appreciated in other countries.



In addition, a key point of their competitive advantage is the technological investments they affirmed that in the next years will invest more and more resources in the industry 4.0 tools. (ISTAT report on Veneto, 2019).

Companies in the region, use mainly own resources as source of funding, in fact the percentage of companies that use stock markets is very low, only 3%.

In contrast, they use banks in order to finance by external sources, more than 35% of companies rely on medium- or long-term credit relationship with banks.

Micro-companies rely more on self-financing compared to the other companies because they have limits access to external funds.

In Veneto, companies use mainly external sources of financing in order to improve their production capacity and to cover their liquidity needs.

In the last years, companies that want to invest in new technologies have to use external sources, but many fiscal incentives through the industry 4.0 plan are ensured to small firms.

Small and medium enterprises are often criticized for their resistance to the change but the collaboration with international realities allow them to do a step forward to the innovation.

The small and medium enterprises of the Veneto region consider their principal competitor, companies that operate abroad and not local one.

Indeed, companies in Veneto, are famous for their export activities, they operate with other international partners. Indeed, 57.3 per cent of them operate across regional borders on the domestic market, 35.8 percent on European Market and only, 23 % in non-EU European markets.

In the last years, new investments are made in relation to the technological innovation thanks, to the industry 4.0 plan, that are now at the centre of the economic growth of the region.

Many regional companies, during the period of economic crises, have also decided to relocate their production abroad causing a production crisis and a decrease in the number of people employed.

On the other hand, many companies, in the territory, have hired new workers during the last years, on average more than the national percentage, more or less six companies out

of 10 have employed new workers in their companies, showing great signs of recovery (Istat Report Imprese Venete, 2019).

They have also highlighted the difficulties in the recruiting process; the high cost of labour is a huge problem for companies (40% of companies have affirmed this) that pay a huge taxation for their employees.

## **2.5 The Innovation process of companies in Veneto area**

The report of Istat of Veneto region, stresses that small and medium firms are involved in technological projects with the highest percentage in Italy (44%), confirmed that this region is the most virtuous in the investment of innovation programs.

In particular, the manufacturing companies are more likely to invest on new technological projects.

Among the various projects, most of companies invest on acquisition of right machineries for innovating their production processes.

On the other hand, services companies are more likely to invest on software. (Istat Report imprese venete, 2019).

On out of third of companies in the Region, which have decided to invest on innovation projects, have also trained their employees, while one out of fourth have implemented the R&D inside the company and moreover another 20% conducted personally the marketing for the launch of these innovative projects (Istat Report imprese venete, 2019).

The adoption of new digital tools is considered a key competitive factor by the most companies in the territory, in particular they use them in the sales phase through different platforms but also in the production process thanks to the use of specific cloud services or other manufacturing tools.

Among SME companies, in Veneto area, emerged that the 38.4% of them are using digital platforms in order to have multi-sector commercial intermediation services followed by real estate brokerage platforms and/or tourist services.

The platforms have improved the competitive strength of companies, simplifying many routine processes and, have helped companies to increase the turnover and profits.

They have also invested in particular business software for keeping the accounts and also in cloud services for the data storage.

In the three-year period 2016-2018, companies that have invested in at least a digital technology, are over 15 thousand, more than 63 percent of the total, while the national average is equal to 62 per cent. (Istat Report imprese venete, 2019).

More than 13.000 companies have invested mainly in digital tools, about 1.900 companies made investments related to the Artificial Intelligence. Investments in this field have mainly concerned the analysis of Big Data and Advanced automation.

An important part of these companies has decided to invest in technologies related to the web, indeed 9.900 companies have involved in connectivity projects that interest the use of fiber or the Internet of Things tools.

Cybersecurity technologies has been implemented by many companies, in the years 2016-2018, almost 6,900 companies.

Other manufacturing technologies like 3D printers and simulation have seen a smaller number of companies as protagonists. (Istat report of Veneto region, 2019).

From a case study in Veneto, came up that the implementation of new technologies depends, indeed, on the sector. (Istat report of Veneto region, 2019).

In manufacturing sectors, 37% of the companies use new digital applications and, in the service, sectors the percentage is higher 64%.

Many Veneto's companies know about new technologies, but they didn't try it. For example, the additive manufacturing is adopting only by 10% of the companies.

Typical small and medium companies of Veneto region which integrate the additive manufacturing with the use of 3D printers, they don't impact on labour market, because the knowledge required are very similar to those previously one.

In addition, 3D printing is usually implement for prototyping purposes and only few companies use the additive manufacturing for the creation of finished products.

In many cases, small and medium companies consider the integration of multiple new technologies the best solution in order to have an increase in the productivity, an increase in the customization and a reduction in the costs. (Istat report of Veneto region, 2019).

For instance, some technologies show a higher level of complementarity than others, indeed, potential integration of technologies seem to emerge around robotics, the industrial IoT and Big Data.

Most of SME companies in Veneto, which have spent resources in digitalization confirmed their great successes and results after the implementation of new technologies, that led an improvement of their knowledge and skills.

On the other hand, firms have not improved so much the quality of their purchased inputs but there is a huge margin of improvement, that in many cases companies still don't really know (Istat, Veneto region report, 2019).

Firms in Veneto confirmed that enabling technologies play an essential role in growth and employment, they allow technological improvements that are able to revitalize the production system. According to the definition given by the European Commission, enabling technologies are: *"knowledge-intensive and associated with high Research & Development, rapid innovation cycles, substantial investment expenditure and highly skilled jobs"*.

They include advanced materials, advanced manufacturing systems, biotechnology, nanotechnologies, micro and nanoelectronics, geospatial technologies.

In 2018, 9.2 percent of Veneto companies produced enabling technologies and 14.9 percent of used them.

In the last years about 70% of companies that operate in the Veneto region, have decided to invest at least in one areas of innovation such as the R&D, workers training, digitalization and environmental and social sustainability.

From data, is emerging the will of companies to invest more and more in the processes of technological and digital innovation.

## 2.6 A focus on workforce in Veneto

As the focus of the thesis, another issue of the recruiting process is the lack of transversal skills and competencies belong to the workers, in particular firms in the territory, are looking for people that are competent in the use of new technologies. (Maura Delle Case, 2022),

As found in the national context, also in Veneto Region, it is still present a mismatch between the labour demand and supply, creating a huge issue for the 29% of companies. Many new universities courses are now focusing on these types of competencies in order to prepare the right future workforce, as a result of the last Industry 4.0 Plan where it is mentioned that the most important goals is the improvement of the universities courses in order to ensure skills to the new generations that have to enter in the working world. (ISTAT report on Veneto, 2019).

In the Istat Veneto Report of companies, emerged that training is a fundamental activity for more than 10.00 companies in order to have a higher quality of workforce but also to overcome the lack of competencies.

The training is divided in internal and external; the former is mainly directed to the new employees but also for the constant training, indeed in Veneto more than 80% of companies are involved in this type of training. The external type is more directed to continually train people.

Retraining courses for new staff shall be carried out by a percentage of enterprises ranging between 22% and 29% depending on the type of management.

The Report informs that more than 40% of firms try to carry out training courses in order to improve the competencies, specifically their technical skills of their workers.

Furthermore, among the small companies, only a small part of them organizes courses aimed at improving IT skills, about 17.2 percent implement courses basic and 14.9 percent advanced courses. (Marini, 2023)

The retraining courses are very useful in order to update the competencies of workers and it is a moment of sharing with other colleagues.

To confirm the importance of the employees- training, more than 60% of companies, In Veneto have focused their investments on training and education of their workers in order

to give them the right competencies to face the innovation that is more and more disruptive. (ISTAT report on Veneto, 2019).

Besides the changes in the skills required, new technologies have also an effect on the professional figures required indeed, the research has found that about 16% of companies that in the future will invest in new technologies, will increase the percentage of workers engaged in specialized professional, interactive and communicative tasks.

Companies that decide to adopt them are more likely to hire highly skilled workers (Corò et al,2020) and they are more likely to create more jobs despite the various economic crises that have affected the entire Italian economy.

Firms who are willing to invest in new technologies should create their own ecosystem in which a financial support is very relevant for helping companies to start investing on them. (<https://www.agendadigitale.eu/industry-4-0/industria-4-0-quali-azioni-per-avvicinare-le-pmi-allinnovazione-il-caso-del-veneto-alto-adige-tirolo/>)

An ecosystem that includes human capital who are the central point of the project, as a result, companies must invest on high skilled by strengthening the relationship between firms and universities.

Universities invest on students by giving them the right competencies required by the companies, on the other hand, companies can invest on training their existent workforce in order to give them the new skills requested for collaborate with new technologies.

In addition, the PNRR guidelines highlighted the importance of new and innovative ecosystems that focus on the collaboration between universities, research laboratories, companies and also the local institutions with the main objective to integrate and transfer of basic and industrial research and technologies among different actors involved. (<https://www.agendadigitale.eu/industry-4-0/industria-4-0-quali-azioni-per-avvicinare-le-pmi-allinnovazione-il-caso-del-veneto-alto-adige-tirolo/>).

#### *2.6.1 4.0 Best practices for the Veneto territory*

In order to facilitate the implementation of new technologies, it is crucial to take some actions to promote the Industry 4.0 plan.

Firstly, companies need to face a facilitate access to the capital through financial incentives.

Secondly, Industry 4.0 need public policies that support it, for example the adequate digital policies at local, national and also international level.

Thirdly, the process of implementation of Industry 4.0 needs the competencies and skills of human capital.

They are necessary in order to use digital tools and they should continually be updated in order to exploit better these technologies; they are able to collaborate with technologies.

People are at the centre of the project of the Industry 4.0.

In addition, companies need to invest many resources on Research & Development (R&D) activities, those initiatives are crucial for innovate the entire process.

R&D investments are mostly undertaken by the private firms without the support of the public makers, and it represents the most critical aspect, especially for SMEs, because they don't have enough resources to invest on these projects and they need public funds.

The fifth dimension is Culture, no company will innovate without the change of mindset and to promote an open, positive, innovative vision that support the implementation of Industry 4.0 tools, otherwise people resist to the change.

The last dimension concerns interactions and integration between actors, involve all internal connections and interdependencies that support the realization of the ecosystem, the value proposition, and the development of collaborations between enterprises, universities, and/or research centres.

The six aspects represent a good starting point to drive the analysis of main actions required to support the adoption of Industry 4.0, both at the individual and ecosystem level. (<https://www.agendadigitale.eu/industry-4-0/industria-4-0-quali-azioni-per-avvicinare-le-pmi-allinnovazione-il-caso-del-veneto-alto-adige-tirolo/>).

This is also the focus of the project “progetto A21Digital Tyrol Veneto” that involved also companies in the Veneto region, that try to give to all actors' best practices in order to implement Industry 4.0 tools through ecosystems. (Matt, 2019)

The potential actions are in line with the one mentioned before with some more details. As mentioned before, public policies are at the centre of the project because they support the existing regulations and laws by adapting it to the new technological system through

for example, appropriate cybersecurity legislation that encourages companies and organizations to protect their data.

In addition, it could be fundamental to implement professional training courses that have as goal the learning of new technological tools and to give to the employees the right competencies.

The project has also confirmed what it was explained before in the “New Deal”, that the main goal of is to focus on the change in the school education. (The Ambrosetti House, 2022).

Educational training is at the centre of the research that focus on the Venet territory, the aim is to develop new IT-related programmes and students should be given the opportunity to field test new Industry 4.0 technologies, for example through the creation of small smart factory projects in high technical schools, with the inclusion of 3D printers, collaborative robots.

The change of educational training should be followed by a more intense collaboration among small and medium local companies, universities and local institutions, only then there will be a complete project.

Companies should work together to integrate different skills and competencies that they already have (such as hardware, software, data, or artificial intelligence skills) and share data and information about common products or machines by implementing shared platforms.

It is a strong signal that Italy and all its regions must invest resources in all these types of projects that focus on innovation because, they are the first step to change the old system that characterized the small and medium enterprises in the Veneto region and it can be an incentive to attract high skilled young people who can return to believe in their country.





# **CHAPTER 3: Case studies analysis: eight Treviso manufacturing companies interviewed**

## **3.1 Methods**

### *3.1.1 General context*

After a general analysis on the impact that the Industry 4.0 technologies have on the Italian workforce and in particular on the skills requested in a company, the research will focus on the Veneto manufacturing system that it is characterized by small-medium enterprises.

In the chapter, the focus will be on Treviso province that, from the data emerged to be a medium province for the investment on new technologies.

Treviso is also characterized by mainly manufacturing companies, that usually invest on technologies in order to improve their productivity. (ISTAT, report on Veneto region, 2019)

Treviso represents the national territory regarding the presence of small and medium enterprises.

The analysis aims to understand how SME in the territory manage the technological change related to the Industry 4.0.

The research has been restricted to eight manufacturing companies, in particular the sectors involve are the textile and footwear and the wood-furniture one.

The main aim is to understand the effect of the Industry 4.0 on the human resources in Treviso manufacturing companies.

The sample are formed by four companies of the fashion industry and four companies of the wood -furniture sector.

As studied previously, Veneto is the third region in Italy in terms of value-added and in 2022, it has produced more than 146 billion of euro in GDP.

Treviso province represents the 18% of the Veneto region in terms of value-added, workers employed and number of companies in the total of region.

The value-added produced is more than 14 billion of euro, it workers are 337.000 and counts more than 98.000 companies in the territory.

It is also the ninth province at the national level, in terms of exportation, with a value of 16 million. (Camera di Commercio Treviso- Belluno, 2023, <https://www.tb.camcom.gov.it/content/14724/studi/MonitorEconomia/>)

The economy of the province is mainly driven by services, with an impact of almost 15.488 million of euro, following by industrial sector with an added value of more than 8.930 million of euro and by agriculture sector with 7.467 million of euro produced.

Indeed, one-third of the valued-added, made in the Treviso Province, come from the manufacturing industry, two-third are produced by the services and only a minimum part come from the agriculture.

The province reflects the regional and the national level, but the manufacturing industry is more relevant in our province compared to the national system.

Treviso province counts more than 79.000 companies that employed more than 337.000 workers, the majority of them 37% are hired from manufacturing companies that are fundamental in the Treviso economy (<http://www.tb.camcom.gov.it/>).

In 2022, the export in the province is increasing in line with the national perspective.

In particular, the most important products exported are machineries, household appliances, furniture, footwear and textile products, and then plastic and beverages.

The leading countries where Treviso companies exported are Germany, France, USA, Spain, Romania, Poland etc, that usually appreciated “Made in Italy” quality.

In the last year, the manufacturing production has slowed down because of the energetic crisis, inflation, the Ukraine and Russian War, compared to the 2021 which counted a rapid economic expansion due to the post-pandemic period in which all activities have started again to be productive.

In Treviso, the employment balance is constantly growing in particular in the manufacturing industry, which is a positive data after a negative period of unemployment. <http://www.tb.camcom.gov.it/>).

It is fundamental to underline that among the manufacturing sector, the fashion and furniture industry are positioned in the average as number of companies and as number of employees in the province.

### *3.1.2 An introduction to the two selected industries*

The part describes the main characteristics of the two sectors selected, the fashion sector and the furniture one.

They are, in fact, two symbolic sectors of Made in Italy, Italian quality, design and craftsmanship, where still nowadays is difficult to processes because they are very related to their manufacturing traditions.

In addition, they are two industries very linked to the territory of Veneto and Treviso where they have also brought positive economic results.

Over the years, small handicrafts for both the wood and textile sectors have specialized in a specific phase of the production process. (Camera di Commercio Treviso-Belluno, 2023)

The result has been the development of two great industrial districts of Treviso, those of wood-furniture as well as the textile and footwear that have dominated the Italian and foreign markets for years.

In recent years, they have suffered heavy slowdowns of their activities due to the various economic crises that Italy has faced and therefore they are trying to relaunch themselves on the market by providing a competitive and innovative product.

#### FASHION INDUSTRY

In Veneto, fashion industry counts 9 billion euros of export and more than 9.000 companies that are the 17% of the total manufacturing in the region, indeed the sector employed more than 100.000 workers.

Fashion is, after mechanics, the industry that drive exports of the Region, in general the fashion industry is one of the leading sectors in the country, that ensure wealth and employment especially in this region.

The sector represents the Made in Italy because is the symbol of craftsmanship and quality indeed it is a very diversified sector that involve textile, footwear, accessories and all secondaries' activities.

(Marta Casadei, 2023, [Tessile-moda: 2023 di crescita ma più lenta. E il driver rimane sempre l'estero - Il Sole 24 ORE](#))

Many companies sell their products directly to the final customer such as those in the district of Sportssystem Montebelluna and there are many other companies that produce for large brands.

Veneto is still a territory where the production for the world's leading brands is concentrated, due to the enormous quality of the technical skills accumulated.

It is very famous the footwear District of Montebelluna and Asolo that counts specialised firms in the production of ski boots but also sports shoes and clothing production.

The success of the district is the coexistence of different types of companies from the multinational one, to the more artisan-based company but, in all activities the Made in Italy is at the basis of their competitive advantage.

The importance of this sector is showed by the level of unemployment that falls to 4.1% and the recruitment process in the fashion sectors increase on average by 50% compared to 2021.

Based on the Infocamere data, the Montebelluna district involve more than 249 companies that employed more than 4,750 employees in the territory.

Analysing the latest performance of the industrial district made by Intesa San Paolo bank, the turnover was increasing in the period before the pandemic with a plus of 6% but during this pandemic period the area was hit by an important economic crisis, scoring -13% in terms of turnover. (Ufficio Statistica della Camera di Commercio di Treviso-Belluno, Distretto dello Sportssystem, Treviso).

In contrast with the negative outcomes, the main future perspectives for the industry are to ensure as always ample employment for women.

Furthermore, the main goals of the next years of this industry are the digitalisation with investments in the technologies of Industry 4.0 and also in sustainability.

Nowadays, the sector is still governed by fast fashion where speed and price were the key points for the success of many brands but, even so the idea is to change direction in favour of a more sustainable solution.

The technologies can help doing this process towards a more sustainable business because new technological tools can ensure better controls in all the phases of the production processes.

Moreover, during the pandemic period, many fashion companies have invested in the digitalisation of their processes, introducing many e-commerce channels and also many production and interconnected machines that streamline the productive process.

([https://nordesteconomia.gelocal.it/impres/2022/12/29/news/moda\\_veneta\\_fatturato\\_18\\_miliardi\\_202212437789/#:~:text=In%20Veneto%20il%20comparto%20moda,dopo%20la%20meccanica%2C%20il%20settore](https://nordesteconomia.gelocal.it/impres/2022/12/29/news/moda_veneta_fatturato_18_miliardi_202212437789/#:~:text=In%20Veneto%20il%20comparto%20moda,dopo%20la%20meccanica%2C%20il%20settore)).

## THE WOOD- FURNITURE INDUSTRY IN THE TERRITORY

Italy is the fourth country in the Europe for growth in the wood-furniture industry.

(<https://finanza.lastampa.it/News/2023/04/18/corre-mercato-italiano-del-mobile-nel-2022-confermato-il-primato-europeo/OTNfMjAyMy0wNC0xOF9UTEI>).

The sector counts almost 50.0000 companies in all the Italian territory, and it is driven by the export in other countries such as USA, France, Germany, Switzerland.

Therefore, Veneto region is the second region in Italy, after Lombardia, for the export of furniture goods with a turnover of 7,3 billion of euros,

The sector employed more than 44.000 workers and counts more than 6500 companies that in many cases are involved in all phases of the production chain.

France is the main country where furniture export of Veneto, are traded, registered an increase of 20% compared to the 2020 and, the other main destinations are Germany and USA.

Companies, in the territory, are the first supplier of furniture for the German market with a share of 40% while, Treviso is the first province for the export with the American market with almost 2 billion of euros. (Federlegnoarredo, Pressconference Salone del Mobile,2022).

The district enterprises are specialized in the production of modern furniture, especially the production includes home and office furnishings, niche furniture for hotels and other spaces, window and window frames, panels, floors and semi-finished products and they are localized in the Piave and Livenza area.

The main characteristics of the industry in the Treviso province is the quality, the craftsmanship and the flexibility in the production process but also, these qualities are complemented with important investment in technologies that makes the different phases of the supply chain very automated, integrated and interconnected.

Moreover, companies are always more and more involved in the sustainability topic, they tried to obtain important certifications that show the ecological productive process of their products. (Ufficio Statistica della Camera di Commercio di Treviso-Belluno, Distretto del Legno Arredo Treviso).

The analysis of the Italian manufacturing production showed that, the 2022 counts an improvement in the production and also recovering the 2019 year.

The wood-furniture sector is the first sector in terms of growth with an increase of 8%. (<https://www.confartigianato.it/2022/06/studi-legno-mobili-filiera-del-made-in-italy>) Nowadays, inflation and the energetic crisis are the main difficulties that the sector is experiencing.

In general, in 2023, the manufacturing sector in Treviso is slowing down even if the production trend remains positive and stimulating.

The main reasons are the stabilization of the post-crisis recovery and inflation that is skyrocketing, causing many problems of loss in the purchasing power of final customers. Indeed, in the report of the CCIA (Camera di commercio) of Treviso- Belluno, emerged that consumer goods sectors are the most affected by this slowing down.

In particular for the industry of fashion, the number of orders is negative, -6% on an annual basis for domestic demand and -7.1% for foreign demand.

The wood and mobile is slowing down due to the end of the fiscal bonuses, in particular -2 % is the decrease in the domestic demand but also the foreign one is still registering a drop.

The main forecast for the next months is still positive and Treviso-based companies are ready to face the slowing down.

### **3.2 The Protocol used for interviews**

For making the interviews, the same protocol for all companies was used.

For an in-depth analysis, eight companies were interviewed, four of textile sector and four for the wood furniture sector.

Each company received the same applications which were divided into 4 blocks.

The interview lasted about half an hour for each company.

For companies in the wood sector were interviewed technical managers while for textile companies, two companies decided to entrust the interview to human resources managers while another company there was the logistics manager and for the last one of the owners. Companies selected for the wood-furniture sector interviewed were Pianca, Doc Quality, Top Linea and Veneta Cassetti while for the fashion sector Benetton Group, Tecnica Group, Diadora and Maglificio Giordanos.

The method includes the division of the interview in four blocks, each of these provides different types of questions.

Firstly, some general questions on the main activity were asked in order to introduce to their main businesses.

Secondly, some questions were asked about the type and level of investments in Industry 4.0 technologies, especially the main goals and their outcomes obtained.

The third block is the focus of the thesis, the impact of new technologies on the workforce, in particular how technologies have changed the skills requested in a company.

It is important to understand the difficulties found by workforce, when companies decide to implement new technologies and how they overcome them.

The last part focuses on the future situation of the company, the importance of the territory in their investments.

In Appendix, it is designed the entire protocol using for interviews.

The interview has been submitted to the various companies were selected to be interviewed.

Firstly, companies that are part of the Treviso province are chosen in order to make a focus on this territory.

Secondly, four companies are part of the textile and footwear sector, and the other half belongs to the furniture industry.

The industries are also the core business for Italy, the famous four “A” in Italian and four F in English (furniture, food, fashion and Ferrari).

Italy is recognized in all over the world for the excellence on these industries, for their quality, innovation, craftsmanship, research.

Treviso is at the centre of the excellence of Made in Italy.

In all interviews emerged that among the strategy plan of these companies one of the key points is the investment on technologies.



They will not leave the art of craftsmanship but will be integrated with more and more technologies which will help people in their job task.

### **3.3 A Stakeholder perspective on the Industry 4.0: Confindustria interview**

Before analysing the results obtained from the interviews of the eight manufacturing companies in the Treviso territory, point of view of a relevant stakeholder, Confindustria is explained through an interview.

The interview is made on the manager appointed for the Industry 4.0 project of the association.

Confindustria meeting give to the thesis a different approach compared to firms interviewed because the association usually operate as a support for SME in Treviso, in the implementation of digital tools.

They organize a lot of project and meeting with other companies, in order to raising awareness among the largest number of small businesses about investing in Industry 4.0 technologies.

One of the most important projects, was created in 2020 and it is called "*Assesment 4.0, evaluation of the digital maturity of a company*" that measures the level of digital maturity of a company and also guarantees to company a program with suggestions and proposals to undertake in order to become more and more an interconnected and a digital company. The initiative is supported by the region's Innovation Digital hubs that facilitate greater digital awareness for companies and is coordinated by Confindustria Veneto.

Among 1800 assessment at national level, 64 are made only in the province of Treviso and Padua.

In fact, companies need to be directed in the path that best suits their necessities and they need to understand on which areas of the production process to invest.

This is the reason why Confindustria together with Assindustria Venetocentro have decided to undertake the project, whose model is based on that established by the Politecnico di Milano in collaboration with Confindustria.

Companies on a voluntary basis can participate and external technicians evaluate them relying on their investment on 4.0 technologies.

The main objectives of this initiative are to provide the company assessment of their level of digitalization, and the future step to follow.

The assessment test is implemented especially in the industrial and technical area of a company, where technologies are used more.

The project is crucial for companies, in order to understand if they are using correctly the Industry 4.0 technologies, for instance, if data are used to improve processes, anticipate the actions on the market, make assessments of investment and strategy in the market, avoid errors and improve the various production and business processes.

In the Appendix part, it is attached the model used by the experts to evaluate the company.

After the evaluation of processes, a comprehensive situation analysis and advice are provided by the specialized technicians.

Therefore, the first step involves the technical company visit and the completion of the questionnaire with various parameters to provide an assessment, and then in the second phase the report is presented to the firm involved, with a complete analysis of the digital maturity of the company and with suggestions and proposals to improve the processes from a technological and digital point of view.

Confindustria Treviso has found that in general most companies rated a score of 3/4 considered a very good result with a potential room for improvement.

The fundamental result for the thesis, is that many companies rated a low score in the human resources area because they do not invest many resources for hiring qualified personnel and for their training.

Some companies have also obtained a score near 5, while others are below the average with a score of 2, which means that they must make important efforts to integrate these digital tools in the various business functions.

Among the companies evaluated at regional level, the construction sector is the one with a lower level of digital maturity.

In addition, in the field of wood furniture are present many companies that are a little below average as a level of digital integration of processes.

This turns out to be in contrast with the evaluations that have emerged from the companies that were interviewed in this field since they invested a lot in the automated instruments mainly in the production phase by buying machines that integrate functions.

Among companies with a higher score were certainly those belonging to the engineering and chemical industries.

As for the textile sector in the province, fashion is included in the average as a score, even if, companies are very often performed niche productions, while mass productions are not carried out as it is perhaps easier to find in companies in the wood and furniture industry. It is a characteristic of the sector in the territory of Treviso, where niche markets are relevant, so the human figure is very often insurmountable compared to the machines, hand work is synonymous of craftsmanship and quality, so for this reason, it is not very often easy to integrate new digital and automated tools.

Indeed, after interviewing a small knitwear company in the province, has emerged that they are slowly trying to invest in new technologies in order to have a more automated productive part, but it is still difficult to change the company culture and the risk is to losing value on the market because you miss the craftsmanship and quality.

### *3.3.1 Confindustria perspective on human resources*

In the interview emerged a fundamental and common point in all projects, companies in this territory are investing too little in human resources that should instead be the focus of the Industry 4.0 project.

The paradigm is that in order to have Industry 4.0 technologies, it is essential to have Industry 4.0 people.

In the evaluation of human resources area v often companies reach a lower score than the other areas because maybe they define roles that are not formalized and unfortunately this is still a typical response of companies.

Many companies have invested in machines and want to optimize processes through them but have not formalized projects Industry 4.0 or appointed leaders in the field.

Some companies have made courses to their employees, but it is still something little developed especially in the corporate culture of Veneto.

As seen in the previous chapters, the Industry 4.0 plan include not only financial incentives for the investment on acquisition of Industry 4.0 technologies but also on the formation of 4. 0 people.

In addition, human resources are little involved in Industry 4.0 projects by firms, their skills in this field are not adequately evaluated and companies have no Industry 4.0 training programs.

There are suitable professionals with great skills, but opportunities are not often exploited by companies.

On the other hand, companies encounter great obstacles to change the corporate culture to their employees who are not very willing to learn using these Industry 4.0 machines because they see them as an obstacle to their work or something that will replace them.

Moreover, college-leavers only have theoretical skills but are more eager to learn using technologies while people with more experience who did not grow up in the digital age have more difficulty accepting new digital tools.

To draw the conclusions of this very interesting interview with the head of digital projects of Confindustria Treviso, it has emerged that, if until a few years ago there was an important distrust on the digital world, companies now run in the field.

Another important initiative of the Confindustria Industry 4.0 project is "The 100 places, Veneto Industry 4.0", where companies of the territory exchange themselves their path on the process of digitalization and hosted the other companies.

They confronted each other to improve and help other companies that are taking this path. They are companies that push a lot in these investments and have an important digital maturity and believe that the path of digitalization is increasingly crucial for their growth.

### **3.4 A brief introduction to the eight companies**

#### *3.4.1 The implementation of 4.0 technologies on the four fashion firms*

Among companies of the fashion sector interviewed in the territory, the results are not common, but they possess different characteristics.

The three largest companies that belongs to the fashion industry, that are Benetton, Diadora and Tecnica Group do not produce in Italy but relocate abroad, while the small knitwear factory has its own niche production.

The three firms have not invested in technologies useful to improve the production phase but they have concentrated their resources in tools that can simplify and optimize other

phases of the production process such as the logistics part for Benetton, the digital services of Diadora and the design and development part for Tecnica Group.

The knitwear factory instead is trying to introduce production machines that are increasingly automated in order to speed up and optimize the production process of the garment.

Benetton is a multinational company with more than one thousand employees that does not produce its products in Italy but abroad mainly in China.

It is a company strongly linked to Italian roots and its DNA made of knitwear and colors. Benetton has grown a lot over the years becoming a world leader in the fashion industry, present in more than 130 countries with more than 4000 stores.

In the last years it has invested in new technologies, especially in the automation of the logistic spaces like the warehouse in order to satisfy the request of the customers that more and more buy through the online channel.

Benetton Group is a company that controls its logistic process both for industrial production and for the purchase of finished products and it has invested in the organization and automation of logistics processes with the main objective of achieving the total integration within the production cycle, from orders to packaging, to deliveries. The logistic center in Castrette is based on an automated system with propulsion based on electromagnetic fields, able to manage individual orders from the approximately 5,000 stores in the world.

The company have been investing in the digitalization for 40 years, but the main investment is the fully automated warehouse “Autostore” arises from a need in the pandemic period, indeed the online channel has grown considerably from 400 orders a day to more than 3000 so, in this period they created an automation that could meet the needs of the company to speed up the logistics process.

The main objective is to optimize storage capacity and order fulfilment and accompanying the future development of the business.

The new platform makes picking operations more efficient, flexible and agile, indeed it reduces the space required, improves picking times and extends the useful life of logistics facilities.

At the top of the structure, there are 53 robots moving the containers to 12 picking and packing stations on the front of the structure, where operators can work more comfortably, without travelling long distances.

It is a technology that follows the rules of the Industry 4.0 plan, it has allowed the company to have a faster return on investment, and to face the investment more lightly also from a financial point of view.

Industry 4.0 served as a facilitator in the purchase of this automation, otherwise it would have been configured differently, it has been a booster for their plan of investments.

The second company presented, Maglificio Giordanos is a traditional knitting factory that has artisan origins even if it is considered a medium enterprise as it has 60 employees.

During the years, not only they keep its craftsman spirit, but they also made investments on Industry 4.0 technologies, they are now more connected in their production phase.

They said that it is a long path the digitalization and for the moment the results are still not, a change must be made from the organizational point of view in order to reduce the strong resistance of employees.

Not many knitwear companies are ahead in the digitalization path because craft reality still operate with handwork.

It is a company born in 1948, founded by the is mother in fact they are a family business, and it is now carried out by three brothers, who have many plans for the future.

A company that, has an employee's age range from 20 to 60 years with different seniority of service, with more than 10 nationalities and purely female.

They are specialized in high-end knitwear product, aimed at quality product, they work for major fashion brands, and they are directed towards products done well and lasting over time.

They operate in markets that wants a fashion but that has a superior quality considered premium.

They have a started a path with Industry 4.0 technologies especially for production machines in the weaving industry, it is a special Japanese technology to make knitted fabrics, they are connected and have obtained a certification.

A path requires a change of mentality; indeed, they approached new technologies to have an organizational change.

Diadora is the third company involved, with a strong attachment to the territory, it belongs to the footwear sector of the Treviso area.

It was founded in 1948, as a company that produced mountain boots, then the family decided to change to the sport sector.

The company has dominated in the field of sports system in the years 70/80/90' in particular in the field of football shoes, they have created the first coloured shoes and also the first shoes with sock to meet the needs of the footballer Marco Van Basten.

Over the years, large competitors have entered in the market causing a severe crisis and decline for the company that in 2009 was acquired by the Polegato family.

To date, the company lives three business lines: performance sports (running, tennis and football), lifestyle part with a very high-end line and the high-end utilities section.

The reference markets are Italy and Europe and for sport performance, they are really strong in the USA, where there are many strong competitors.

The firm has introduced new technologies to simplify people's lives, they have implemented business process automation software aiming to digitalize the entire process and workflow, eliminating paper, operators are relieved of many tasks that were still carried out on paper.

The new technology has positive consequences in terms of efficiency, employee's well-being and sustainability.

Sustainability is not just a marketing theme, but they actually believe that something can be done for future generations to have a positive impact on the environment.

They have eliminated kangaroo skin in football boots, and they were the first company to do so, going even in contraindication.

In addition, they introduced a platform for the centralization of help desk activities in order to respond quickly and efficiently to the issues of internal customers or employees of different areas, to provide them support, gather all the information and facilitate the work of operators.

They also have artificial intelligence in view of machine learning in the sales area; in fact, the tool includes modules of business analysis and predictive analysis, that allow them to be more responsive to the market and to define errors.

Furthermore, they are working on the introduction of the SAP Concur module, improving life for people who travel, as a result it lightens the activities related to the expense note, which are still managed through Excel sheets.

While the SAP module allows firm to merge these activities in a single software through travel booking via smartphone.

Simplification is the greatest result of new digital technologies, they amplify the quality of time that people spend in the activities, that before were too repetitive.

They are trying to eliminate the amount of work but focusing more on the quality of the work, improving results and be more performing.

In the HR field, they are also implementing a budgeting and labour cost related tool in order to disconnect from Excel sheets and have a technology that dialogues with payroll providers around the world, trying to centralize all activities related to the cost of labour in one software and elaborate the budget for human resources.

Tecnica Group is a leading company in the world of sports system, it manly develops equipment for winter sports and footwear.

It is a Group that is composed by Bizzard and Nordica that deal with skis a, while Tecnica group follows more the part of the boots and there is also Tecnica Outdoor that follows sports footwear, at the end Lovat leader in the mountain sports footwear.

Two other brands, Rollerblade and Moon boot, also moved into a more fashion market and vision.

Tecnica group follows all these brands from the design and creation to the marketing of the products of each brand through the final consumer or e-commerce channel.

As for innovation, the company is always attentive to new market trends when designing its products.

The company has reacted to the Industry 4.0, investing in the Research and Development of products, in a perspective of digital transformation of the whole company.

The world of the boot is a particular one as it combines many different technologies, different skills, indeed, boots are composed by hard components (plastics) and soft components (shoe inside).



Since the boot was born from the soft part and evolved into more hard components, in the past the realization was done in a very artisanal way, prototypes and mock ups were made by hand.

The modus operandi happened up to a few years ago while nowadays the company introduce the opposite process where, first the realization of the plastic design component is made to CAD (computer-aided design) then the prototype and finally the mold takes place.

The digitization took place, about ten years ago with the passage of the design of the boot in 3D.

Subsequently, once the mathematical model is made, the process of making the prototype through 3D printers is becoming digitalized.

In fact, the company is investing more and more in the 3D printer machines.

The prototyping phase can have several more functional and aesthetic declinations and with more or less small components; therefore, as 3D printers have evolved, the company followed the innovations and invested in them according to the needs of the company.

Two macro-trajectories for the future, one is to implement 3D printing in the perspective of functionality because prototypes are still not skiable; therefore, they will try to get to have digital prototypes with 3D prints already functional.

The other development path of digitalization will be that of the study of finite elements which is already widespread in the automotive sector, where it is possible design the 3D piece to computer and in addition allow you to simulate the stresses that pieces have in the use phase.

A further development possibility in the field of digitalization will be the one in the aesthetic field that will allow to have all the colour variants in digital without having to realize many prototypes that will waste a lot of time and energy.

Innovation for the firm goes beyond the product but also focuses on processes, not only introduction of machines such as 3d printers but also the implementation of computer tools applications such as SAP, in all business processes.

The key project is to have IT tools within the company to be increasingly competitive against competitors.

They are working on the concepts of sustainability, through a project to give a second life to ski boots with the aim to make the product recyclable, technologies are used as a means to obtain an increasingly sustainable product.

Among the strategic pillars, there is an important digital evolution in order to achieve higher goals such as being more sustainable and integrated and connected between the various groups within the company.

They invest in apply technologies to get directly to the end consumer, as through e-commerce where technologies are fundamental with the aim to understand his feedback and anticipate the trends and new needs.

All aspects of digital transformation have evolved over time, focusing on the investment in new IT tools.

#### *3.4.2 The implementation of 4.0 technologies on the four furniture firms*

Among Treviso-based companies interviewed that belongs to the wood-furniture industry emerged that they have many common points.

Indeed, all four firms have invested in Industry 4.0 technologies that make the production completely automatized, in order to become more productive and flexible.

The first one is Pianca, a Treviso - based company, which belongs to the furniture industry.

It was founded in 1956 and its core business is the production of living rooms, kitchens. It employed more than 350 workers, 100 located in the main headquarters and others located in other production plants.

It is a manufacturing company that has a position in the medium- high market producing also for third parties but mainly work directly on the final market.

Since the early 2000s, they began to use machineries that were interconnected, which took orders directly from a graphic program and then processing in order make orders on the panel producible.

Production machines are more and more interconnected to ensure an internal control and also an important data exchange that is useful to anticipate the trends.

The main methodologies used are database entries for the means of production while, they spec invest also in PLC devices that communicate with the server to provide information on energy consumption.

The process is mainly automatic from the order to the production, the operator should simply insert the required parts inside the machine and control the process.

Workers controls also the quality of produced pieces, but they are little aware of what the machine is doing, they are no longer artisans.

For many years, they have invested in technologies because the demand of the market requires more customized solutions, indeed it is necessary to make digital investments in order to distinguish themselves on the market.

They were interconnected 4.0 already when Industry 4.0 was not yet a project of the Italian government, indeed after that moment, they adapted their machines to the rules that the industry4.0 technology plan provided.

New technologies improve the competitiveness of the company, in order to better respond to customer needs and to be more flexible.

Through interconnected machines, company can develop more complex products that were previously impossible to produce except with the craftsmanship.

All the competitors of the territory are going in this direction, trying to invest more and more in new technologies and buying machines that allow to automate the production.

The second wood-furniture company, TopLinea, started its activity in 1982, it employs more than 80 employees and since its foundation has grown from 1,200 sqm to 30,000 sqm covered, adding a new factory with several new production lines.

TOPLINEA S.p.A. is a leading company in the field of components for home and office furniture.

It deals with the production and direct sale of semi-finished products for the furniture industry (doors/ tops for kitchens, furniture for living rooms, bathrooms and bedrooms).

The internal processing cycle is highly automated, while local contractors is used for particular processes, thus fully exploiting the advantages of the Treviso-Pordenone furniture district.

TOPLINEA S.p.A. holds international patents for the realization of special types of processing on the profiles of doors/ floors. Even nowadays, the research and development

part, on the product, on the production cycles, the raw material, represents an important part of the budget and resources, which the company commits.

The clientele counts the most famous kitchen brands of the "Made in Italy", so much that the product is aimed at a quality target of medium/ high range.

The company is present on the international market and operates in several European countries, Japan, China, South Korea, Qatar, USA, Australia, Iran, UAE.

The products are marketed in these countries without the presence of branches and the total annual turnover of sales abroad is about 8.2 million Euros.

For the promotion, it participates with its own stand at some national and international fairs such as: SICAM Pordenone (October), INTERZUM Cologne (D) (May), ZOW Bad Salzuflen (D) February.

The expansion, however, presupposes a strong propensity for technological innovation: internationalization means preparing for a continuous confrontation with global competitors and those who constantly innovate their products can better market them on foreign markets.

Their product consists of kitchen or bedroom door and kitchen countertop mainly, they sell 55% of their products in Italy, for the rest, they count on Europe and outside the EU, mainly Australia.

They do not have many employees, about 80 halves are between office and warehouses while the others work closely with the machines in production and are distributed in production sites of huge size.

The company was automated about 20 years ago and since 2008 in particular, 16 out of 20 machines are automated.

Nowadays, machines must be connected as allow to have more efficiency in the work, to monitor, to determine the performance and to check any faults and prevent them.

Their production begins with the sectioning of a whole panel, the pressing and processing, drilling and cutting, the only part not yet interconnected is the packaging because it is a manual operation.

The interconnection allows Top Linea to optimize the production, at all stages of the production process.

Indeed, it is the software that in the phase, for example, of sectioning indicates in how many parts to cut the panel in order to maximize efficiency and avoid waste.

Already in the 2000s in this sector, there were many production machines that were interconnected and automated, especially in the cutting phase.

The reason that drove the company to invest in new technologies is to stay in the market, competitors are all in the same direction.

In addition, digital technologies have allowed an increase in productivity, better fault management and therefore to have less production waste.

Everyone knows what competitors do and they all move in the same wavelength required by the market.

Veneta Cassetti is the other company, a small and medium enterprise of the wood and furniture sector and mainly produces drawers and it now employs more than 30 workers. Starting from the raw material to the finished product that sell to the final consumer, they are not subcontractors.

The automation process is already working in 2014, thanks to the consulting firm Projecta.

They laid the foundations for today's Industry 4.0; indeed, the firm was already automated before the Italian Industry 4.0 plan materialised.

In 2018, they made the most important investments in the purchase of production machines and the Industry 4.0 project helped them economically.

They continually invest in new machines, starting from the acquisition of an automatic loaders for the squares and the automatic unloaders but also a drain for the line of recharge.

Moreover, they invested in a machine with an automated discharge and then also in drilling machines.

Even in this period, they are trying to acquire right machines which are always interconnected in order to remain more and more competitive in the market.

Thanks to the Industry 4.0 technologies, they obtained lower costs, decrease the production time and improve the data available for process control.

Machines offer a lot of data that can be consulted daily and make accurate forecasts and analyses.

In the future, the company will invest more and more in these technologies in order to stay attractive in the market.

The last company is “Doc quality elementi per il mobile” leader in the field of furniture and wood that was recently acquired by another bigger company.

It produces semi-finished products for furniture manufacturing such as doors, drawers, shell of cabinets, kitchens and offices and work mainly as contractors, they do not work on design but on finished part of the process, but soon they would set up a design office to internalise also this part of the supply chain.

They work mainly on order using materials such as chipboard in order to realize the finished product, they try to be more sustainable using products that come from controlled wood.

Customers require a lot of quality certifications in order to prove that materials are environment friendly.

Main activities include material cutting, squaring, edging and drilling, not making assemblies and at the end, the semi-finished product arrives at the customer and starts from a panel.

It is a company of about 80 people and, but they employ also 100 workers during the peak period.

In 2017, the company was still almost exclusively manual but from that year, they began to grow acquiring interconnected machines.

Companies have no future without interconnection, in fact automatized productivity has increased the level of work from 25.00 panels per day processed to 60.000 per day within 7 years.

Mainly, they are edge banding, squaring machines and drilling tools.

Industry 4.0 technologies have given the flow, firm always know where it is, a total control of what is happening, from the warehouse to the finished product, has been reached.

New technologies have guaranteed greater flexibility, greater control and also greater quality avoiding errors and bottlenecks.

### **3.5 The workforce analysis on selected firms**

The eight companies selected distinguish for industry, size, culture, number of people employed and especially for their different investments in Industry 4.0 technologies.

On the other hand, they all have invested in digital tools in order to be more competitive in the international markets, to increase their productivity, to be more flexible, to reduce the percentage of errors and to streamline processes.

The key point of the thesis is the impact of Industry 4.0 technologies on the human resources considering these companies.

The third and the central part of the interview made to the eight companies, focuses on questions about the effect on human resources of new technologies.

In fact, questions submitted include:

- Among the technologies used, is there any relationship and impact on human resources?
- Did you first invest in human resources and then acquire technologies? Or did you realize after there were human resource changes to be made?
- Have you had any difficulties? And how did you overcome them?
- What kind of skills are needed? Did you change the competencies required after these investments?

First of all, the results are varied among the two industries considered.

#### *3.5.1 Human resources results in the fashion companies*

As seen in the presentation of the eight companies, the fashion firms have very different characteristics each other's, also emerged in technologies investment as they decided to implement different tools.

Regarding the impact on human resources among fashion companies, the results show common points and also some different visions.

Benetton Group, Tecnica Group and Diadora are enterprises with an international supply chain while, Knitwear Giordano's counts on an Italian production of their products, they are trying to implement technologies for improving their production quality.

Benetton has chosen to invest in technologies to optimize the logistics part of their supply chain.

They found that new technologies have created an important upgrading of the work quality, indeed robots and the automatized machines for the logistics, simplify people work also at the ergonomic level, workers are less tired and more productive.

Operator is more confident and driven during their daily activities, it is not necessary to invest in long periods of training as in the past, but she/he is driven by a system based on screen-driven technology that guide people in their actions.

Benetton technologies have simplified daily-activities of logistic workers.

In addition, automatized technologies have allowed greater flexibility, decreasing the temporary work requested because the automatized system is ready to face even peaks of work.

Investments in more automated logistics have not decreased the number of people employed but have changed the type of their work.

They did not recruit new staff, they try to grow the staff that they already have, both for the more routine and technical work but also for more managerial jobs.

The disruptive technological revolution is accompanying with an important transformation of the personnel, who now carry out very digitalized activities, changing their skills.

Competencies have been simplified, changed and updated in order to simplify employees work and to have more control about their daily activities.

A common result among companies is the initial resistance by people.

At the beginning, workers are not willing to accept the introduction of new technologies because they fear being replaced by them.

On the other hand, after a period of training and an important work in the business culture, the majority of workers changed their opinions and believe in the power of technologies. Nowadays, the Benetton logistic managers said that it is very difficult to find technical figures with adequate skills and companies usually steal each other's, in addition also operators are difficult to hire.

The lack of technical figures is common point in all interviews.

In general, new investments depend on the culture and size of the company.

People easily accept new technologies if the company is able to create the right corporate culture, they have to understand the positive aspects of new way to doing business.



For an international company like Benetton is easier to invest large quantities of financial funds in Industry 4.0 technologies, but it is fundamental that incentives for the industry 4.0 are used also by small and medium enterprises that are trying to be more innovative and competitive in the market.

Large companies can train the other smaller companies in order to have a track to follow in this long path to the digitalization.

In the future, Benetton is working in new projects in order to automatize more and more the logistics process and human resources remain at the centre of the initiative.

Diadora is another international company with an important relation with the territory, which invest in technologies for support the non-productive activities of the company.

At the beginning, like the Benetton case, new digital tools are seen as a kind of “enemy” by people due to the substitution fear even if, digital instruments simplify the work of people and allow them to save a lot of time, speed up the work, increase the productivity, avoiding excessive manual work.

Diadora but also in Benetton, Tecnica Group and in the Knitwear, Giordano’s believe in the growth of people together with technologies through employees training.

Before introducing a new technology, people should become aware of new tool in order to understand their positive and negative aspects and start to appreciate it, in fact training is fundamental to learn how to use the new tool but also to do a step forward to accept the change.

In the territory, according to the HR Director of Diadora, new technologies are being implemented in companies in a patchwork and there is not a unique awareness of the advantages of digital tools.

Diadora together with the other companies interviewed in this industry, believe in the development of system that allow also small firms to invest in digital tools.

They believe in the power of Confindustria, that organize a lot of meeting in order to introduce, small firms in the new world and they try to invite also many international firms like Benetton, Diadora and Tecnica, in order to share an international vision of this change that can be an example for other realities.

Diadora believe in the collaborations between universities and companies, indeed they promote many internships in order to train students.

Benetton has a warm-up initiative for internship and then after a period of instruction, company usually decide to hire the student in order to grow inside the company.

They think that young people can change the vision of the company, providing a new innovative perspective that can change the long-term strategy of the company.

Moreover, Tecnica Group and also Knitwear Giordano's rely more and more on new skills and competences of young people, they are trying to implement some collaborations with universities and technical institutes in order to introduce young people in their companies.

There should be much more collaboration between universities and companies, to reduce this skills gap present in the territory.

Diadora tries to balance young resources together with more experienced ones, having many projects also with product creation institutes.

For the future, it is very important to consolidate the instruments already in without removing humanity to the process, otherwise the risk is a process of depersonalization of the activities; therefore, it is very important to balance technology with human resources, trying to get people to collaborate a lot within the companies and with the machines.

Tecnica Group is another large company interviewed which operate in many international markets.

Tecnica is investing in many automated and interconnected software for simplifying all activities.

For various changes, is required a transformation of the skills of company's staff, indeed they are used to work with many Excel files but now the company is introducing new management software such as SAP and apps that will connect the whole functions of the firm.

Skills are changing also in the R&D function; indeed, they have decided to invest in technologies like the 3D printers that change completely the design phase of the ski boots. During the years, people are used to design the ski boots manually with physical prototypes, nowadays the investments in digital tools have allowed Tecnica to have 3D prototypes.

Young employees have adapted very quickly to digital change, while other more resistant employees' company has decided to train them more and now, they have understood the importance of change and they work very well with new automated machines.

It also depends very much on the background from which people come, their attitude and motivation and it depends also on what the company transmits to its employees.

As confirmed in the previous interviews, the process can change skills and develop new competencies but on the other hand, for many people could create a situation of fear.

People need time to accept huge transformation, and, in many cases, they also have negatives emotions about new tools because they have difficulty to understand how these tools work.

As the same for the other fashion companies polled, the gap between what an employee was before and what is now is tied with training directed at the staff.

All companies are agreed to the fact that the digitalization process it can be followed by a change of mindset, of corporate culture, they have to work on deeper concepts of the organization in order to change the culture of the organization.

Tecnica started an interesting project called SOFT ("Shape in our future together") to listen to people and guide them to the change, by submitting online questionnaires to understand the parts of the digital process that should be improved according to their point of view.

It turned out that one of the aspects to be improved in this process is the communication company has to involve more people in the process of digital change.

If the company can involve more people, they are more likely to accept the implementation of new tools.

Tecnica required technical and transversal skills to their employees to adapt to the process of evolution.

It is crucial to involve more people in the process, to have empathy with them and they require the same from their employees that have to relate the cognitive skills with the technical one.

For Tecnica, the digital transformation is a common direction that other companies also have; in fact, many companies include the digital process as a priority in their strategic plans.

It is the task of every single company to find the way to implement them in the right way and change the culture and corporate mentality in favour of new technologies.

Together with Benetton, Diadora, also Tecnica group believe in the collaboration with other companies, to raise awareness on technological change and to help smaller companies to innovate.

Tecnica consider essential the collaborations with universities to bring the two worlds closer together, for instance through company's lectures that can help students to enter deeper in the business concepts.

ITS (technical institutes) could be more implemented more as a result they diminish the gap of technical competences and give the right skills to the future workers.

They are usually less theoretical and more practical compared to universities, creating a deeper exchange between company and institutes.

The last company interviewed that belongs to the fashion world in Treviso is the Knitwear Giordano's that is the smallest company interviewed.

It is a small company that have a niche production of high-quality knitwear, and the core part of their business is to keep this artisan heart, and the Industry 4.0 goes to impact in this sense.

They have started to invest in new technologies for two years, and they cannot see the results in this moment.

The company has different visions inside, many people have accepted the introduction of new tools, but the majority are creating an important resistance to the change.

The phenomenon is more visible in these small realities that have a traditional vision that can lock-in the possible growth of the company.

Confindustria project are essential in order to open the possibilities to small firms that should innovate their activities.

In a small reality like the knitwear is even more difficult than large companies to introduce such big changes and people are very wary about the presence of technologies.

Technology, together with experience and knowledge, can do great things, but it takes time for both sides to be able to agree.

The use of the machines has not been complicated but in an artisan reality, is complex the process of acceptance, people are used to work with hands.

They are trying to change the corporate culture with important training courses but also listening people and their opinions.

For companies that make built and tailored garments, it becomes difficult to use mainly technologies because for some parts the manual work is still relevant.

People should update their skills in order to grow with the company, indeed the firm believe in the collaborations with universities and specialized institutes in order to innovate its culture and mindset and have a new vision.

For the future they are open to new investments, but they have to make some small steps in order to ensure optimal results.

### *3.5.2 Human resources results in the wood-furniture companies*

The other companies interviewed belong to the wood-furniture industry in Treviso territory.

Companies questioned counts very similar characteristics in terms of size, number of employees and investments on Industry 4.0 technologies.

During last years, they have invested in automated technologies for the production part of their supply chain in order to make it more flexible, optimize their productivity, reduce the errors and to eliminate the production waste.

In all companies interviewed emerged that they have production interconnected machines that manage all phases of supply chain from the order to the finished goods.

The manual part of the work has been completely eliminated despite people build furniture were considered artisan but nowadays they carry out more digital tasks.

Workers manage and control a digital machine that can produce all parts of a furniture from cutting part of the wood panel, edging, and drilling.

The interviews show that all companies have experienced many consequences on their human resources after the implementation of new technological tools.

Analysing the first company Pianca Spa, that transform the production process from manual to automatized.

Considering the other three companies interviewed, they have noted the same changes, all firms substitute their manual production with an automatized one.

Nowadays, artisan people are very rare, machines created more similar pieces missing the uniqueness of the production ensured only by manual work.

On a human level, a little manual skills and product competence have been lost, but much more has been acquired on technical and digital skills.

Companies look for someone who is smart with the use of machines and in some cases, the new role of the production operator can be considered too repetitive, but still required necessary important digital and technical skills.

Until a few years ago, operator had not attended schools, but they had only learned by doing, while nowadays, almost everyone has attended at least some technical or professional institute.

All companies have trained their employees to use new digital tools in order to have more confidence with their operation.

People with more experience are moved to new machines in order to advance and learn something new and they have tasks to explain to the new workers how to use and manage automatized machines.

It was found that companies train their employees in order to learn how to use a new technological tool, but they do not focus on a completed formation of the personnel regarding the Industry 4.0.

As in the other companies interviewed also, Pianca employees initially try to resist to the new tools but after many years, the company revealed that their workers could not work without them.

As found in the interviews with fashion companies, also furniture firms have important difficulties to find people with specific skills especially in technology world.

They still have many theoretical and not very practical skills as a result company has to invest a lot of resources and time for their training.

In addition, also in the wood-furniture companies, the collaborations between technical institutes, universities and companies are very important; indeed in 2020, Pianca had 15 university students (computer scientists, management engineers) who have brought innovative ideas for the company.

Top Linea is another company specialised in the production of furniture in Treviso province.

They invested in technologies that make the production more automatized and interconnected.

They exposed the disruptive relationship between human resources and technologies, as even the simple worker is always accustomed to using the technologies in his daily life, so he expects that even in his work the use of it is fundamental.

Therefore, employees are no longer afraid of technology but rather they collaborate with them, people do not expect to work manually but they must program the machine and operate it.

The company is investing in new technologies for many years and their workforce is used to operate with new digital tools, do not suffer anymore of “fear of change”.

Training is continually fundamental in order to take confidence with technologies, employees remain always updated through formation courses.

An important result reached is that looking at their historical data, they are now producing much more than 20 years ago and having automated a lot over the years, but the company has more employees.

So, it is only a myth that technologies substitute the human resources.

Initially, Top Linea has experienced the difficulty of accepting new technologies for fear of being replaced.

Another common issue for all companies is the difficulty, in recent years to find staff, especially the technical one, they miss the use of a machine skills that require a minimum of mechanical skills.

Until 20 years ago, technical expertise was required only in the metalworking sector, nowadays also in the furniture one, and cannot be found because there is a lack of technical skills in the territory that are increasingly required by automated companies as TOP LINEA.

Young people who will enter in the company must be trained in order to understand the mechanism of the technologies used in the production.

Top Linea, believe that the ITS that are specialized technical institutes are essential for proving the right young technical figures.

The firm thinks that also Italy as the German program, would improve the technical institutes because they are fundamental to include right people with the right competencies in these companies.

Veneta Cassetti like all the other six companies polled, experienced a devastating impact on human resources when they started to invest in technologies for the production.

Indeed, older employees who had always been used to work manually and physically see themselves surrounded by computers that are not always easy to use for them, for this reason many have quit their workplace.

Therefore, they have not been able to adapt to new types of tasks, while many others have conformed very quickly, and they feel facilitated in their work.

The company has tried to facilitate the transformation process by giving to their employees the right tools to face the change, in particular they invest a lot of resources, like other companies, in training.

In the last year, it is very difficult to find staff since there are no suitable figures, with the required skills.

Young people who are willing to work in production are nearly impossible to hire and the few who have been hired have not achieved good results, they have difficulty using a computer on a production machine.

There is a lack of basic training from high schools and for this reason Veneta Cassetti has in many cases provided internal training to the new young employees.

The company believe in the possibility to cover the gap between schools and companies, and it is ready to meet schools in order to invest in young people.

The last company interviewed is Doc Quality Elementi per il mobile and it belongs to the furniture industry of the Treviso province.

During years, it has invested in the innovation process of its production in order to ensure better economic results.

Human resources were initially very reluctant to change, they thought that working within this sector did not necessary include the use of technology; instead, they slowly changed their idea.

The change was taken badly but, nowadays, is accepted and the news are taken always in a positive compared to the beginning.

The resistance observed in the use of technology has now turned into positivity, they slowly reached a change in the corporate culture and adapting it to this new reality.



After a critical period, people believe in the technology development of the company. In the last years, the firm relied on automated production machines that reduce also the physical effort of operators, reducing the danger and the risk of accidents in the production that is another big issue of Italy, where even today many people die for the accidents at the workplace.

Workers are learning to do checks on the machines, to understand where waste occurs and to improve the process more and more.

In the office, technicians are required while operators are guided more by experience and internal training in fact, the support of a person with more experience is still crucial for new operators that drive the worker in the new mechanism of the production.

The machine is operated both digitally and manually, the human factor will always remain indispensable in this area.

In Treviso territory, companies that want to achieve a certain result are automated and are going in this direction.

For Doc firm, the sector requires many numbers that can be obtained only with a few mistakes and greater control, so machines allow companies to make all steps.

Concluding, it is true that as the other companies showed, there is a lack of skills.

In Italy, schools do not prepare adequately but companies need young people who will be the future of these companies.

In Italy, ITS should be sponsored more like in German, that invest many funds in ITS institutes compared to the Italian government.

Doc Quality is ready to deepen the collaborations between companies and schools in order to train young people and to give them opportunities for growth.

Even in production, it is difficult to find staff because machines need to be managed and the right technical skills are required.

The important thing is to have meritocracy within the company, many who started from scratch now are machine leaders, people should be highly valued.

Key finding from the interviews	Industry	Main Industry 4.0 Technologies adopted	Technological effects	Impact on human resources	The main consequences on workforce
<b>Benetton</b>	Textile	Logistics robots	Faster and flexible processes, more competitiveness, faster deliveries, more customer satisfaction	Resistance to change and disruptive change of job tasks	Less human effort, more training, different skills required, less temporary work
<b>Diadora</b>	Footwear	Business software	More flexible, integrated and streamlined processes, greater competitiveness	Resistance to change and disruptive change of job tasks	Employees can focus on other important activities, more training, new competencies
<b>Tecnica</b>	Footwear	3D printers for R&D Business Software	Deeper and innovative R&D phase, greater competitiveness, streamlining and integrated processes	Resistance to change and disruptive change of job tasks	More training, corporate culture focus, new integrated skills
<b>Maglificio Giordano's</b>	Textile	Production machines	More productivity, more flexibility, less human errors, more competitiveness	Resistance to change and disruptive change of job tasks	More Training, new skills, Corporate culture focus, few results
<b>Pianca</b>	Wood – Furniture	Production machines	More productivity, flexibility, less errors, and waste	Resistance to change and disruptive change of job tasks	More training, technical skills, Collaboration with institutes
<b>Top Linea</b>	Wood – Furniture	Production machines	More productivity, flexibility, less errors and waste	Resistance to change and disruptive change of job tasks	Training, technical skills, Collaboration with institutes
<b>Veneta Cassetti</b>	Wood – Furniture	Production machines	More productivity, flexibility, less errors, and waste	Resistance to change and disruptive change of job tasks	Training, technical skills, Collaboration with institutes
<b>Doc Elementi per il Mobile</b>	Wood – Furniture	Production machines	More productivity, flexibility, less errors and waste	Resistance to change and disruptive change of job tasks	Training, technical skills, Collaboration with schools



## Conclusion

The thesis studied the effects of the use of Industry 4.0 technologies on human resources of manufacturing companies.

In particular, the focus has been on eight companies, four of them belong to the textile and footwear industry and the other four are part of the wood-furniture industry of the Treviso territory.

The eight firms were interviewed in order to understand the main effects of the digital tools on the workforce, considering small and medium manufacturing enterprises of the province.

Before explaining the main results obtained in the case studies analysis, it is fundamental to do an overview of what has been studied in the previous chapters.

The first chapter is an introduction of the main topic with the definition of Industry 4.0 by Pereira, and then the main technologies that belongs to this Fourth Industrial Revolution are analysed.

The chapter also presents the main theme that deals with the effects of new technological tools and their impact on human resources trying to insert many different authors' perspectives and giving space to the "skills gap" phenomenon, in which companies need workers with updated competencies, which are not easy to find.

In the first section of the research are also underlined the implications of 4.0 technologies in different jobs and in different regional contexts.

The chapter concludes with a reflection on universities' role in improving the skills gap and increasing collaborations between the institutes and firms.

The second heading gives some significant information on the Italian manufacturing system also with fundamental data in order to perceive the relevant investments in innovation and in the new technologies for Italian companies.

Afterwards, there is also an important part that focuses on the consequences on these new investments on the Italian workforce.

The second part of the chapter is concentrated on the Veneto manufacturing context and on the level of innovation of this Region, in order to figure out the degree of investments in new Industry 4.0 technologies in a Region characterized by small and medium enterprises.

The third and the last chapter is fundamental because it treats the empirical evidence on eight concrete cases.

For the case study analysis, they were selected eight companies in the province of Treviso, a representative zone made up of small and medium sized manufacturing companies.

The eight companies belong to two different industries, the fashion industry, and the wood-furniture industry, that are core industries in the province. They represent Made in Italy, craftsmanship, quality and design.

The results obtained are different in the two sectors chosen, but they have also many points in common.

A first consideration that emerged after the interviews, is that the introduction of new technologies has had a disruptive impact on the workforce.

Most workers in all companies interviewed resisted the introduction of these new work tools, they did not accept the change in their tasks, especially the replacement of many of their activities that are now carried out by new technological tools.

People feared technologies would lead to their dismissal and they believed in a radical automation of companies, but although the workforce has had to adapt to new tasks, they remain essential to the survival and success of companies.

The first consideration leads to the second one, the investments in new technologies did not create unemployment as Caruso and other authors pointed out, rather they change the tasks jobs performed by workers.

Nowadays, people have to interact with technologies and machines in order to perform their daily tasks.

Companies say that the secret to overcoming the resistance of people to technology has been to listen and train them as best they can.

Besides the training, many companies are trying to change the corporate culture and to overcome the obstacles caused by the implementation of new technologies, by listening more their employees and involve them in all decision-making processes.

The process will allow firms to create a positive atmosphere throughout the company.

Training is also the answer to the skills gap that has emerged since the introduction of new technological tools.

The workforce needs training to learn how to use and collaborate with new technologies and above all, companies aim to hire new professionals who are competent in managing digital technologies.

Skills gap should be solved by government and institutions, investing in new university degree courses that offer competencies required by companies, as a result in recent years, greater collaboration between companies and schools are created.

All companies confirmed their intention to invest more in the relationship with universities and technical institutes, to bring students closer to the working reality, also through lectures by companies at universities, which are a great learning and training opportunity for students accustomed to the classic theoretical lesson.

Companies are now starting internship projects and then turn them into new possible human resources in companies.

The blame, however, must not fall only on the lack of proper training by schools, but also on companies.

Considering that in recent years the “Calenda Plan” and, nowadays the PNRR (Piano Nazionale di Ripresa e Resilienza), a European project to relaunch the economies after the pandemic period, (Openpolis, 2023) have not only offered tax and financial incentives for the introduction of these new tools but have also made funds available for training Industry 4.0, to which companies would have had access.

Most companies did not request these incentives because unfortunately even today, especially in Veneto, they do not consider training the workforce as a priority.

In the interview with one of the main stakeholders, Confindustria, (which very often advises companies on Industry 4.0) has emerged that companies, mainly SME did not invest enough in the training of their workforce, which in the long term, will decrease the competitive advantage of companies.

Another relevant fact to reflect on, is that among the companies interviewed, the four SMEs belonging to the furniture sector, that have their production in Treviso, and even the knitwear factory, declare their difficulty to find technical staff and operators, with the appropriate skills in production.

While the largest companies such as Benetton, Tecnica, and Diadora, in the fashion world, which relocate abroad the production, are looking more for new managerial professional staff.

It is most likely that small and medium-sized companies still do not invest enough in new professionals who are able to manage these technologies, but rather they tend to hire technicians more. (Riccardo Sandre, 2021)

In the future, the two skills, those technical and managerial, will be equally important in order to have better results in management change within companies.

Finally, it is true that all companies have invested in new technologies, but on the other hand, few companies are adequately investing in human resources.

A major collaboration between the ministerial institutions, and local ones will be desirable, as also mentioned in the New Deal, in which institutions will work together in order to promote the right policies for different territories.

For instance, new policies for SME will be necessary in order to bring them closer to the topic of employees training and a main stakeholder like Confindustria, can be the intermediary in order to help companies to implement the right practices to train their employees.

In addition, to assist public policies that are fundamental for the development of small and medium companies, the task of large companies and multinationals should be that of the drivers, to motivate and advise smaller companies on human resource management after the implementation of Industry 4.0 technologies.

Many agreements in partnership with Confindustria have been made in an attempt involve more and more small realities on this issue, but so much more still needs to be done.

Companies need support from institutions but also from open companies, that are an example to follow, in order to grow step by step to reach a radical change.





# Appendix

SECTION 1: The model of evaluation the digital maturity of a company by

Confindustria:

The company's digital maturity is measured against four evaluation parameters:

1. Execution
2. Monitoring and Control of Processes
3. Technologies
4. Organizational Structure

and eight macro processes that make up the value chain:

Design and engineering

Maintenance

Human Resources

Production

Supply-chain

Quality

Logistics

Customer care and sales marketing

For each area of interest have been submitted questions to which the technicians of Industry 4.0 gave assessments from 1 to 5 and also for human resources function was so, in fact below I would like to summarize the main questions and the scale of assessment for each area:

- How is Industry 4.0 perceived in your company? The evaluation index was:

A risk

A phenomenon to be understood.

A change with positive and negative aspects

Opportunities for improvements in some business areas

Opportunities for improvement for the whole company and its business

- Have you defined leadership and coordination roles for the implementation of the Industry 4.0 strategy?

No

Some roles but not formalized.

Some roles formalized in some single business units.

A formalized team

Formalized roles both at the top management and in the single business units

- How involved is the human resources management function in the development of the Industry 4.0 strategy?

No involvement

Little (only top management, sporadically)

Enough (only top management with continuity)

Much (involving different levels, with continuity)

Fully (the function at various levels is involved in the development of the Industry 4.0 strategy)

- Do you have a process of evaluating the skills of your operators to implement the Industry 4.0 strategy?

We have never made an assessment.

We have carried out partial assessments of operators' competences.

We have carried out assessments of operators' skills.

We have carried out and regularly update assessments of the competences of operators, without specific reference to Industry 4.0

We have carried out and regularly update assessments of the competences of operators, with specific reference to Industry 4.0

- Do you have any staff training programmes on Industry 4.0 topics?

We have no training programmes.

We have defined training programs for a few management profiles.

We have defined training programs for management profiles and some managerial

We have defined training programmes for managerial, managerial and operational profiles.

We have defined a comprehensive programme for staff training.

- Do you have a program to attract and retain qualified personnel?

We have no initiative to improve working conditions, well-being and work-life balance.

We have identified some initiatives but not yet implemented.

We have taken sporadic steps to improve work, well-being and work-life balance.

We are transforming the sporadic initiatives implemented so far into a real program.

We have defined and launched a coherent programme of actions to improve working conditions, well-being and work-life balance.

- How do you assess the alignment between the reward mechanisms and the Industry 4.0 objectives?

Null (absence of explanation of the reward system or the objectives of Industry 4.0 or no common point)

The reward mechanisms are based on indicators unrelated to the Industry 4.0.

The reward mechanisms are based on several indicators, including some attributable to Industry 4.0 objectives.

The reward mechanisms are based on indicators to a large extent attributable to Industry 4.0 objectives.

Reward mechanisms are linked to performance and growth assessments skills, defined based on the strategies included) Industry 4.0.

- The level of involvement of employees in change processes, such as Industry 4.0?

None

Employees are informed.

Employees are consulted, they are asked for opinions and suggestions.

Employees get involved in prioritisation and alternative development.

Employees are co-creators of change, actively participate in all stages of the change process.

- What is the level of digitalization of resource management processes human?

None

The IT system only supports administrative and non-integrated processes.

IT system only supports administrative processes in an integrated way.

The IT system supports administrative processes and has some additional basic functionality (e.g., selection, performance management, etc.)

The IT system supports all aspects of HR management in an integrated way and has advanced features (e.g., self-service, analytical, etc.)

- Have you planned investments in technologies to improve conditions of employees' work?

We have not considered investing in technologies to improve the working conditions of employees.

We have not evaluated the adoption of technologies beyond those needed to comply with legislation/regulations.

We have a general idea of the technologies we could invest in, but we have not yet assessed the costs and benefits.

We have assessed the costs and benefits of some technologies to improve the working conditions of employees.

We made a comprehensive and detailed investment plan in technologies to improve the working conditions of employees.

SECTION 2: The protocol used for the eight companies interviewed.

This is the main track of all interviews:

#### FIRST BLOCK

- Could you explain the main activity of the company? What do you stand out in?

#### SECOND BLOCK

- Let's talk about innovation, have you had changes in the last period? Especially about Industry 4.0
- What was your motivation for investing in Industry 4.0 technologies?
- What kind of investments have you made, in which type of technologies?
- Have there been any results? What impact have these investments had?

#### THIRD BLOCK

Talking a bit about the focus of my thesis, how was the impact on human resources?

- Among the technologies used, is there any relationship and impact on human resources?
- Did you first invest in human resources and then acquire technologies? Or did you realize after there were human resource changes to be made? (increase/decrease and skills change)
- Have you had any difficulties? And how did you overcome them?
- What kind of skills are needed?

#### FOURTH BLOCK

- What about investments in Industry 4.0, how do you see other competitors? Is there talk of investments in these technologies?

- Is it true that there is a lack of expertise in the area, as you often hear in the newspapers? And what do you think?
- Can collaboration between universities and other institutions help in the search for suitable skills? Have you invested in new young people with the right skills for this type of change?
- Talking about the future, would you feel ready to invest in new technologies? Or is there still much to improve?



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