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The impact of Industry 4.0 and digitalization on Food and Beverage sector: Quantitative analysis of Parma's Food valley

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“Anyone who stops learning is old, twenty or eighty years old. Anyone who continues to learn remains young. The biggest thing in life is to keep one's mind young.”

Henry Ford

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Introduction

Industry 4.0 and digital transformation are two words nowadays used more and more, not only in the business world but also in everyday life. There's no doubt that the business world is rapidly changing. It is racing at breakneck speed toward a digital economy in all sectors. Several technology and business drivers are propelling this evolution, and the massive digital transformation that is currently underway will affect businesses and consumers right across the globe in multiple sectors and in everyday life. Indeed, we can say that new technologies are changing the way we live, communicate and even work.

In the first chapter of my thesis, after the description about the main figures of digitalization in Europe and the characteristics of the digital transformation as Internet of Things, Industry 4.0 and Smart Manufacturing, I go further in the path to Industry 4.0. Below a brief history about the industrial revolution from the first one, with the introduction of steam power engine, to the last one in which we see a fusion of technologies that are blurring the lines between the physical and the digital spheres. Differently from the others, this revolution is spreading at an exponential rather than a linear rate. It is disrupting every industry in every country, it is changing every business models that will been characterized by real time production, machine controlled production, decentralised production and customized production. Like all the revolutions, it brings also with it threatens as greater inequality, unemployment and deep changes in the labour market. Human and society and the way work is organized have been transformed too. Indeed, the change in business model requires developing the skills of employees to better meet the machine interface and work effectively together. We will witnessing a collaboration between machines and workers.

In this context of changes and challenges, industry is the leading actor that can take advantage and benefit most. Europe and Italy have moved in this direction with the implementation of the industry plan 4.0. The interventions of EU Commission aim to coordinate efforts towards the digital single market or a digital market without borders between the different EU countries. The purpose is to increase competition and bring simpler availability of data at a global level. Meanwhile, in Italy was launched the

national plan Industry 4.0 entitled *Investment, Productivity and Innovation*. The plan represents an opportunity for all the enterprises that want to exploit the advantages of the fourth industrial revolution. The plan is based on policies that want to help companies toward digitalization, giving incentives to those firms that desire to innovate. The aim of the Italian government is to have a greater competitiveness of the product due to the greater functionality deriving from Internet of Things.

After the launch of the "Piano Industria 4.0" I want to understand how companies are reacting. I try to quantify the phenomenon, choosing as a reference the industrial district of Parma located in Emilia Romagna, that is famous for Food and Beverage productions. The choice to perform a district analysis is for the familiarity with the Italian territory. The district in fact represents the Italian economic model and for its peculiarities it has a medium-high technological and innovative capacity.

Thus, in the second chapter, the efforts of my thesis are focused on the peculiar characteristics of the Food and Beverage sector. Firstly, I give a measure of the importance of the sector in Europe and Italy, one of the most expanded in terms of the other manufacturing sectors in Italy. Then, I go further in the complexities of managing the agro-food value chain, as hygienic safety, traceability and quality issue. At each stage of the agro-food chain, practices could be adopted to become less energy intensive and therefore smarter due to the technologies of the fourth industrial revolution. The result should bring more efficiency and quality for all the actors involved in the chain. The actors in the food supply chain are producers as farmers and farming companies, the processors or food industries, retailers and distributors, and at the end consumers. Another important aspect in the food-chain is sustainability, that in this case means involving environmental, technology, market, regulatory and socio-economic considerations. Digital technologies can help the sustainability of the chain and support the farmers in producing safety and quality products. The agro-food sector is transforming to which we call the *Digital agriculture* or *Precision farming.* Data management become one of the most crucial element of digital farming because enable that information are transmitted to all the actors in the chain. The most interesting areas of research that currently concern the agro-food sector involve the dematerialization of procedures, traceability, precision agriculture and the Internet of Things. Another area

that Internet of things and the new technologies influence is retailing. Thus, food and beverage companies are continuously innovating the online grocery, because they want to guarantee a range of newer, fresher and higher quality products and at the same time ensure a great service to customers. In order to realize all these changes and support the digitalization, new skills and capabilities must be developed. Indeed, changing a business model does not only mean implement the new technologies of the fourth industrial revolution, but also requires developing the skills of employees to better meet the machine interface and work effectively together. Food organizations must develop new business culture based on a set of digital skills, accepting the advantages related to the digital transformation.

In the third chapter, I move my attention on the Parma's Food valley. On the provincial territory are indeed concentrated a whole series of connected agricultural and industrial activities forming a network that allow to define the Parma area as a district of agro-food. Research laboratories in the region together with universities, work for the quality and the safety of their raw materials, machines, industrial installations and finished products. Moreover, the link with the university brings about several high skilled and specialized employees. We can divide the food and beverage sector of Parma in six big areas: pasta and bakery products, milk and dairy products, animal preserves, vegetal preserves, milling products, and beverages. I chose the district to perform my analysis because clusters have always been incubators of innovation, able to offer small and medium enterprises possibilities of growth and integration, exceeding their size limit.

In particular I choose the questionnaire as a survey method and the aim was to quantify the adoption of technologies, understand what are the reasons behind the non-adoption and if the sector owns the right level of knowledge and economic resources to innovate toward the digital revolution. For companies that are implementing the technologies, the survey investigated the transformation at the organizational level and the changes at the operational and worker level. Overall, companies underline the great impact of industry 4.0 on their economic performance. The results suggest that in the coming years in the Italian agro-industrial supply chain there will be an increase in demand for skilled and specialized workers that can be satisfied both by hiring new staff and by training and

retraining the human resources already employed in the company. In general, we can say that new technologies can drive business growth, innovation, job creation and demand for specialized skills but by contrary they can also displace entire roles when certain tasks become obsolete or automated.

CHAPTER 1: INDUSTRY 4.0, AUTOMATION AND DIGITAL TRANSFORMATION

1.1 Digital transformation process, Internet of things and Industry 4.0: a brief look

Digital technologies and the web world are transforming the environment in which we live, every aspect of life and every sector of activity. Europe is also trying to foster the transformation of the European economy into a digital one. The aim is to enable European companies to compete on global markets through targeted interventions aimed at encouraging the dissemination of digital goods, services and technologies, eliminating current obstacles and improving access to new capital. The OECD report "*Digital Economy Outlook 2017*" outlines the enormous potential for growth and innovation in companies, linked to greater adoption and use of ICT, in almost all sectors.[1] Two technological pillars, digitization and interconnection have been driving the digital transformation, complemented by a growing ecosystem of inter-related technologies. The development of the digital economy depends on the adoption of digital technologies by individuals, firms and governments. In 2015 the Italian framework was characterized by a diffusion of limited technologies still very limited: in terms of percentage of the population having access to Internet, Italy ranks 33rd out of 36 countries (only Colombia, Turkey and Mexico can boast worse data).[2] Moreover, there are few companies active in the digital sector and even less those that use information and communication technology (ICT) to increase the profitability of their business. However, in recent years, the use of digital technologies among individuals, firms and governments has increasingly augmented, and continues to growth at a fast pace.

Optimize the use of digital technologies and skills, according to a study conducted by Accenture (Strategy Digital Disruption), presented at the World Economic Forum

[1] OECD (2017), *OECD Digital Economy Outlook 2017*, OECD Publishing, Paris.
[2] OECD (2015), *OECD Digital Economy Outlook 2015*, OECD Publishing, Paris.

2016,[3] could generate 2 trillion of dollars of global economic production in more by 2020.[4] The study notes also the wide role of digital in the economy in the first 11 nations of the world, indicating that more than a fifth of the world's gross domestic product (GDP) is attributable to the digital environment in the form of skills, capital, goods or services. According to them 63% of the companies are experiencing disruption meanwhile 44% are highly susceptible to future disruption.[5] Moreover, the report calculates the value of intermediate digital goods and services used in production. Just over a fifth of world production (22%) is connected to this digital economy of skills and capital. In Italy the digital economy contributes today to 18% of GDP, against 33% of the US, 31% of the United Kingdom and 29% of Australia. The peninsula is ranked tenth, among the 11 nations of the world analyzed by the Accenture report, compared to the digital economy on GDP, but it is among the countries with the greatest growth opportunities if it manages to optimize its digital resources.

One of the characteristics of the digital transformation is the Internet of Things. The evolution of sensor technology, together with solutions and software capable of extracting intelligence from the enormous volume of information that devices and machines generate, will allow a clear reading and understanding of reality within the decision-making process and the anticipation of market trends.[6] The convergence of Cloud, mobile, big data and social on the one hand, and sensors on the other, is starting to generate enormous opportunities for companies that will allow customers and employees to offer new services and new ways of interacting. People, things, machines and processes are becoming increasingly interconnected online, creating a permanent

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[3] World Economic Forum (2016), World Economic Forum White Paper Digital Transformation of Industries: In collaboration with Accenture.
Available on: http://reports.weforum.org/digital-transformation/wp-content/blogs.dir/94/mp/files/pages/files/digital-enterprise-narrative-final-january-2016.pdf [Consulted in 03/2018].

[4] Accenture (2018), Accenture Digital Disruption.
Available on: https://www.accenture.com/it-it/digital-disruption-index [Consulted in 03/2018].

[5] Accenture (2018), Disruption need not to be an enigma.
Available on: https://www.accenture.com/us-en/insight-leading-new-disruptability-index [Consulted in 03/2018].

[6] Carapellotti, F. (2017), *Governare l'economia 4.0. Il Digital Data Officer per una Digital Transformation vincente*, Maggioli Editore, Santarcangelo di Romagna.

channel between the real world and the virtual dimension, and revolutionizing everyone's way of interacting not only in the private sphere but also in the business and corporate context. The Internet of Things (IoT), relying on sensors, information and analytics tools will enable the creation of new generations of increasingly automated and intelligent solutions. At world level, this revolution involves a profound transformation of production processes and a progressive convergence between the industrial system, ICT technologies and communication infrastructures.[7]

Another of the areas of greatest impact of the digital is certainly the manufacturing, so much so that we speak of the fourth industrial revolution or Industry 4.0.[8] The possibility to exchange information in real time between customers, factory and suppliers, allows to create an integrated and optimized production flow based on customer needs, with positive effects on the customer experience. The revolution we are witnessing has positive impacts on the whole value chain. The progressive mutation of the manufacturing industry will bring with it important opportunities to re-launch the Italian system, traditionally fertile ground for innovation. The manufacturing vocation that characterizes the country should not be experienced as a limit, but as an opportunity.[9]

Our traditional production fabric is made of numerous companies that can benefit greatly from the digitalisation of operational processes. In fact, among our excellence we include not only luxury, clothing, furniture or food, but also areas with high added value such as automation, robotics, industrial components. These are the areas where we are at the forefront of research and development and where, thanks to our consolidated experience, we can play a leading role in the coming years. The

[7]Feng, X., Yang, L.T., Wang, L. and Vinel, A. (2012), *Internet of Things*, International Journal of Communication Systems, vol 25, issue 9.

[8] NTT Data (2017), Digital Transformation: Five impact areas for manufacturing companies to consider. Available on: https://uk.nttdataservices.com/en/-/media/assets/white-paper/managed-mfg-digital-transformation-whitepaper.pdf [Consulted 04/2018].

[9] I-Scoop (2016), Digital transformation in the manufacturing industry: challenges and accelerators. Available on: https://www.i-scoop.eu/digital-transformation/digital-transformation-manufacturing/ [Consulted in 04/2018].

digitalisation of the factories constitutes on one hand an important opportunity for growth, on the other an opportunity to increase competitiveness with productions that are more flexible, less costly and more responsive to customer needs. However, the transformation will involve major investments and the ability to cope with change by companies. Italy, which is second in the manufacturing sector in Europe, represents 20% of the wealth of the country, it needs a national program like that developed in Germany.

Smart manufacturing is destined to become the paradigm of the manufacture of the future. Thanks to some innovative digital technologies, industries will be able to have greater interconnection and cooperation between their own resources and what will drastically change efficiency and competitiveness, with important repercussions on business processes and possibilities. The application areas are wide: from smart objects for tracing processes to big data to support quality management, from advanced automation in internal logistics to cloud platforms dedicated to collaboration in executive processes.[10]

1.2 The path to Industry 4.0

The term Industry 4.0 is a result on the history of the industrial revolutions, which so far is perceived in three stages (Figure 1). At the end of the 18th century, the introduction of hydropower and steam power engine brought a change on both the social and the industrial world. The first industrial revolution began in Britain with the mechanization of the textile industry. The society passed from an agricultural one to an industrial one. The use of water and steam power allowed production to be accelerated significantly compared to tasks previously performed manually, the production became mechanized (e. g. mechanical weaving looms). The simultaneous increasing prevalence of

[10] Cosenza, M. (2015), Che cos'è lo smart manufacturing?, Wired.
Available on: https://www.wired.it/economia/lavoro/2015/07/09/smart-manufacturing/?refresh_ce= [Consulted in 04/2018].

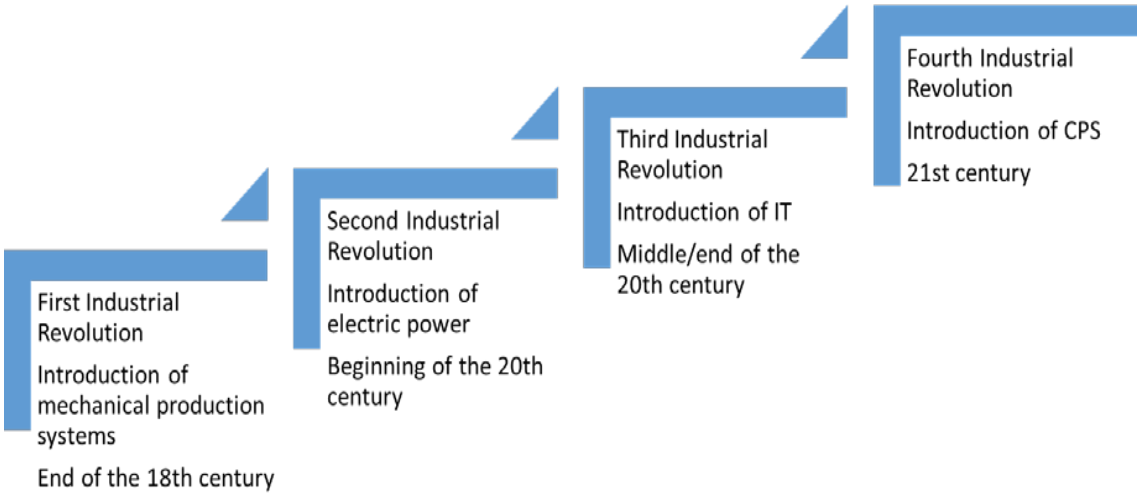
steamboats and railway trains made transport and logistics considerably easier. The use of the telegraph made the communications easier and faster. The prevailing energy resource was coal.

The second Industrial Revolution is chronologically attached to the beginning of the 20th century and ushered in the new era of industrialization. The electrification of production by introducing electric power – oil replaced coal as the leading energy source – resulting in an expansion of mass production (assembly line work). Fordist mass production with taylorist production processes triggered an increase in productivity, which also facilitated a social middle class and the beginning of a welfare government. The third Industrial Revolution is chronologically attached to the 1970s and is also referred to as the digital revolution. The increased use of computers ushered in the change from an industrial to an information society. The introduction of electronics and information technologies allowed for further automation of production. A great extent of the control and coordination of machines, processes and the global integration of suppliers are performed with the help of computers. Microelectronics, new materials and bioengineering introduced new production methods, applications and the development of new products and services.

Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical and the digital spheres.
There are three reasons why today's transformations represent not merely a prolongation of the Third Industrial Revolution but rather the arrival of a Fourth and distinct one: velocity, scope, and systems impact. The speed of current breakthroughs has no historical precedent. When compared with previous industrial revolutions, the Fourth is evolving at an exponential rather than a linear rate. Moreover, it is disrupting almost every industry in every country. And these changes sign the transformation of entire systems of production, management, and governance.

Figure 1

The four stages of the Industrial Revolution



Source: Wolter, M. I. et al. (2015), *Industry 4.0 and the consequences for labour market and economy*, Institute for employment research.

Nowadays billions of people have the possibility to be connected through Internet and mobile phones that allow them to have access in an easy and fast way to knowledge and information. And these possibilities are augmented by the recent revolution and its technologies such as artificial intelligence, Internet of Things, robotics. The start date of the fourth industrial revolution has not yet been established because it is still in progress and only a posteriori it will be possible to indicate the act, the moment and the innovation founding, even if the term "Industry 4.0" was named for the first time at the Fair of Hannover in 2011. Industry 4.0 stands for an interactive networking between production and the digital world. This transformation includes elements such as big data, autonomously operating systems, Cloud computing, social media, mobile and self-learning systems. This development is more of an evolutionary process than a revolution. The following provides a standardised definition based on German literature, even if, to date there still is no clear and distinct definition of how exactly to interpret the term Industry 4.0, Forschungsunion Wirtschaft und Wissenschaft (German Science-Industry Research Union 2013) provides the following definition[11]:

[11] Wolter, M. I. et al. (2015), *Industry 4.0 and the consequences for labour market and economy*, Institute for employment research.

"Industry 4.0 essentially refers to the technical integration of Cyber Physical Systems (CPS) into production and logistics as well as applying the Internet of things and services in industrial processes – including the resulting impacts on the value chain, business models, as well as downstream services and work organization."
(Forschungsunion & acatech 2013)

1.3 Enabling technologies

The background on which industry 4.0 stands out is the new relationship that can be achieved between the physical world of human beings (the actors of the economic-social system, i.e. entrepreneurs, workers, consumers) and the digital world (computers, the sensors, the virtual world and so on). The union of the two worlds is very complicated, and we are studying the most suitable interfaces to obtain it, but the synergies and advantages that would be obtained are very high as we would be able to exploit all the enormous digital technologies, now used in minimal part, to make significant progress in improving production and social systems. Digitizing the entire production system in a very pervasive way, with effects in all economic sectors.[12]
From the merger of the physical and the digital world the result is what is called the Cyber-Physical System (CPS)[13], a world composed of a complex network of machines, physical goods, virtual objects, computing and storage structures, communication devices, energy containers, which interact with them and with economic operators. The objective of the industry 4.0 is to use this cyber-physical system to improve the industrial and distribution processes, both in the sense of obtaining more efficiency, and therefore a reduction in costs that guarantees lower sales prices and more final demand

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[12] Magone, A. and Mazali, T. (2016), *Industria 4.0 uomini e macchine nella fabbrica digitale*, Guerini e Associati, Milano.
[13] Wan, J., Cai, H. and Zhou, K. (2015), *Industrie 4.0: Enabling Technologies*, International conference on intelligent computing and internet of things.

from the consumers, in the sense of adding new products and new services, which today are impossible to implement due to the limitations in the use of technologies.[14]
The list of technologies that will enable the affirmation of the industry 4.0 is long and complex; I describe the main ones.

Internet of things (IoT).
This definition of success includes the set of components and technological devices (sensors, gps and others) that can be incorporated into physical objects and machinery, which ensure the interface between the physical and the digital world and allow communication through the Internet with other objects, to exchange information , to modify the behavior based on the received inputs, to memorize instructions and therefore to learn the interaction. It is a field that opens up unprecedented solutions, beyond the possibilities of ICT as we have known so far. The development of IoT has obvious consequences on the digital factory and disruptive effects: unprecedented levels of flexibility, personalization of the product up to the single sample, dialogue in real time between market, design, suppliers and production, important effects on the characteristics of the plants, production volumes and products. Among the most important outcomes will be the large-scale dissemination of products and smart objects, with potentially boundless applications, because every physical object or product in theory can be equipped with terminals capable of transferring information and receiving instructions, even at a distance.[15] It is an effect that is called "servitizzazione" of manufacturing, that is the deep integration between products and services.[16] Together with the product are also sold pre-sale and post-sale services, assistance and customer care.

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[14] Pearce, P. (2017), How advancements in manufacturing technology are transforming the industry. Available on: https://www.plex.com/blogs/industry-4-0-advancements-in-manufacturing-technology.html [Consulted in 04/2018].

[15] Weber, R. H. and Weber R. (2010), *Internet of Things*: *legal perspectives*, Springer, Berlin.

[16] Bacchetti, A., Zanardini, M. and Avesani, G. (2018), La servitizzazione e il suo impatto sulla supply chain. Available on: https://www.industry4business.it/connected-enterprise/la-servitizzazione-e-il-suo-impatto-sulla-supply-chain/ [Consulted in 05/2018].

Big data.

The term is used to summarize the set of technologies that allow to collect and process the great mass of information that transit through the Internet, and describe for example the market trends, consumer habits, the reputation of brands, the demand for goods and more.[17] The biggest problem in the development of big data is perhaps the difficulty in processing the data in order to obtain useful results in making decisions. With industry 4.0, the digitalization of plants can transmit millions of data on the characteristics of the production cycle, which today are mostly rejected because of their difficult interpretation; but through big data technologies it is assumed that they can be analyzed to improve the efficiency of the system, with reference to three specific dimensions: the speed with which the data can reach the processing centers and be submitted to the analysis in time restricted; the volume of data that can be processed; the variety of data processed, coming from heterogeneous and differentiated sources.

Certainly to manage growing and constantly expanding information, coming from numerous sources (sensors, web, social media, wearable devices), in very high volumes and different varieties, we can not use the technological solutions of the past, too expensive or limited. Instead, we need more complex and different metrics from those commonly used in data warehouses, new hardware configurations faster and more efficient thanks to the use of parallel computing, multi-core processors, larger memory spaces, new solid-state disks.

Additive manufacturing.

According to the research made by Tofail et al.[18], additive manufacturing (AM) is fundamentally different from traditional formative or subtracting manufacturing. AM is more versatile, flexible and customizable and can suit more sectors of industrial

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[17] Harvard Business Review (2018), The explainer: Big data and analytics.
Available on: https://www.youtube.com/watch?v=3C0aLuNIecc [Consulted in 08/2018].

[18] Tofail, S.A.M., Koumoulos, E.P., Bandyopadhyay, A., Bose, S., O'Donoghue L. and Charitidis, C. (2018), *Additive manufacturing: scientific ans technological challenges, market uptake and opportunities*, Elsevier, vol.21, number 1, pp 22-35, Amsterdam.

production. The production cycle for 3D printing begins with the creation of a virtual model of the component to be produced, elaborated using a numerical simulation and three-dimensional vision software; subsequently, the digital file is transferred to the printer, which can also be located very far from the design area. The printer spreads thin layers of powders that are melted and aggregated to each other, layer by layer, creating the final product. This feature of the process defines the name by which the type of production is qualified, additive manufacturing, i.e. production by adding material, as opposed to the traditional technology of subtracting production, for example with machine tools that remove material from a block of metal. The main benefit of AM technology is that it enables the flexible production of customized products without cost penalties in manufacturing.[19] If until a few years before the 3D printers were confined in the laboratories of the movement maker, or hailed as a vehicle for the revival of digital craftsmanship able to collect the heritage of Made in Italy, the evolution of techniques and characteristics of materials molding is favoring more attention also from the industrial world.

Even if this technology is still far from a large-scale diffusion within factories, while the presence of 3D printers in real-world artisans is growing, it is believed that it will produce important effects in areas such as prototipation (where it would allow efficiency gains and time savings), the production of components, the spare parts chain (characterized by extemporaneous demand, wide range and very limited series).

3D printing determines a shift for several reasons: because it allows the mass customization of the product, the production of complex shapes that can be built with the technical limits imposed by the mold, the flexibility in using the same production line for different productions , the fast response to an increasingly volatile market that forces companies to quickly change the quantity and type of production. Among the advantages indicated, it is worthwhile focusing on the first, as it recalls a reasoning that fully involves Made in Italy. The mass customization of the product consists in the possibility of creating a piece tailored to the individual consumer, without having to make a single mold, at a cost that would make the final product very expensive and

[19]Piller, F.T., Weller C. and Kleer, R. (2015), *Business Models with Additive Manufacturing—Opportunities and Challenges from the Perspective of Economics and Management*, Springer, Cham.

destined to a high end segment of the market: with 3D printing the consumer segment that refers to this "exclusive and elitist taste" destined for a few is enlarged, and almost everyone will be able to refer to the elitist product. This technology is therefore the start of a change that concerns not only production but also flexible planning. Industry 4.0 and additive manufacturing emphasize the possibility of co-designing the product in a synergistic and parallel way, with the contribution of several companies, each one specializing in a small phase of the production cycle realized later with 3D printing. In other words, it is a process that allows artisan companies that evolve in the so-called "digital craftsmanship"[20] to incorporate the quality, art and creativity typical of Made in Italy, even in the new technological context. Moreover, allowing the production of complex shapes that cannot be built with the mold, 3D printing generates opportunities to create new products or to incorporate creativity into current products, facilitating the emergence of companies that have in their industrial design their competitive advantage. 3D printing has an effect on the production cost structure. In an article published in 2013 in the journal Research Technology Management, the economist Irene Petrick[21] proposes to substitute the concept of economies of scale with the concept of economies of ones, that are the advantages obtained by the company thanks to mass customization, deriving from the reduction of fixed costs to the advantage of variable costs. This allows the reduction of barriers to entry into new businesses leading to increasing competition and opportunities for craft enterprises to extend their niche specialization to new market segments.

The new organizational structure described by the article, more focused on the management of marginal costs, could allow a revitalization of the work organizations based on productive decentralization and on the horizontal relationships of the network constituted by the company, one of the most typical solutions of industrial districts. It is probable that economies of scale and scope will continue to be important in our

[20] Magone, A. and Mazali, T. (2016), *Industria 4.0 uomini e macchine nella fabbrica digitale*, Guerini e Associati, Milano.

[21] Petrick, I.J. and Simpson, T.W. (2015), *3D Printing Disrupts Manufacturing: How Economies of One Create New Rules of Competition,* Research Technology Management.

production systems, as mass customization applies only to certain types of goods. In fact, the application of this technology cannot be applied to the industrial sector that I describe in this thesis. Therefore, it can be assumed that the 3D printer does not replace the old production system but integrates it, allowing obtaining customized goods where there is a demand (love for variety), where complex shapes are not compatible with the old technologies, where finally the raw materials are expensive and deserve to save on processing waste. In general, the greater differentiation of the product that the new organizations allow becomes an element favorable to the specialization.

Augmented reality.

Also in this case, as for the IoT, we refer to a family of technologies rather than a single device. In general, wearable devices or anyway able to increase the information available to the user in real environments (rather than in digital laboratories as is the case with virtual reality). The industrial applications of these technological solutions are still limited and experimental, as well as the market potential of consumer uses, but they are potentially very large if we consider the maintenance and the guided repairs, the warehouses and logistics centres.

Interconnected robots.

Among the most accredited technologies in Industry 4.0, there are robots capable of working alongside men without barriers. These robots can be trained and operate on small scale even for very simple operations. They are used to perform the heaviest and dangerous jobs inside the production plants (as happens in an Audi plant). They become very important in factories that face a sharp increase in the average age of labour force, as demographic seniority involves strong functional limits in the most difficult tasks. The new robots are called collaborative because they live a deep interaction,

autonomously and safely, with human operators, acting as a sort of personal assistant, to the point of opening the doors to new models of work organization at the factory.[22]
But at the same time they are revolutionizing logistics activities, especially in automated warehouses such as the well-known Amazon, as they are able to perform all the warehouse operations: pick, pack and ship. As we will see, logistics activities are also revolutionizing the Food and Beverage sector, thanks to the help of these robots and automated warehouses. Furthermore, the effect of the technology of new robots on the labour factor is very complex. The manual and repetitive tasks are for the most part substituted and new jobs are created.

Digital Manufacturing.

It indicates a production process that uses the innovations produced by the intersection of many technologies mentioned above, first of all 3D printing, Internet of Things, big data, simulation tools, three-dimensional visualization and assisted production. The peculiarity of the method is that it allows simulating the entire production cycle before its actual start-up. The ultimate aim is to verify the possibilities of improvements and increase efficiency, in the sense that these systems allow to create the complete definition of the production process in a virtual environment, simulating the behaviour of the single actors: the machines, the workers, the raw materials, semi-finished products, components. Digital manufacturing integrates company functions facilitating the exchange of information.[23] For example between the design area and the production area, with regard to the product and production methods; and once started, production guarantees feedback of the activities, providing information that is re-introduced in the design step to exploit the data collected at the factory.

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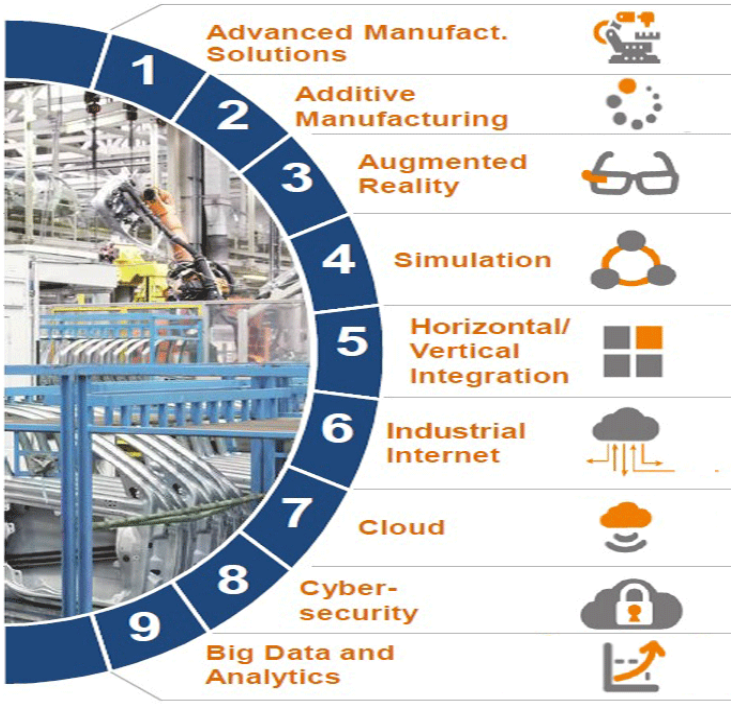
[22] Rüßmann, M., Lorenz, M., Gerbert, P., Waldner, M., Justus, J., Engel, P. and Harnisch, M. (2015), *Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries*, The Boston Consulting Group.
[23] Trisolino**,** M. (2017), Industria 4.0 & Digital Manufacturing: professioni "a banda larga", Engage. Available on: https://www.engage.it/rubriche/industria-4-0-digital-manufacturing-professioni-banda-larga#DhcjS51z8EVpZ1JC.99 [Consulted in 09/2018].

In summary the enabling technologies of the Industry 4.0 are nine, and are described by the figure 2:[24]

1. Interconnected and rapidly programmable collaborative robots
2. 3D printers connected to digital development software
3. Augmented reality supporting production processes
4. Simulation between interconnected machines to optimize processes
5. Information integration along the value chain from the supplier to the customer
6. Multidirectional communication between production processes and products
7. Management of large amounts of data on open systems
8. Security during network operations and open systems
9. Analysis of a large database to optimize products and production processes.

Figure 2



Source: Serio, L. (2017), Come cambiano i modelli di business, Ialweb.

[24] Serio, L. (2017), Come cambiano i modelli di business, Ialweb.
Available on: https://www.ialweb.it/resources/evlive/sharing3fvg/17-03-01Serio.pdf [Consulted in 10/2018].

However there are few examples of enterprises that fully adopt all the nine technologies and that can be defined for real business 4.0. Industry 4.0 does not mean adopting this or that technology but knowing how to integrate the various technologies, with an approach that will allow the digital world to interact with the human one, both inside the factory and outside it.

1.4 Challenges and Opportunities

What the fourth industrial revolution bring with it? Like all the revolutions that preceded it the fourth industrial revolution has the power to augment the income levels in the entire world. Consumers have the biggest gain from this revolution, because they become able to access more affordable products and have access to the digital world. Technology has made possible to produce products and services in a cost saving manner. New customized products and services are created and they increase always more the efficiency and the pleasure of our lives. According to the Economist, the lines between manufacturing and services are blurring.[25] Rolls Royce no longer sells jet engines, but it sells the hours that each engine is actually thrusting an aeroplane through the sky. If we want booking a flight, buying a new clothe or making a payment, we can make it sitting on our coach. Transportation and communication costs will drop enormously; logistics and global supply chain will become more effective. Thus the cost of trade products will decrease and the result will be a bigger growth in the world economy and the creation of new markets.

However, this phenomenon bring also with it threatens; the revolution could bring greater inequality, unemployment and deep changes in the labour market. Like all the revolutions, this one will be disruptive. Automation and digitalization may substitute for labour across the all economy. This is a scenario that could scare. The displacement of

[25] The Economist (2012), The third industrial revolution.
Available on: https://www.economist.com/leaders/2012/04/21/the-third-industrial-revolution, [Consulted in 09/2018].

workers by technology may increase the discrepancy between returns to capital and returns to labour. However it is also possible that this discrepancy will lead, in aggregate, to an increase of safe and rewarding jobs. The outcome is likely to be some combination of the two. A shift that may happen according to the article "Average is over" by the famous journalist of the New York Times, Thomas Friedman[26], is that the best jobs will require more and a better education to make themselves above the "average". In the future, talent, more than capital, might represent the critical factor of production. The manufacturing jobs of the future will require more skills. Many dull, repetitive tasks will become obsolete. Most jobs will not be on the factory floor but in the office nearby, which will be full of designers, engineers, IT specialists, logistics experts, marketing staff and other professionals. So what is required of the worker of tomorrow to be the protagonist of the new factory? Doing more and better, in terms of managing complexity, and problem solving. That is, knowing how to act appropriately and on your own initiative, possess communication skills, organize work together with others in a team structure.

In short, it is required more and more potential and subjective skills. Moreover these skills appear necessary for the qualitative enrichment of the work, to ensure a more interesting environment, to promote autonomy and improve the professional experience. In the paper of Klaus Schwab[27], it is predicted that the revolution may give rise to a more segregated labour market, on one side the educated high skills and high-paid workers and on the other side the low-skills low-paid workers; and this for him will increase social tension. Inequality represents one of the greatest societal concerns linked with the Fourth Industrial Revolution. The people that most will take advantage from these innovations will tend to be the providers of intellectual and physical capital, the innovators, shareholders and investors, which explains the rising discrepancy in income between those dependent on capital versus those dependent on labour. Schwab argued that new technology may be the reason why the wealth in the population of high-income

[26] Friedman, T. (2012), *Average is over*, New York Times.

[27] Schwab, K. (2016), *The fourth industrial revolution: what it means, how to respond*, World Economic Forum.

countries has decreased: the demand for high skilled workers has increased and that for less educated and lower skilled worker has decreased.

This helps explain why so many workers are disillusioned and fearful that their own real incomes and those of their children will continue to stagnate. It also helps explain why middle classes reports a mood of anxiety around the world and a sense of dissatisfaction and unfairness. Discontent can also be exacerbated by the pervasiveness of digital technologies and the dynamics of information sharing typified by social media. About 40 percent of the global population now uses social media platforms to connect[28], learn, and share information. In an ideal world, these interactions would provide an opportunity for cross-cultural understanding and union. However for Schwab, they might also create and propagate unrealistic expectations as to what constitutes success for an individual or a group, as well as offer opportunities for extreme ideas and ideologies to spread.

While consumers will have little difficulty adapting to the new age of better products, swiftly delivered, governments may find it harder according to Schwab. Their instinct is to protect industries and companies that already exist, not the upstarts that would destroy them. The ability of government systems and public authorities to adapt will determine their survival. If they prove capable of embracing a world of disruptive change, subjecting their structures to the levels of transparency and efficiency that will enable them to maintain their competitive advantage, they will endure. If they cannot evolve, they will face increasing trouble. This will be particularly significant in the sphere of regulations. The current system of public policy and decision-making evolved as a response of the Second Industrial Revolution. The whole process was designed to be linear and mechanistic, following a strict "top- down" approach. However, this approach is not anymore possible due to the great speed of the Fourth Industrial Revolution and the big impacts that this bring with it, legislators and regulators are

[28] Williams, B. (2017), *There are now over 3 billion social media users in the world – about 40 percent of the global population*. Available on: https://mashable.com/2017/08/07/3-billion-global-social-media-users/?europe=true#eyfOtdp78aqy [Consulted in 09/2018].

being challenged like an unprecedented degree. How can they preserve the interests of the consumers while continuing to support innovation and technological change? Regulators must incessantly try to adapt to a new, fast-changing environment, like the private sector did by adopting a flexible response to software development and business operations. In order to accomplish this result, governments must always collaborate closely with business and civil society.

Finally, the Fourth Industrial Revolution will shape and influence not only the way we live but also ourselves as individual. Our lives will be influenced: the time for work and leisure, our privacy, our consumption patterns, the way we meet people, we develop our skills, and nurture relationships. Some studies, such as that of Can Jiao et al.[29], explain that staying always connected with the phone could diminish some human capacities, such as empathy and cooperation. Constant connection may deprive us of one of life's most important assets: the times to pause, reflect, and engage in meaningful conversation. Another individual challenge posed by the new technologies is privacy. Debates about fundamental issues such as the impact on our inner lives of the loss of control over our data will only intensify in the years ahead. However the technology and the disruption that comes with it are not two exogenous factors, in fact humans can control them. We have the power and the opportunity to shape the Fourth Industrial Revolution and direct it toward our common objectives and values. To do this, however, we must develop a comprehensive and globally shared view of how technology is affecting our lives and reshaping our economic, social, cultural, and human environments.

[29] Jiao, C., Wang,T., Peng, X. and Cui, F. (2017), *Impaired empathy processing in individuals with internet addiction disorder: an event-related potential study,* Frontiers Human Neuroscience.

1.5 The impact on business

There is clear evidence that the technologies that underpin the Fourth Industrial Revolution are having a major impact on businesses. We can understand how this will inevitably create new business models for the enterprises. A strict application of all the technologies of Industry 4.0 would bring major change in the entire business model. According to some authors and researchers,[30] this phenomenon will be the most powerful driver of innovation over the next few decades. The business world's digitalization is breaking down the traditional barriers of industry and there is the need to rethinking the all business model in this new framework. Also if there is not so much research about the argument because authors are more focus on the technologies of the revolution. These lasts are transforming the current path of value creation, which in turn has brought organizational consequences and opportunities. The value chain of the firm that implements the technologies of the fourth industrial revolution, is horizontally and vertically integrated[31] and the related interoperability, that can be defined as the connections and communications between human and smart factories, expands the firm traditional boundaries and the stakeholders network.

Horizontal integration refers to the cross-industry linking of production processes. We mean an integration of the ICT systems, of the data network and of the company resources in the various production phases and of the economic planning along the entire value chain. The integration takes place in the execution of data and material exchange both internally in the company and to other external parties. The aim is to achieve continuous real-time cooperation between all the parties involved for the benefit of the product and optimize the flow of goods and information within the value chain. This share of resources and data happens autonomously through machines that calculate

[30] Kaggermann, H. (2015), *Change through digitalization- value creation in the age of the industry 4.0.*, Springer, Wiesbaden.
[31] Ibarra, D., Ganzarain, D.J. and Iguarta, J.I. (2017), *Business model innovation through industry 4.0: a review*, Elsevier, Amsterdam.

the requirements for basic materials, tools and personnel, identify utilisation and reorder materials from upstream entities.

Vertical integration on the other hand defines optimising the flow of in-house goods and data with the objective of increasing quality and flexibility. It describes the intelligent cross-linking and digitalization within the different aggregation and hierarchical levels of a value creation module.[32] For both aspects of Industry 4.0 it is crucial that information are processed in real time, that all processes along the value chain are linked, communicating, and furthermore to be able to take self-organised action. Self-organisation in particular shows Industry 4.0 will not have hierarchically and centralised planned production management, but rather the product knows how it is to be processed, what it is needed for and where it needs to be transported. These improvements are made possible by a flexible and dynamic integrated project management, which allows adapting the requests of each client. In summary, this results in the following four key characteristics for the term Industry 4.0:

- Real time production:

Material, inventory and movement sequences will also become replaceable by real time production. It is about coordinating the flows of materials specific to requirements. The technologies of the Industry 4.0 permit indeed to minimise the stock in the warehouse. The quantities produced will be given by a make to order logic instead of a make to stock ones, where the quantities were calculated on the base of the forecast of the demand. Inventory can be reduced, in extreme cases, even be completely eliminated. The constant communication along the value chain and between the production process and the product allow the reduction of processing time and a high utilisation percentage. The supply chain can be fully integrated.

[32]Stock, T. and Seliger, G. (2016), *Opportunities of sustainable manufacturing in industry* 4.0, Elsevier, Amsterdam.

- Machine controlled production:

The second aspect concerns the changes within the production plant: with the connection between the machines, and indirectly with the traceability of the components to be assembled and the semi-finished products to be transformed, an intelligent network is created that automatically controls the production process. It controls both the quantity and the quality of the product.

New robots and artificial intelligence replace the human work and the machines control all the production process. Digitising the value chain reduces the internal operating costs. The labour productivity is augmented. The direct connection between the machines permits to change in real time the materials required and to respond to the change of demand. Automation through Industry 4.0 is very flexible and can be implemented specifically depending on the sector and company.

- Decentralised production:

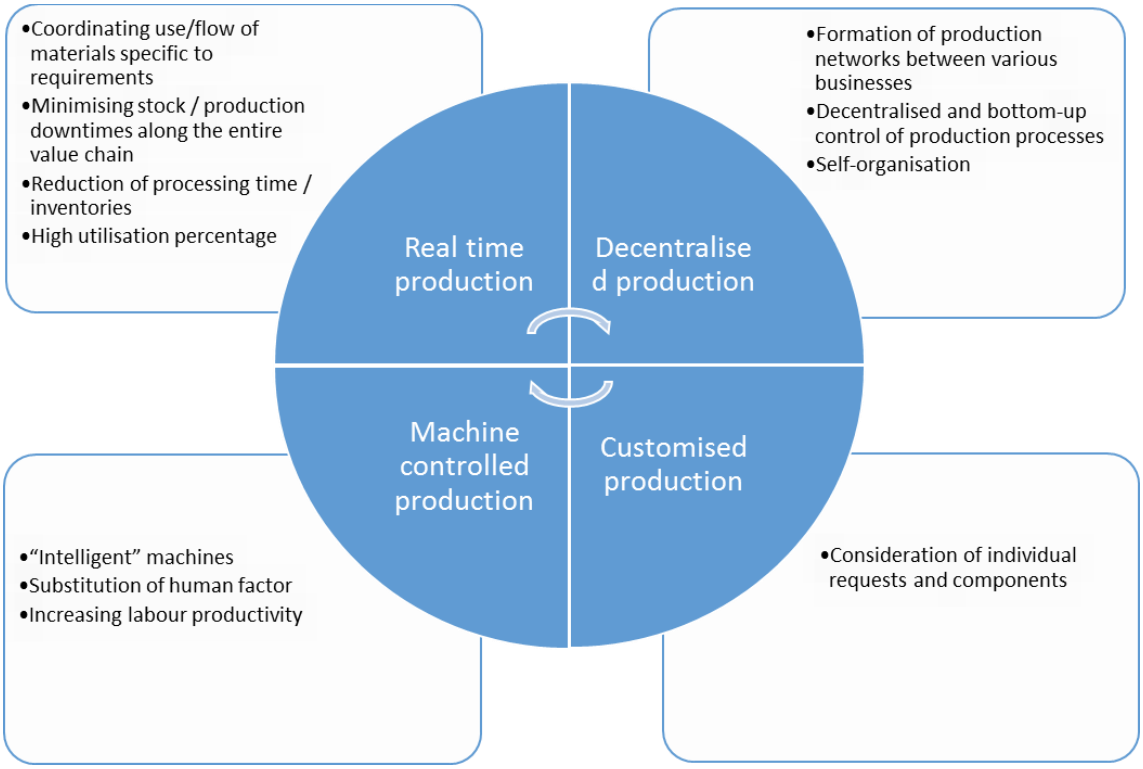
The principle of the Internet of Things advances the creation of new organizational structures. Since each product in the Industry 4.0 may be unique, it will be difficult to centralize or optimize operations in the traditional way. Optimization may be through a decentralized organization.

- Customized production:

We move from mass production to mass customization. The flexible production and the short execution times allow the emergence of new business models and personalization. New technologies allow creating new products and more differentiated according to the taste of the client without changing the costs of production. They considerate the individual requests and components. The products will be manufactured on demand and will be the perfect match with customers' needs.

The key characteristics of the industry 4.0 impacts on business are summarized in the following figure:

Figure 3



Source: Wolter, M. I. et al. (2015), *Industry 4.0 and the consequences for labour market and economy*, Institute for employment research.

Thus in the transition toward Industry 4.0 the production process will be not anymore based on traditional economies of scale but it would be based on economies based on knowledge and not on the volume accumulated. In this kind of knowledge-based economy the source of competitive advantage is not more linked to a cost reduction or a differentiation strategy but it is linked to the skills and competencies that a firm possess and the ability of this firm to create new knowledge and continually develop and produce innovative product and services. The long-term growth of organizations will be dependent on their ability to identify, cultivate and exploit the core competences.

The sectors most affected by the fourth revolution are those where large companies or very innovative companies operate, such as aeronautics, mechanics, and transport. On the contrary, there are still very few studies on the entry of industry 4.0 in the sectors characterized by small businesses and crafts, where the impact of new production models is less clear and more difficult to describe. Industry 4.0 is a technological and organizational approach created to evolve the big business, it must still be adapted to

other dimensional forms of business. However, since Industry 4.0 means making the current productive resources work more intelligently, we can hypothesize its effects of use in all economic sectors, not only in the manufacturer ones.

1.6 Effects on Organization of Labour

From the research *The Future of jobs*[33], it has emerged that technological and demographic factors will profoundly influence the evolution of the labour market in the coming years. As we said, business has to respond to the new trends of this revolution. However, the digitalization of the world changes both business and private life in a radically way. The world is becoming more and more connected, but these changes don't affect only business. Human and society and the way work is organized have been transformed too. For instance, mobile device and social media are two technologies of the revolution that have already changed the design of manufacturing work. The manufacturing environment of the future should be fit with the new context of technological developments. The introduction of the Cyber-physical-system (CBS) means for the industry a higher interconnected environment and highly interactive. This system will create a new quality of flexible working in the future. With the increased automation, monitoring and control and autonomous systems, the future workplaces has less or no need for constant human interaction. Humans are monitoring the processes and are more involved in maintenance, improvements and innovations. According to Bauer et al. in the article *"Transforming to a hyper-connected society and economy-towards an industry 4.0"*[34] tasks will be distributed in multiple dimensions of time, space and content. Work will not be anymore dependent on fixed workplaces or fixed scheduled. The nature of work will shift towards more intensive knowledge-based jobs.

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[33] World Economic Forum (2018), *The Future of jobs Report*.
Available on: http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf [Consulted 12/2018].
[34] Bauer, W., Hämmerle, M., Schlund, S. and Vocke, C. (2015), *Transforming to a hyper-connected society and economy – towards an "Industry 4.0",* Elsevier, Amsterdam.

The workforce will have to continuously develop new competencies and capabilities in order for the firm to stay competitive, the employees will necessitate new qualifications in the manufacturing environment. In the future the aim is to make employees and teams in CPS production systems into equal. The decision-making process and authority have to be in line with the principles of decentralisation of the industry 4.0. The organization of the division of labour must fit the new framework in order that better decisions can be taken. Employees may have the opportunity to regulate their own work, which will need more multi-task competences focused on media and social skills. Social media has the effect to reduce the cost of knowledge transmission and it does this by removing the need for long coordination and process and complex decision-making channels. However, with employees gaining more authority, traditional tasks and the role hierarchies will change.[35] The tasks assigned to employees will be not anymore focused on only one skill but it will require more multi-disciplinary competences. In the future, working in teams that are mixed according to age, gender, origin and attitudes will be more normal. This could potentially lead to major improvements in creativity and productivity but also lead to an increased risk of conflicts due to the diversity of the groups. The design of the interactions, the management of diversity, will become one of the defining competences of successful leadership.

Hence, the big factories are facing the overcoming of hierarchies with autonomous "islands" where men and machines live together, team of workers and robots. Even the new relationship with consumers upsets the organization of work, in a way that some scholars say that the smart factory stands for mass customization as the Taylorist factory stood for mass production. Managerial thinking cannot have the gaze turned to the past today, but must produce the development of innovative and experimental solutions to foster the emergence of revolutionary organizational principles in order to make the productive environment fluid, competitive and "human".

[35] Tvenge, N. and Martinsen, K. (2018), *Integration of digital learning on industry 4.0*, Elsevier, Amsterdam.

1.7 "Servitization" of manufacturing

According to Baines et al., the definition of servitization has coalesced as "a process of building revenue streams for manufacturers from services." [36] The "servitization" of the manufacturing companies is one of the consequences of the digitalisation and the industry 4.0. The industry 4.0 is pushing companies to a change from product to service mindset. Furthermore, researchers have illustrated that manufacturing firm should expand their role in the value chain by extending their products with service so that they do not have to compete only on the base of manufacturing costs. The result is the so-called product-service-system (PSS), in which products and services are integrated in order to offer a better fit with the consumers' needs.

However, the term "servitization" is not one of the most used in managerial disciplines and in fact is a term not widely known in many companies but represents an important strategic asset in these days. With the introduction of technologies such as big data, cloud computing, augmented reality, are created new ways of interactions and thus new ways to understand better the customer's needs and a lot of times these needs are associated with available services integrated with the products, such as pre and post sales services. Customers become part of the value creation process.

1.8 Europe 4.0

The European Union has decided to focus its efforts on the innovative process in order to create a European digital portal for the world of universities and research, linking these two subjects to make them cooperate more easily. The interventions of the EU Commission aim to coordinate efforts towards the digital single market or a digital market without borders between the different EU countries, giving rise to the European

[36] Baines, T.S., Lightfoot, H.W., Benedettini, O. and Kay, J.M. (2018), *The servitization of manufacturing; a review of literature,* Journal of manufacturing management.

Open Science Cloud to connect the research centres.[37] It will be essential to have a definition of protocols and common standards at European level to promote the full integration of production chains. Thus, what is the single digital market?

It is a strategy that aims to open up digital opportunities for people and companies and to strengthen Europe's position as a world leader in the digital economy. The free movement of people, services and capital is ensured. At the same time individuals and companies can have access to online activities and exercise them in a fair competitive environment. Furthermore, a high level of protection of personal and consumer data is foreseen, regardless of nationality or place of residence.

In the single digital market there will be less obstacles and major opportunities, companies can operate and innovate freely. Sometimes the obstacles of the single market are diffused also to the digital market. For instance, digital markets tend to be predominantly national for those that regard the services. Of the European enterprises[38] only the 7% of the small-medium enterprises make international operations. This can change only by moving the online the single market.

According to the previsions[39], the digital single market could bring 415 billion Euros to the economy of Europe, it can create 3,8 million of jobs, especially for the young and can create a dynamic environment based on knowledge. It has the objective to boosting employment, economic growth, investment and innovation. It can also expand markets, offer better services and transform public services. It can create opportunities for new start-ups and allow companies to grow and innovate.

With the digital single market, venture capital will also be more attracted to Europe, because it will no longer be able to interact in a complicated context but in an unified ones. Hence, the European Commission wants to promote the electronic commerce and that everyone has better access to digital goods and services so that everyone can take

[37]European Commision (2018), Internal Market, Industry, Entrepreneurship and SMEs.
Available on: http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_it [Consulted in 09/2018].

[38] European Commission (2018), Digital single market.
Available on: https://ec.europa.eu/commission/priorities/digital-single-market_it [Consulted in 09/2018].

[39] Maci, L. (2016), Cos'è il mercato unico digitale europeo e perché può farci guadagnare 415 miliardi, Economyup. Available on: https://www.economyup.it/startup/cos-e-il-mercato-unico-digitale-europeo-e-perche-puo-farci-guadagnare-415-miliardi [Consulted in 09/2018].

full advantages of the opportunities of the digital economy. The digital single market will be based on 3 fundamental pillars[40]:

1. Improve the availability to digital goods and services across Europe for businesses and consumers;
2. Create a favourable context for the development of services innovations and equality conditions for digital networks;
3. Maximize the growth potential of the digital economy.

The more detailed objectives of the European Commission are:

- Promoting electronic commerce in Europe and making the deliver of goods beyond the border less expensive and more easy
- Modernizing the european practices about copyright
- Collaborating with online platform in order to create an equal context for everyone
- Strengthening the cyber security through the ENISA, the agency of the EU for cyber security policies, in order to protect citizens and companies
- Exploiting the opportunities of the open economy of data ensuring the free flow of data
- Ensuring that everyone have the best connection possible to participate fully at the digital economy
- Adapting the policies about the private security to the new digital context
- Helping small and medium enterprises, researches, citizens to guarantee that they can exploit at best the digital technologies with the right competencies and financing european research on technology.

[40] Cattari, M. (2016), *La strategia per il mercato unico digitale in Europa*, DigItalia.
Available on: http://www.cdeita.it/sites/default/files/Cattari.Digitalia.pdf [Consulted in 11/2018].

Given the endless opportunities it is providing and will provide digital evolution on the world market, the EU Commission is driving European companies to align with the world's technological development standards in order to be able to take full advantage of these possibilities.

Digitization will bring a simpler availability of data at a global level that will increase competition, so a process of innovation of European states will be necessary to defend its competitiveness.

Germany is at this moment the most structured country on industry 4.0, of which the industrial power is above all. In reality the strength of the German approach lies in the choices of industrial policies linked to the policies of research, education and training. Even the school in Germany has set challenging objectives to educate and qualify the workforce. His *Industrie 4.0* plan will focus on the financing of corporate projects and applied research centres and tax breaks for investments in technological start-ups, all in collaboration with the country's major industrial and technological players.

Sweden has a plan, called *Produktion 2030,* which focuses on: renewable energy, flexible industrial processes, virtual reality, *human-centered* production systems, services for products and production, development of product-production integration.

Spain currently does not have a plan for Industry 4.0; the only strategy is on a regional basis, the *Estrategia Fabricacion Avanzada* in the Basque Country.

France has a strategic plan, the *Usine du Future*, based on five specific points: development of industrial technologies, incentives for companies that invest in innovation, work and wages, reinforcement of European and international collaboration and finally promotion of the plan between industrial and citizens.

1.9 Italy 4.0

Italy has always been characterized by a unique economy due to the presence of small and micro (less of ten employees) enterprises managed by the family. Hence, the 95% of Italian enterprises have these dimensions and also an organizational structure very simple. Instead the industry 4.0 requires specific and advanced competences and the

family owned enterprises it would not be sufficient to handle the new innovation transformation, it will be necessary to have new figures that are able to manage and reinforce the business competitiveness. Italy is the second nation after the German in the European classification of manufacturing and both countries have also ah high degree of diversification. According to the synthetic indicator of structural competitiveness of the manufacturing sectors in Italy (ISCo)[41], in 2015 the first places of the ranking were the beverage companies, the pharmaceuticals, the chemistry, the machinery and electrical equipment companies. The sectors with lower values are the same that already showed lower competitiveness relative to the beginning of the recession (2011): textile and clothing, wood and printing. Beverages and chemistry are the sectors that show the earnings broader structural competitiveness than in 2011.

The model of the Italian industrial district with artisan tradition has its strong point in Made in Italy, always synonymous with design and high quality. This aspect can be a huge advantage for the revival of the Italian economy, if it will be applied effectively the new 4.0 technologies that are characterized by the great customization of the product.

One of the "weak" points of the Italian structure concerns the fields of research and development (R&D) and developments and innovation (D&I). The investments in research and development have been increased in the other European countries, even if in a heterogeneous way. Italy follows a different path, the dynamic of the expenses in real terms in research and development are slower, however we can see the first signs of improvement in the innovation field. As a matter of fact, another study of the Istat is regard the investments in innovations, in the years between 2014-2016, 48,7% of Italian companies of industry and market services with at least 10 employees has carried out innovative activities. 30.3% are "strong innovators" (innovate products and processes); almost 25% "Product Innovators" (but not process); 18.5% "process innovators" (but not of product); about 22% "Soft Innovators" (innovate only the organization or marketing); 4.9% "Potential innovators" (they have carried out innovative activities that

[41] Istat (2018), Rapporto sulla competitività dei settori produttivi.
Available on: https://www.istat.it/storage/settori-produttivi/2018/nota_stampa.pdf [Consulted in 09/18].

have not been translated into innovations). The share of innovators is increasing compared to 2012-2014.

Thus, how much is the stimulus of the central government in favour of research and innovation?

The "Ministero per lo Sviluppo Economico", the 21th of september 2016, presented the national plan industry 4.0 entitled *"Investment, Productivity and Innovation"*.

According to the "Ministero dello Sviluppo Economico", the national plan industry 4.0 2017-2020 represents an opportunity for all the enterprises that want to exploit the advantages of the fourth industrial revolution. The plan establish concrete policies based on five principal guide lines:[42]

- Operate in a logic of technological neutrality
- Intervene with horizontal and not vertical or sectorial actions
- Act on enabling factors
- Orient existing tools to promote technological leap and productivity
- Coordinate the main stakeholders without holding a directing role

The first key directive tries to boost the private investments in goods and technologies of the fourth industrial revolution by moving an amount of 10 billion of private investments, 11,3 billion of private expense in research, development and innovation and 2,6 billion for the private investments *early stage*[43]. The second key directive is about the competences. The government wants to spread the 4.0 culture through the digital school and work school alternation, it wants also to strengthen the knowledge through universities and technical high school, finance the research and create competence centers and digital innovation hubs. The pre-established result is that of

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[42] Maci, L. (2018), Cos'è l'industria 4.0 e perché è importante saperla affrontare, Economyup. Available on: http://www.economyup.it/innovazione/3713_cos-e-l-industria-40-e-perche-e-importante-saperla-affrontare.htm [Consulted in 12/2018].

[43] Ministero dello Sviluppo Economico (2016), Piano nazionale industria 4.0, investimenti, produttività e innovazione. Available on: http://www.sviluppoeconomico.gov.it/images/stories/documenti/Industria_40%20_conferenza_21_9 [Consulted in 09/2018].

being able to have 200,000 university students and 3000 managers specialized on 4.0 subjects. As regards high schools, 100% of students enrolled in technical institutes will be trained on the topics of Industry 4.0 and about 1,400 research doctorates with ad hoc focus are planned. Lastly, the third directive is about governance and awareness.

The government's aim is, indeed, to educate the people about the importance of the industry 4.0. From the national industry plan the government expect to have a major flexibility of the production of small batch of goods with the same costs of the mass production; greater speed from prototype to mass production through innovative technologies; a bigger productivity and better quality. And as a final result the government expect to have a greater competitiveness of the product due to greater functionality deriving from the Internet of Things[44].

[44] Ministero dello Sviluppo economico,Sviluppo economico, industria 4.0 (2018). Available on: http://www.sviluppoeconomico.gov.it/index.php/it/industria40 [Consulted in 09/2018]

CHAPTER 2: FOOD AND BEVERAGE SECTOR

2.1 Introduction

After having described the effects of the fourth industrial revolution and the digitalisation transformation, I can now try to understand what are the effects of this phenomenon on the Food and Beverage sector, investigating in all the stages of the value chain, from the small farmer to the big retailer. Starting from telling about the characteristics of the sector and the management and the sustainability of its supply chain, I want to examine the numerical impact on the sector of the digitalisation and industry 4.0 and investigate about the consequences for the labour market, the organization of labour, the retail activity, the supply chain complexities, cost reductions, efficiency, profits and losses. The *observatory of the School of management of Politecnico di Milano*[45] let emerge the data about the digital agro-food and in particular on the dairy sector that have been showed in the fair about "Dairy 4.0: the digital innovation in support of the entire supply chain". The Observatory tries to understand the impact of the technological innovation on the dairy sector, in collaboration with the *Crit-Polo digitale di Cremona*. Empirical results showed that the use of Internet to guarantee the quality of the alimentation of the cattle lead to a saving of 64000 of euro every year. Furthermore, smart sensors and traceability in the transportation of the dairy products can reduce the compromise products and thus diminishing the waste with savings that go above the 10 million per year. In the agro-food context, the dairy represents the most technologically advanced, with a huge amount of data due to the pedometers for monitoring the cattle, with the more revolutionary management systems of the herd, and the robots for the milking. The analysis shows also that the benefits could increase with the introduction of innovative digital tools that would require only a little investment. The expected benefits are huge for the entire supply chain: from the

[45] Corcom (2017), Agrifood alla svolta digitale. Più qualità, costi abbattuti.
Available on: https://www.corrierecomunicazioni.it/industria-4-0/lattiero-caseario-con-la-svolta-digitale-piu-qualita-a-costi-piu-bassi/ [Consulted in 09/18].

farmer to the suppliers of raw materials, from the industries to the final consumer. In order to understand the benefits of the innovation in the dairy sector and in general in different ago-food sectors, a clear knowledge of the whole supply chain because it is from the integration of the various economic agent in the chain that value is created and both parties could take advantage of it. The partnership between *Crit-Polo digitale di Cremona* and the *Observatory smart agro-food of Politecnico di Milano* is a strong answer to the concrete needs of the agricultural world to improve the competitiveness and the quality of their work. The dairy sector is one excellence in the agro-food world and represents an example for success that other companies should follow as best practices.

2.2 Food and Beverage in Europe

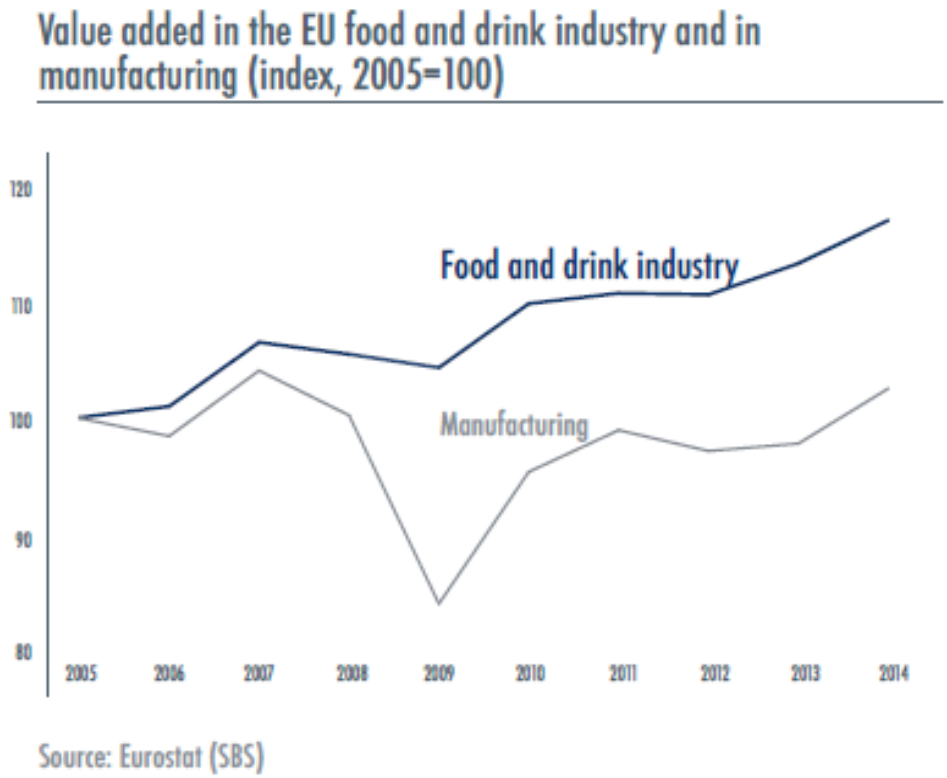
Food and Beverage represents one of ours society greatest tradition and pleasure. Today there are available a wide variety of food and drinks and with an always more increasing quality. This sector is part of Europe's social, economic and cultural fabric.
Food, in fact, is not only a way to survive and feed ourselves but it is something more, it represents our culture and our history. Cultural and regional groups have different nutrition habits and preferences and like people and cultures food habits change with them. Food practices and preferences are imported and exported in all the world.
According to the European Commission Food[46] and Beverage industry in Europe is one the biggest manufacturing sector in terms of value added and employment degree. It represents also a big asset for trade with non-European nations, food and drinks exports in fact, have doubled in the last 10 years and now they reach 90 billion of amount and contributing to a positive surplus of 30 billion. The food and drink sector also accounts for more than 285.000 SMEs that generate almost 50% of the industry turnover and they provide 2/3 of the employment of the sector. European food and drink is very

[46] European Commission (2018), Food and drink industry.
Available on: https://ec.europa.eu/growth/sectors/food_en [Consulted in 09/18].

appreciated by overseas nations. The legislation and the European Single Market are tools the enable the free circulation of food and drink and help the competitiveness of Europe. The single market also strives to augment the opportunities for trade by various trade agreements and negotiations with overseas countries. The European Commission is making efforts to increase the competitiveness of the European food. In generally the competitiveness of EU food and beverage industry is going well and they make exports in a global scale of high quality, safe and healthy food. Only in recent years the sectors face a decrease in relative terms, especially in terms of slower growth in added value and labour productivity. Certain problems related to the decrease of the sector can be attributed to the supply chain functioning, as the sub-optimal relationships in the supply chain, the lack of transparency, the lack of skilled workers and the low market integration across European countries. The 2017 edition of the *"Data and Trends of the EU Food and Drink Industry"*[47] give a picture of the structure of the European Food and Drink sector showing figures and trends. The report also provides an EU and global ranking of food and drink companies. According to the report, the food and beverage contributes to the EU gross value added for 1,7%, the 15,4% is the share of F&B turnover in manufacturing and the 12,8% is the share of food and drink value added in manufacturing. The F&D industry is ahead of other manufacturing sectors, as is showed in the graphic 1, and the food and drink turnover grown of 413 billion over the past 20 years.

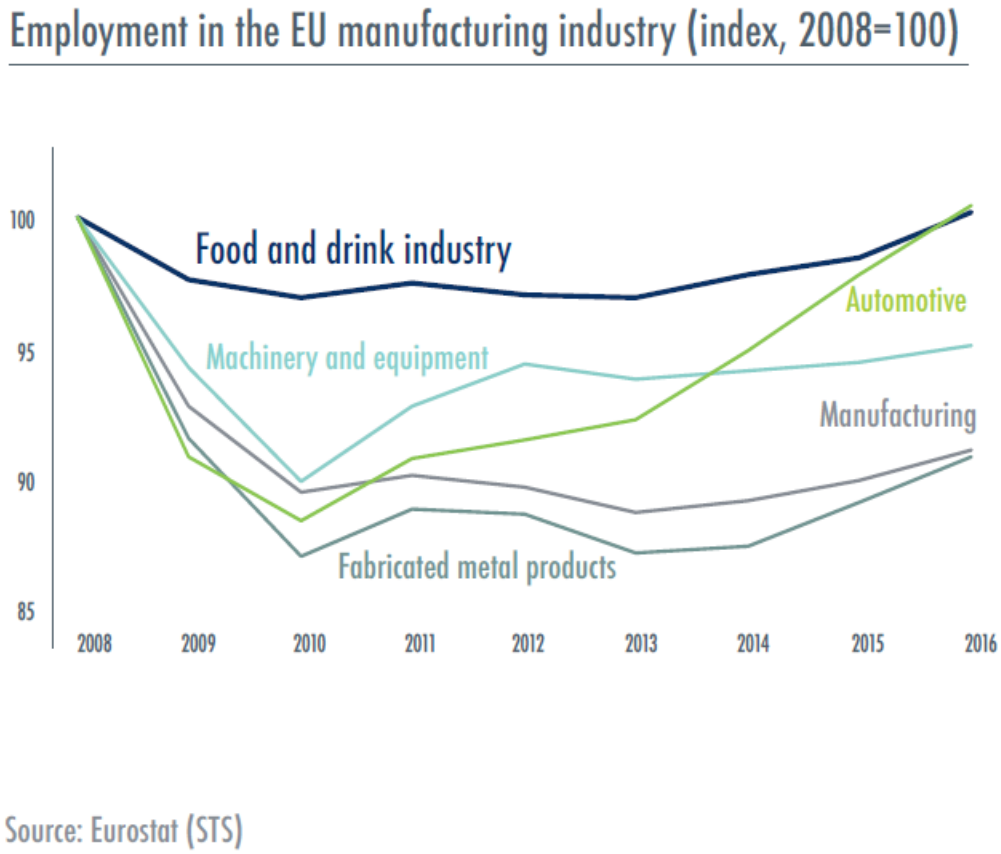
[47] Food and Drink Industry (2017), Data and trends of the EU. Available on: https://www.fooddrinkeurope.eu/uploads/publications_documents/DataandTrends_Report_2017.pdf [Consulted in 10/18].

Figure 4



Regarding the employment, there are 4,24 million of employees related to this sector in Europe and represents the 15% of the total employment in the manufacturing sector. Compared to the other manufacturing sectors, the EU F&B is a key job provider and a relatively stable employer. The average number of person employed by a food and drink company is 15, one more than the average in manufacturing sectors (Graphic 2).

Figure 5

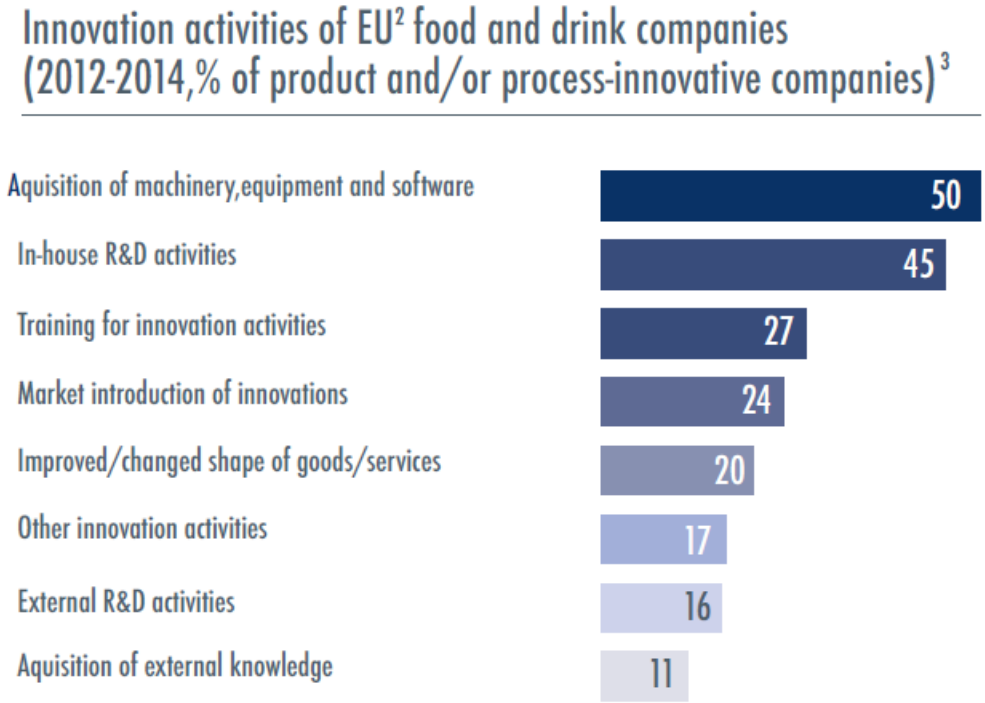


The report also considered the employment in the all food supply chain. The driving forces in the food supply chain are agriculture, the food and drink industry and retail. Around 31 million professionals work in the extensive food supply chain across the EU, from agriculture and the input industry to food and drink services. Talking about innovation and research and development, the EU food and drink industry has a lower R&D investment intensity compared to several food and drink industries worldwide.

Innovation is defined as a new significantly improved product or process, a new marketing method, or a new organizational method. During the period 2012-2014, more than one quarter of all food and drink companies reports marketing innovations. Organization, process and product innovations took place in 20% of all companies. Half of product and or process-innovative food and drink companies were engaged in

acquisition of machinery, equipment and software and 45% of them run in-house R&D activities (Figure 4). They found out that the key barriers to innovation are: lack of finance, low market demand for innovations and too much market competition.

Figure 6



Source: Eurostat

2.3 Food and Beverage in Italy

The Italian agro-food sector is one of the most expanded in terms of the other manufacturing sectors in Italy. It represents an excellence in the level of quality, safety and technological innovation at "the state of the art", sustainability, biodiversity and respect of the tradition. Furthermore Italy is characterized by big territorial and climate diversities that have been transformed in cultures, histories and unique traditions. These

traditions have brought with it a variety of small and medium family-owned enterprises. These firms characterized by a simple organizational structure, are not big enough to compete in the international markets exploiting the economies of scale that derive from the huge volume of production. Thus they decided to compete in the foreign markets with high quality products and maintaining high prices. Italian food sector, production and retail remain highly fragmented[48], with a very competitive business environment. Their key of competitive advantage is the uniqueness of their products. The Food and Beverage sector has always played a key role in the Italian economy and for its development policies are increasingly implemented with the aim of promoting the true 'Made in Italy' food farming abroad. These actions are aimed at combating the so-called "Italian Sounding", that is the use of geographical names, images and brands that evoke Italy to promote and market products not referable to our country.

The key factors of food and beverage industry in Italy are the variety of the range of products, the top certification of the quality of the products, the close link with the territory and the culture, the high safety standards, the ability to combine tradition with the constant innovation of the process and the product. Italy is ranking as second in Europe in this sector with a revenues in 2015 of 55 billions of euro[49]. Below is a summery of the main sector data (Figure 7).

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[48] Atradius (2017), Market Monitor, focus on food performance and outlook.
Available on: https://atradius.it/pubblicazioni/market-monitor---focus-on-the-food-industry---italy.html [Consulted in 10/18]

[49] ICE (2017), L'agroalimentare in Italia, produzione e export. Available on: https://www.ice.it/sites/default/files/inline-files/NOTA_AGROALIMENTARE_E_VINI_2017.pdf [Consulted in 10/18].

Figure 7: data food and drink sector in Italy

Turnover	137 billion + 3,8% on 2016
Number of companies	58.000
Employees	385.000
Export	32,1 billion
Import	22,1 billion

Source: Federalimentare (2018), Report conclusivo agroalimentare 2017/2018.
Available on:
http://www.federalimentare.it/new2016/AreeOperative/FormazioneContinua/ConvegnoFinaleGiugno2018/ReportConclusivoAagroalimentareGiugno2018.pdf [Consulted in 10/18].

The long period of crisis has caused a 10% drop in domestic consumption (2007/2016), however the sector has held up better than the remaining manufacturing sector, in fact the reduction in the number of companies did not exceed 2.5% (above all small and micro) and employment contracted by 20,000. The driving force of the recovery were exports that allowed the increase in turnover and the average company profitability from 7.8% (2011) to 8.6% (2016). Therefore in 2017 the Italian agro-food industry continued to grow with a turnover of 137 billion euros, equal to + 3.8% on 2016 and consolidates its position as a second manufacturing sector, up 16% from 2008 to the present.

Food and drink industry in Italy is also going toward research and innovation.
It invests 8% of turnover in research and development (1.8% in formal and informal R&D of innovative products and processes, over 4% in new plants, automation, ICT and logistics and about 2% in analysis and quality and safety control), combining the knowledge, traditions and localisms of the Italian food model with constant process and product innovation. Today, about a quarter (25%) of agro-food turnover consists of products for which innovation, even incremental, is an essential factor. If we consider the current trends in food consumption patterns, this component of more "evolved" products are destined to increase their weight compared to the so-called classic food (pasta, preserves, cheeses, wine, oil), which currently accounts for about two thirds of the sector's total turnover (65%). Furthermore, the increase in exports, especially towards markets and consumers with tastes and eating habits profoundly different from

those Italian and European, determines a constant search for the correct balance between product innovation and preservation of tradition in order not to distort the characteristics of Made in Italy.

Furthermore, in Italy there are different agro-food districts in which the proximity between the supplier and the producer plays a crucial role in the advantage of these, and also the geographical positions is fundamental in the food and beverage sector because this last is strictly linked with its territory. As an example I can list some of the most famous Italian districts[50]: the dairy district in Parma, that produces the famous Parmiggiano Reggiano Dop; the district of Gragnano that produces a big variaties of products from the tomato to pasta and wine; the district of Conegliano Valdobbiadene located near Treviso, produces the famous prosecco wine; district of Santo Stefano Balbo; district of prosciutto di Parma. In all these districts the key of their competitive advantage is the proximity of the various stages of the production process, the availability of specialized suppliers embedded in the territory and especially the transmission of knowledge and techniques due to the geographical proximity. A clear example of the importance of this sector in Italy is the "FICO, la fabbrica industriale contadina"[51] an international agro-food fair situated in Bologna by the big firm Eatitaly. The group Eatitaly World wants transmit the food Italian culture to the world and the use of the new technologies in the sector. It made that through an exhibition composed by 40 industries, 40 restaurants and various number of artisan shops. The all fair is characterized by a high degree of technological advances, in fact, inside FICO, although there are many references to our origins and the Italian food and wine tradition, there is also a lot of technology. FICO thus succeeds in combining the past and the future, in a present that embraces technology and tradition at the same time. Logistic is an essential element in all the organization of the fair. In the actual economic context, in which the marginal profits on the product have been decreased and differentiate from the

[50] Osservatori Distretti (2018), Osservatorio Nazionale dei distretti italiani.
Available on: http://www.osservatoriodistretti.org/node/10/distretto-agroalimentare-del-prosciutto-di-parma[Consulted in 12/2018].

[51] Bevilacqua, F. (2017), La fabbrica italiana Contadina, cosa c'è di Fico?, italiachecambia.org .
Available on: http://www.italiachecambia.org/2017/12/fabbrica-italiana-contadina-fico/ [Consulted in 10/18].

competitors is always more difficult, here the logistic become a fundamental key, a competitive advantage in the optimization of economic resources for reducing the waste and decrease the costs. For this reasons a lot of logistic operators become specialized in a certain sector, in this case in the food and beverage ones in order to better resolve the problems linked with the specific product.

2.4 Agro-food Value Chain

Today there is always attention by governments and business to the environmental problems and concerns and about the consequences of the ever-increasing production, distribution and consumption of agro-based products. For this reason is important to have a good knowledge of the agro-food sector to better realize a sustainable supply chain. The major issues that concern governments and business are related to the involvement of producers, as small farmers, and the pressure to meet the stringent food safety and quality regulations. Corporations, especially those of retailing one, may play a critical role in creating sustainable agro-food supply chains. Thus, what is an agro-food value chain? First of all, agro-food chain and networks are important because they provide producers access to markets, then they also affect the social, economic and environmental sustainability of all rural communities. We known from the famous economist Michael Porter, that defined the value chain in his book *Competitive Advantage* 1985[52], as "a set of activities that a firm operating in a specific industry perform in order to deliver a valuable product or service for the market". Porter proposed a general value chain that firms could use to examine all their activities and see how they are connected. The way in which a value chain is performed is determining in affecting the profits and costs of the organization and also helping an organization to understand what is its core activity. The value created and captured by a

[52] Porter, M. E. (1985), *The Competitive Advantage: Creating and Sustaining Superior Performance*,Free Press, New York.

company minus the cost of creating that value is the margin of the firm. The figure beyond represents the generic value chain of Michael Porter (Figure 8).

Figure 8

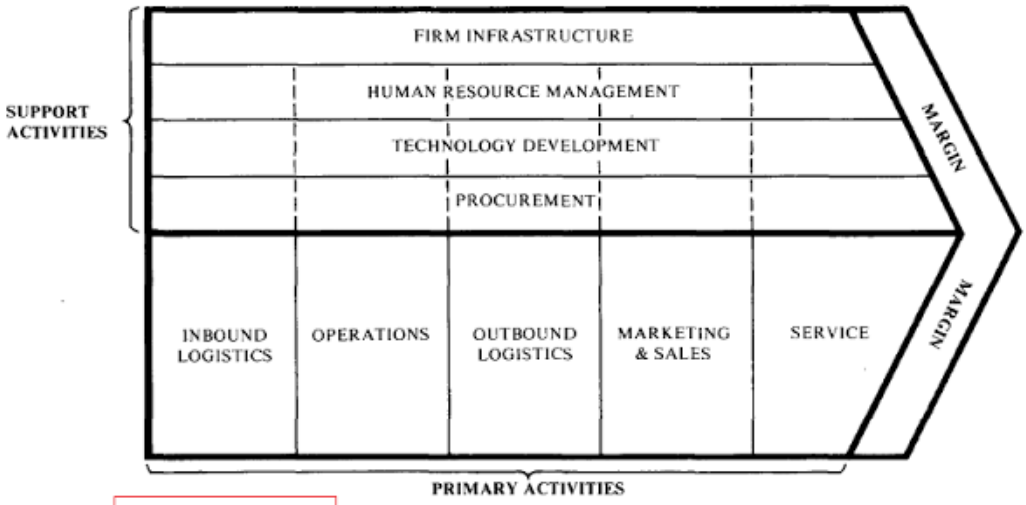

Figure 2–2. The Generic Value Chain

The agro-food value chain starts form activities of the value chain from the production in the farm to the processing, distribution and retailing to the consumer. According to the authors Chen et al (2005)[53], the terms "value chain", "supply chain", and "agro-food system" can be used interchangeably with slight differences on meaning dependent from contexts. In this case we can use the same term. Usually the agro-food supply chain is formed by a lot of independent actors and they are globally interconnected through a series of complex networks. The trend of globalisation is posing challenges to the firm that produce agro-food products, because the environment become always more complex and distant. Hence, serious concerns have been expressed by governments about the sustainability of these supply value chains. There are two main types of agro-food supply chain, one for fresh agricultural products and one for processed food products. The emergence of super markets imposes challenges to the agro-food supply chain. The globalisations process changes the mode of connectivity

[53]Chen, K.Z., Shepherd, A.W. and da Silva, C. (2005), *Changes in food retailing in Asia—Implications of supermarket procurement practices for farmers and traditional marketing systems*, FAO.

between the food production and the final consumption. From the global value point, the value chain perspective has become a central focus of many international development strategies. Sustainable agro-food has a critical importance for every country, because food security and safety it closed related to public health. Efficient and sustainable value chains are very complex because there are a lot actors involved and norms and policies that differ from country to country. An efficient logistic and distribution activity is very useful to guarantee a sustainable food supply chain and new technologies have a major impact in helping distribution. As we previously explained, the technologies of the fourth industrial revolution could improve the efficiency and the transportation and distribution, and we will see how this is fundamental in the retail of food. Logistics mechanisms change from country to country due to the differences in infrastructures, geographical situations and social capital. The global supply chain is defined as the set of economic administrative and political agents that work along the economic process of the production of the product. Thus, the global network is composed by suppliers, manufacturing and processing companies, distribution centres and computer operators. According to the article of Zecca et al.[54] *"Supply chain management and sustainability in agro-food system"* the main object of an efficient management of the supply chain is reduce the uncertainties. In the specific case of the food and beverage sector the main challenges that need to be face are the product bulkiness, seasonality, inadequate infrastructure and low market links at the firm level.
The traditional view of the food supply chain is usually represented as figure 9.

Figure 9

[54] Zecca, F. and Rastorgueva, N. (2014), *Supply chain management and sustainability in agri-food system: italian evidence*, Journal of nutritional ecology and food research, vol. 2, pp 20-28, ASP.

Furthermore, it is necessary to link relationship that happens within the value chain.

Food safety and high quality product are responsible for the functioning of the all supply chain and it improves customers ' satisfaction and trust. A sustainable supply chain requires transparency among the chain and a trusted relationship between the economic agents. The literature defines what are the main characteristics of the sector that have to be taken in account when managing the supply chain.[55]

The first one is hygienic safety, a key concern for all the stakeholders and represents the primary and most important goal of food producers. Safety is respected if all the stages of the cold chain are made in the respect of standards and norms. The second characteristic is traceability. It is a useful tool to trace the products during all the stages and also to guarantee food safety. Traceability also describes the information about the product process and history from the grower to the final consumer. The last characteristic I want to describe is the quality issue. Quality is essential in the realisation of the food industry. Compliance certification is one of the tools used to ensure the quality of products and the other two characteristics are themselves necessary to produce a product that is safe, good and healthy. Logistic is essential to move the product as fast as possible through the supply chain in order to guarantee the valuable quality and safety characteristics and traceability is the mean that help the logistics operations. Hence, logistic management can be considered as part of the supply chain management, that plans and controls the flow and storage of foods. Now the structure of the global market and the relative supply chain of the agro-food sector is going under big transformation due to the breaking of worldwide barriers and the new technologies availability. For this reason is becoming more important have a great knowledge about the dynamics of the supply chain and have a series of written rules and standards to deal with these complexities and ensure a great product for all the citizens.

At each stage of this food supply chain, current practices can be adapted to become less energy intensive and therefore smarter due to the technologies of the fourth industrial revolution. Such efficiency gains can often come from modifying existing farming and processing practices and distribution techniques at little or no cost.

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[55] Conray, P., Oehl, F. and Henry, C. (2011), *Food Safety: Top concern of food industry CEOs*, Food safety magazine.

After food has been harvested, improved transportation and infrastructure, better insulation of food storage facilities, reductions in packaging and food waste, and more efficient cooking devices offer the possibility of reducing additional energy use and costs in the food sector. The result is higher efficiency and quality.

2.5 The actors in a food supply chain

The stages of the chain that bring about the final product start from the raw materials to our plates, the so called "from farm to the fork"[56]. The chain is formed by a series of actors and relationships working together to make the food available. According to Dani and Page, the roles of the various actors in the chain is subdivided like below .

2.5.1 Producers

The food supply chain starts at the producer level, which produces food from the first raw material, vegetables, fruits, meat, fish and so on. The producers are farmers and the farming companies differ from the family-owned small ones and the big corporations. There are also actors in the food supply chain that provide inputs to the producers like farming machinery, fertilizers and so on. Usually these input providers have a strong power along the supply chain and they could charge the price they want. One complexity that influences the efficiency of the producers is climate change. Climate change, in fact, is unpredictable some time and can create environmental disasters and a delay in the all production process. Another concern for the producer is that their margins is getting smaller and smaller and thus they are increasing the sell price to have a more sustainable gain and continue to produce. This is fair for the all sustainability of

[56]Dani, S. (2015), *Food supply chain management and logistics- from farm to fork*, Kogan Page,London.

the supply chain but it is also causing problems on the availability of the core food products.

2.5.2 Processors

Processors are those people that transform food into products that satisfy the requests of the customers. This stage is also known as food manufacturing and it prepares the fresh product in ones that is ready to eat for the customers. Food processing companies are usually big corporations diverse in their nature because they transform food in different stages; for example freezing or making bakery products require different procedures. The food manufacturers need to have a strong relationship with the other food provider in the downstream supply chain and they need more technology addition and distribution channels to respond to the customers demand. A problem that producers are facing is the scarcity of resources, like water and energy.

2.5.3 Retailers and distributors

Distributors and retailers are two different entities. Distributors are those actors that link producers, processors and consumers. The distributors products can be both fresh food or processed ones and they deliver that to the various consumers entities. Distributors usually have their own distribution centres or warehouses when they keep food. Distributors a lot of times have to deal with local regulations when they act o a global basis and cross international boundaries. Instead, retail is the process of selling food products to customers through different channels of distribution. The retailers satisfy the demand identified through a supply chain. Retailers can be in the form of local shops or big super markets. A lot of times consumers have a large choice of retailers.

2.5.4 Consumers

Consumers are the final entities in the food supply chain. Food safety and quality is the major concern of customers. A challenge in which governments and food-sector organization have their focus is the food wastage at the consumer end. Awareness of the consumers can be a useful tool in order to reduce this phenomenon.

2.6 Types of food chains

Among the food supply chains we can differentiate between those who serve a business company and those who serve directly the final consumer. The second type tries to cover and satisfy the needs of customers.

2.6.1 Commodity- and producer-focused chains

If the product that comes from the farming process is not a fresh food like vegetables that are directly sold in the supermarkets, the other products are sold to manufacturing food companies that will process, transform and package the product into a final one. Strategic partnerships for this kind of supply chain are a tool to purchase big quantities of raw food materials. The deal of the commodities are conducted within contracts, in which the two parties sign to buy or sell an item for a future price decided today, with delivery and payment happening in the future. Usually the commodities that are deal in the contract are cocoa, palm oil, coffee, sugar, cereals, grains and so on. However, the price of these commodities is influenced by climate change, uncertain weather, and variations in global demand and supply.

2.6.2. Consumer-driven value chains

In the consumer-driven value chain food traceability is a very important element for the customers satisfaction. Meanwhile in the commodity chains food are processed, traded and sell to a retail environment, in the consumer-driven chain food is directly sold to the final consumer. The consumer-driven chain for this reason is more regulated and sometimes also vertically integrated. The consumer-driven chain works more on the principle of collaboration and cooperation than the commodity-driven ones. There are some barriers to enter and the codes and standards to respect, for instance some management systems for quality like the ISO 14000 or ISO 9000. Also tracking and tracing are very important because retailer make a stringent traceability scrutiny.

2.7 Factors influencing the food supply chain

The food and beverage sector is influenced by many factors, some of them are environmental so linked with climate change, but others are industrial, technological, economic, social and political. All these factors shape the availability of food, the quality and the transport of these. The actors in the food supply chain are trying to improve the functioning of the chain. The complexities in the chain comes from different areas:

- agriculture production;
- governmental and non-governmental actors;
- processing quality;
- consumer and market preferences;
- local authorities;
- logistic companies;
- a host of other small companies that are involved in the supply chain .

We know that the world is in continuous change and that now the advent of new technologies and business models are rethinking the way food is made and transported. Innovations in processing food and delivery have made products more adaptable for global distribution. Information and ICT technologies have made possible to respond to the increasing demand of customers.

2.8 Sustainability of the supply chain

In order to verify if a supply chain is sustainable or not, it is important to define and understand what it is and how become sustainable. Deloitte gave a definition of sustainability[57] as the responsibility for the impact that the organization exerts on its surroundings, in business, environmental and social terms. We can say that sustainability is a comprehensive management tool for the organizations in order to maximize the economic long-term value but not only, also social and environmental value. As we said, the recent trends of the world pose continuous challenges and sustainability development could represent a solution to maintain the competitiveness of the enterprises. Sustainability requires that the organization is aware of the presence of stakeholders outside the firms. Thus a firm is not operating alone in the environment but in a network of relations with the stakeholders and this relation a lot of time is based on mutual trust. The idea at the base of sustainability is that the first firm's objective is not maximize their profit but instead the primary objective is to maximize the "profits" of the community and the stakeholders. Sustainability is also regard transformation and development of the organization as well as the creation of long-term value based on knowledge and innovation. Linked to the concept of sustainability there is that of Corporate Social Responsibility (CSR). Corporate Social Responsibility is a business

[57] Deloitte (2018), Sustainability and corporate social responsability- response to the challenges of the modern world. Available on: https://www2.deloitte.com/ru/en/pages/risk/solutions/sustainability-and-csr.html [Consulted in 10/2018]

model that contributes to sustain development by allocating economic, social and environmental benefits to all the stakeholders[58] (Figure 10).

Figure 10

CSR is a broad concept that encompasses various topics such as human rights, environmental effects, healthy and safety, working conditions, corporate governance, economic development. Due to the power that many large companies have over the interests of sovereign nations, it is important their responsibility in this sense. Many corporations advocate the concept of the "triple bottom line"[59]: social, environmental and economic, or "people, planet, profit". Nowadays, the supply chain has emerged as the focus of corporate social responsibility. For instance organizations may hire a diverse workforce and empower the role of woman in the firm or another strategy can be ensuring that the international raw materials are taken in the respect of the foreign population. An example of a supply chain that follows the concept of corporate social responsibility is that of Fairtrade. Fairtrade[60] is a foundation that tries to empower farmers and workers in the developing countries by ensure fair living conditions and combat poverty. How Fairtrade is able to do that? They promote sustainability by setting social, economic and environmental standards for both companies and the

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58 Financial Times, Definition of corporate social responsibility. Available on: http://lexicon.ft.com/Term?term=corporate-sociòal-responsibility--(CSR) [Consulted in 10/18]

59 Brown, D., Dillard, J.F. and Marshall, S. (2006), *Triple bottom line: a business metaphor for a social construct,* Universitat autonoma de Barcelona.

60 Fairtrade, Il marchio del commercio equo e solidale.
Available on: https://www.fairtrade.it/ [Consulted in 10/18]

farmers and workers who produce the food. For farmers this means protect the workers environment and receive a fair salary plus an additional fairtrade premium to invest in the business community. Fairtrade is only an example of how to guarantee sustainability and development but there are a lot of corporations that now are using CSR business strategy as a model to doing business and as a marketing strategy. In the case of the Food and Beverage sector, a sustainable supply chain involving environmental, technology, market, regulatory and socio-economic considerations can be developed only when the stakeholders in the food industry come together and work beyond their organisational boundaries. Tracing products and tackling food loss and food waste is a good starting point for effective collaborative action. In particular retailers play a crucial role in the agro-food supply chains. Also the effort of governments are fundamental in the respecting of the global supply chain, they can establish a climate-resilient agricultural production system that make an efficient use of resources and avoid wastes, reduce gas emissions, ensure adequate nutrition encouraging an healthy lifestyle and take special care of the needs of the poorest people. Organised supply chains provide opportunities for the adoption and testing of new approaches to corporate social responsibility such as social accountability, good agricultural practice (GAP), total quality management, and hazard analysis at critical control points (HACCP)[61]. All these measures try to ensure the quality and safety of products. Several voluntary initiatives such as fair trade and ethical trade like codes of conduct and collective agreements have provided some benefits, but more challenges remain. Another initiative is that of Food and drink Europe, a food industry confederation that is trying to implement the UN Sustainable Development Goals (SDGs).[62] The sustainable development goals are part of the 2030 Agenda of the UN, that is a universal agreement relying on the actions all the countries for their implementations. Also private companies are always more aware about sustainability concerns, as in the case of Unilever, one of the biggest company of food and beverage and consumer goods worldwide. Unilever made the sustainable and

[61] Naik, G. and Suresh, D.N. (2018), *Challenges of creating sustainable agri-retail supply chains*, IIMB Management Review.

[62] Food and drink Europe, Food and Drink commitment to UN development goals. Available on: https://sdg.fooddrinkeurope.eu/ [Consulted in 10/18].

equitable growth as their core strategy, a real business model to create a long-term value for their stakeholders.

2.9 The digitalization in agriculture and food systems

The worldwide food is challenged to feed an estimated global population of 9,7 billion people and there are problems linked to the resource scarcity[63], the world is not an infinite resource to be squeezed but a finite resource to treat with respect. Agricultural land areas are already into production and the remaining ones are decreasing due to urbanization. Moreover the quality and safety of food is threatened by climate change and uncertain geopolitical landscape. Another concern linked to the food system is the change of the diets in many populations, now the diet is more based on animal-protein so there is the need to an efficient use of the primary sources. A strategy for enhancing the productivity of the production process can be implemented; it is characterized by the optimization of resources, the more intensive use of some production areas that are underutilized such as West Africa and Southeast Europe, a lesser waste of food in the supply chain, an expansion of the local environment production system, an healthier conditions of animals and crop. Digital technologies can support the farmers in producing safety and quality products. As we said previously nowadays digital transformation is affecting many sectors and also the related business models. The agro-food sector is transforming too and the consequences are huge. Today there are already many farmers that are using the digital technologies such as smart-phones, tablets, sensors, robots, drones and satellites.[64]

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[63] Van Es, H. and Woodard, J. (2017), *Innovation in agriculture and food systems in the digital age,* Cornell University.

[64]Simon, M. (2017), Robots Wielding Water Knives Are the Future of Farming, Wired. Available on: https://www.wired.com/2017/05/robots-agriculture/ [Consulted in 12/18].

Digital agriculture, also referred as "precision farming"[65] is a database system that comprehend data that are important for agriculture and provide farmers with an optimal decision-making function that help them to make the best decisions during agricultural production and marketing process. The aim in digital agriculture or farming is to enable the automation of sustainable processes in agriculture using the available information.

In digital farming there is the need for differentiated communication structures to deal with the complexities of the multitude of actors involved. Two conditions are necessary to make possible digital farming: smart machines and connected machines.

Smart machines are able to monitor, receive and process data meanwhile connected machines, must be able to transfer information and data between other machines and with business partners.

Thus, data management become one of the most crucial element of digital farming because enable that information are transmitted to all the actors of the supply chain. Thus data are important for the European farming sector in order to remain sustainable and competitive in the global environment. In particular in the food sector, data is an instrument to demonstrate the food safety and quality and respect societal expectations. In this way traceability and transparency are improved and it is produced better food for the growing population. Data bring to the digital agriculture several advantages, for instance:

- Data can be considered as a technology enabler: they are useful for precision farming tools work better, for instance in the use of Variable Rate Technology data improve the variable rate maps.
- They improved production processes thanks to the ensured visibility and transparency and it provides new opportunities for the operational control.
- They provide a support for the decision of the farmer giving information about the environment circumstances.
- The operations of the agriculture process are improved and inputs and outputs are optimised. Data are a tool to enhance efficiency and performance.

[65] Nesta (2015), Precision Agriculture: almost 20% increase in income possible from smart farming.Available on: http://www.nesta.org.uk/blog/precision-agriculture-almost20-increase-income-possible-smart-farming[Consulted in 12/18].

Another thing in which an efficient data management is useful is to connect stakeholders in rural agriculture, field agent, agro-input company and farmer[66], in order to improve agent productivity, product sales, and farmer crop yield. In this way both agro-input company and farm performance are improved.

These technologies help the farmer with a range of problems, such as the crop monitoring, water management, data collection. Many agricultural improvements can be facilitated by the new available technologies. Farmers can immediately known what the economic implications of a particular course of action. Farmers can now control in real time the healthy conditions and welfare of their animals, that can be monitored individually, this permit them to plan more efficiently and effectively their operations. There are many benefits linked to the use of digital technologies and they may include animal performance and optimization of process inputs. Digital technologies can also lead to a reduction of labour, improve the working conditions for farmers and reduce the environmental impacts of agriculture. Digital agriculture has been defined by Woodard et al[67]. as *"the deployment of computational and information technologies in farming, which will play a key role in achieving innovation goals. It is a new direction for precision agriculture, a more established concep*t *that is historically aimed at crop production".* The new digitalisation and automation offer new opportunities for the agriculture world for the availability of connected data and Internet of things as part of the fourth industrial revolution. These lasts can be applied in all the stages of the agriculture production system. The management of the farm is in transformation from a general management of the farm's resources to a highly organized, real-time and hyper-connected management. The expected benefits of the digital agriculture are more profitable, productive and sustainable systems.

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[66]Accenture (2018), Digital agriculture: improving profitability. Available on: https://www.accenture.com/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Digital_3/Accenture-Digital-Agriculture-Point-of-View.pdf [Consulted in 12/2018].

[67] Van Es, H. and Woodard, J. (2017), *Innovation in agriculture and food systems in the digital age,* Cornell University.

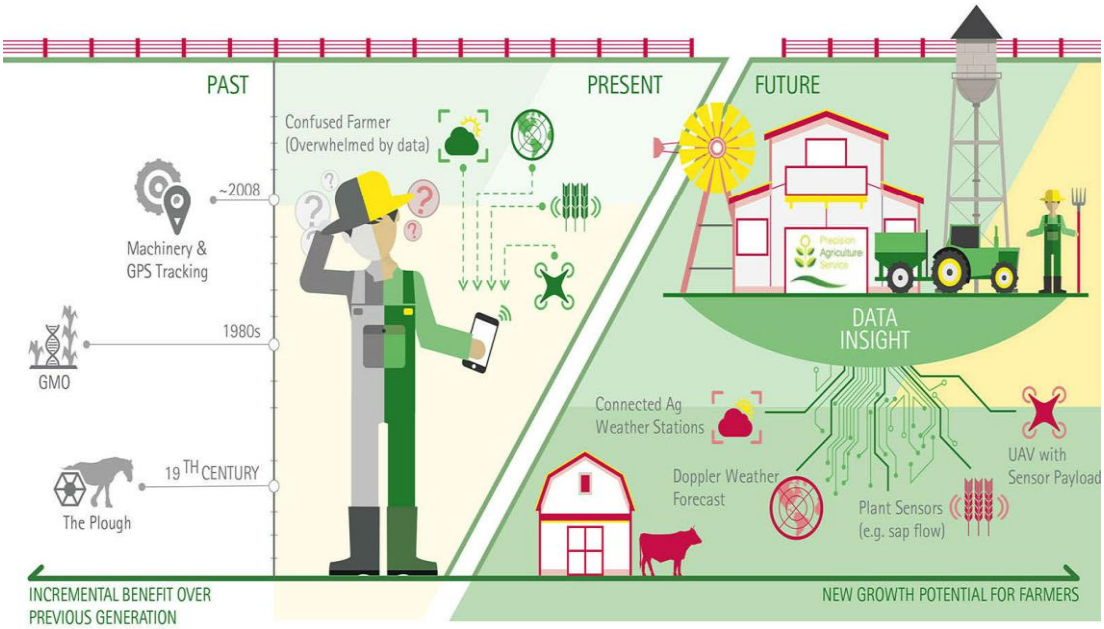
The technologies used include sensors, communication networks, artificial intelligence, robotics, and others advanced machinery and Internet of things. Each of them brings something valuable for the farmer. The utilisation of these technologies requires talent and knowledge so the necessary working force will shift from a low-skilled manual job to high-skilled ones. The digital agriculture innovation is both knowledge intensive that skills intensive because the solutions require knowledge ranging from broad to specific. Usually the solutions in agro-food are more complex and less scalable than the others manufacturing sectors. For this reason here digital transformation in the sector appear to be slower adopted than manufacturing counterparts. The digital innovations are for the major part used by few global-scale big companies. These company leaders are especially located in North America and West Europe and they differentiate themselves by their own ability to develop new skills, knowledge and technological improvements[68]. For the smaller companies is more difficult to innovate in this sense but in recent years they can offer also innovative technology solutions, typically these small companies are located in the same geographical areas. The link between universities and industries in many developed countries is a big incentive for the spread of the knowledge about the technologies of the fourth industrial revolution. In developing countries, university research in the field is limited by the separation of agriculture from the other science discipline. In general, the primary innovations occur in only certain states because of the institutional and economic barriers. The use by farmers across Europe varies from country to country. Small farms around the world follow traditional farming practices, most of the time is due to the lack of information and capital required for the introduction of these technologies. These workers lack of agriculture knowledge, technology and they see no benefits from the adoption of the technologies.

Moreover, these technologies require an initial investment and they could seem too much complex and discourage their adoption. Awareness is essential for the understanding and adoption of them and also training can be a specific tool in order to

[68]Donnan, D. (2016), Agriculture is a fertile ground for digitalization, Food quality and Safety. Available on: https://www.foodqualityandsafety.com/article/agriculture-fertile-ground-digitization/ [Consulted in 11/2018].

enhancing the competences of the producers, so that also reach also small and medium enterprises.

Figure 11



Source: Accenture

The future of farming is very bright. There are always more precision agriculture technologies every day and they represent an enormous value added for the farmers in the way they change the organization and management of the firm. The farmer of the future will be an individual more acquainted with the technologies of the fourth industrial revolution capable of managing the data available and the Internet of things, if now it is confused and overwhelmed by data, institutions, universities and other stakeholders in the chain have to collaborate in order to improve and permit the transmission of knowledge. Data will be gathered more frequently and accurately and the farmer then will analyse and interpret those data and he could take the appropriate decisions in real-time. The digital agriculture has the benefit to improve potential

profits, make agriculture more productive in order to satisfy the increasing demand of customers. It is not only beneficial for farmers and organization but also for the society as a whole.

Some examples about the digitalisation of agriculture are in the farming of oysters in Tasmania.[69] The technology company, the Yield, has made a partnership with Bosch. The objective was to avoid the contamination from pollutants and avoid diseases that bring with it. They had used sensors and predictive analytics in order to make precise prevision about the contamination of water so that farmers could reduce oyster loss. Another example is about the savings of water in the cultivation of potatoes. PepsiCo was a case of success in doing that, thanks to the technologies of the fourth industrial revolution. They were able to monitor the humidity of the ground and to make more efficient weather forecasts. This lead to an improvement in sustainability and a decrease in the water used for irrigation.

Moreover, digitalization of the agriculture process may have the benefit to advance many of the Sustainable Development Goals (SDGs) of the UN 2030 Agenda. It helps by reducing the production loss and improve food security, by creating a sustainable management of water, by giving more power for those that work in agriculture, by improving farmers supply chain through integrated systems and sharing of information, by helping the development of cities and communities, by providing information which allows consumers to be more responsible, by improving water quality with aquaculture technology, by allowing companies to partner to increase the impact on all the sustainable development goals through improved availability of information.

[69] Breakthrough (2018), Digital agriculture, Projects breakthrough, disruptive technology executive briefs. Available on: http://breakthrough.unglobalcompact.org/site/assets/files/1332/hhw-16-0025-d_n_digital_agriculture.pdf [Consulted in 12/2018].

2.10 Defining the terms Agriculture 4.0 and Digital farming

We can explain the passage that pass through agriculture 1.0 to agriculture 4.0 and what it changed during the years with the related benefits.

Agriculture 1.0 is that situation that appears in the early 20th century[70]. The major part of the population was active in the agriculture field but the productivity was still low and agriculture was based on labour intensive. They were able to feed the population but with a high degree of people working in the sector.

Agriculture 2.0 was remembered as the great revolution and happened in the late 1950s. In this phase have been created new tools for agriculture like pesticides, fertilisers and new machine for improve the working conditions. Thus the productivity was increased.

With agriculture 3.0 was born the precision agriculture. It started when GPS signals were made available for public use. What does it mean precision farming? Precision farming enhances the precision of operations and permit to known to position of the single animal rather than the herd as a whole. The objective is to minimize the use of input and obtain a more quantity of output, hence, improving the efficiency of agriculture. Precision agriculture imply solutions for[71]:

- Guidance, the firsts GPS systems were used for a scope of guidance. The firsts solutions appeared in the '90s and then in the 2000s the technology improved until an accuracy of 1 cm.
- Sensing and control: the technique of Variable Rate Application permitted in the 2000s to map and sensor the application of a material in a precise location or the quality of the area where the material is being applied to.
- Telematics is a technology inspired by the transportation industry and it is used to monitor the vehicles in order to optimise the logistic in the farming process.

[70] European Agricultural machinery association (2017), *Digital Farming: what does it really mean?*
[71] Ivanov, I. (2018), Digital technoogies in agriculture: adoption, value added and overview, Medium. Available on: https://medium.com/remote-sensing-in-agriculture/digital-technologies-in-agriculture-adoption-value-added-and-overview-d35a1564ff67 [Consulted in 11/2018].

- Data management is tool available from the birth of portable computers in order to manage data.

Then in the passage towards agriculture 4.0 the introduction of intelligence was crucial. In 2010s we can assist to the improvement of a lot of technologies as:

- Big data analytics,
- Cheap and enhanced sensors,
- Micro-processors,
- Cloud based ICT systems,
- High bandwidth communication.

Moreover, smart technologies are affecting also physical products adding a non-physical service in order to transform data into value adding information and optimise the agronomic process. Agriculture 4.0 also enhances the cooperation between the actors in the supply chain and data are the glue of the relationships between them.
The term agriculture 4.0 is strictly related to that in industry 4.0 and means an integrated external and internal networking of farming operations. For describing the same phenomenon are also used the terms Smart agriculture and Digital farming. Thus thanks to the new revolution in agriculture information are available for all farm sectors and processes, communication is carried out electronically, and the processing of data are automated. We can say that agriculture 4.0 opens the way to a new revolution of farming that it will be based on artificial intelligence and robotics.

2.11 The current state of digitalisation in Italy

The most interesting areas of research that currently concern the agro-food sector involve the dematerialization of procedures, traceability, precision agriculture and the Internet of things. Among these factors, the fourth is the most complex, because the

Internet of Things embraces a truly huge and constantly evolving sector. We are talking about a growth so fast that can make a technology obsolete at the same time it is applied. How can this situation be managed? How does the agro-food system have to approach the digitization process that is penetrating all sectors? It is not a simple answer, but we can try to give an idea of the dimensions.

According to the Istat data[72], the agriculture sector is transforming but only the 4% of the agro-food firm are digitalized. A number that change with the 1,3% in the south of Italy and with 2% in the islands. Between the firms of the sector only the 1,2% surf constantly the Internet. These are really low percentages, conditioned by the lack of skills among company leaders, but also by the "oldness" of Italian digital infrastructures, certainly accentuated in rural areas. Although the very negative data, we can identify some niches in which the digitalization process is increasingly efficient. Among the companies with biologic production, 63% of these are in the south, the indicators on digitalization are increasing. According to Bioreport, the 15.6% of companies that produce biological products are digitalized, compared to 4% nationally is a big number. The 10.8% has a website, compared to 1.8% nationally and 2% practical e-commerce, compared to national 0.7%. This is big step forward if we think that only few years ago, talking about e-commerce in the agro-food sector seemed impossible. Today, thanks to new consumer buying preferences, e-commerce has become the new challenge.

If the digitalization of companies were to develop decisively, Italy could become a leader in online food & beverage sales. The Kpmg survey, presented at the "Italian food takes off on digital platforms" workshop, held at Cibus Connect, is talking about a return of over 3.5 billion euro. The e-commerce of food and drink in Italy covers only 0.35% of total food sales (€ 570 million), but represents an enormous opportunity to be exploited. Although Made in Italy food is appreciated all over the globe, it is absolutely

[72] Vecchio, Y. (2017), Digitalizzazione in agricoltura, a che punto siamo? Osservatorio alimentare. Available on: http://www.osservatorioagr.eu/approfondimenti/digitalizzazione-in-agricoltura-punto/ [Consulted in 12/18].

necessary to propose the right mix of products and create targeted strategies, identifying exactly the markets where digitalization go better.

Furthermore, consumers are increasingly aware of the origins and methods of production of what they eat and they require always more safe, healthy and quality foods, thus it is important let known them where the foods come from. To achieve this information, integration between apps and QR Codes is an important tool. An example? QR Codes present on peaches and artichokes packages that, through special digital applications, allow us to trace the path from which the product originates, to know its characteristics and understand its production process.
Smart-phones become for consumers, but also for producers and consultants, the most important tool for finding information on the product before purchasing.

2.12 Logistic and traceability in food and beverage, a case of Logistic 4.0

How are transforming logistic and supply chain with the advent of industry 4.0? There are already a lot of enterprises that understand the opportunities of the digitalization of the value chain. The benefits are huge in terms of saving time, reducing costs of raw materials and enhance the customer satisfaction. Companies that want to remain competitive must digitize and connect their supply chains, extending them even beyond their borders. In supply chain 4.0, the normal techniques of supply chain management are applied to industry 4.0 technologies thus, Internet of things, robotics, big data, to improve performance and customer satisfaction. Logistic has undergone a profound change, digitalization creates a disruption and requires companies to re-think the design of their supply chain.

To create sustainable food and beverage supply chains, data needs to be recorded in the supply chain for traceability and visibility. For food manufacturers is really important to ensure a steady supply of raw materials. The food and beverage industry has to control the all supply chain, maintaining relationships with their suppliers. Software and

technologies help the process of control and evaluation giving visibility of the stages. Traceability also help the pressure of consumers that want to known always more the origin of what they buy and eat. They want to be sure that they buy a product that does not hurt the environment and the producers. The technologies of the fourth industrial revolution permit to manage and controlling through automation and data capture the movements of the containers. The main task includes the traceability and control of the movements of containers and accumulation of transport units within the logistic centers.

During my internship at System Logistics Spain I had the opportunity to visit their centre of distribution in Valencia with the industrial machine for the automation of the food and beverage sector. System Logistics, in fact, is a leading global supplier of innovative solutions for intra-logistics and material management. Their aim is to optimize the supply chain and the manufacturing operations worldwide. System has a special focus on food and beverage industry and it develops solutions for automated storage and picking. System Logistics is now part of the Krones group, a German worldwide company leader for packaging and automation in the food and beverage sector with a turnover of over 3 billion of euro. Their human resources are characterized by an high level of knowledge of the industry in which the customers operate. System logistics is a dynamic company that invests in research and development activities and it is always at the forefront of technological innovations. The innovative solutions can improve the quality of labour and efficiency. Their vision is to constantly spread innovation as a way of improving the quality of life. They supply intra-logistics solutions in order to improve occupational health and safety, simplify the complexities of process and flows, optimise the use of resources and increase reliability and performance. The key of their competitive advantage is innovation as they always search for new ideas in order to create high value solutions. Moreover, Krones group is a big player in the food and beverage supply chain, it provides breweries, beverage bottlers, and food producers all over the world with individual machines and with complete production lines. Their aim is driving digitalization and shape the way of food and beverage's doing business in the context of Industry 4.0.

The warehouse that I visited in Valencia, is a centre of distribution of Coca-Cola Spain, and System Logistics has the aim to improve at best the management of these products. In this way they become able to answer to the increasing demand of the Spanish Catalan area's market. How does it work the centre of distribution of System Logistics? First of all, for them digitalisation is subdivided into five aspects: integration, digitalised supply chain, collaboration, analytics and total productive management (Figure 12).

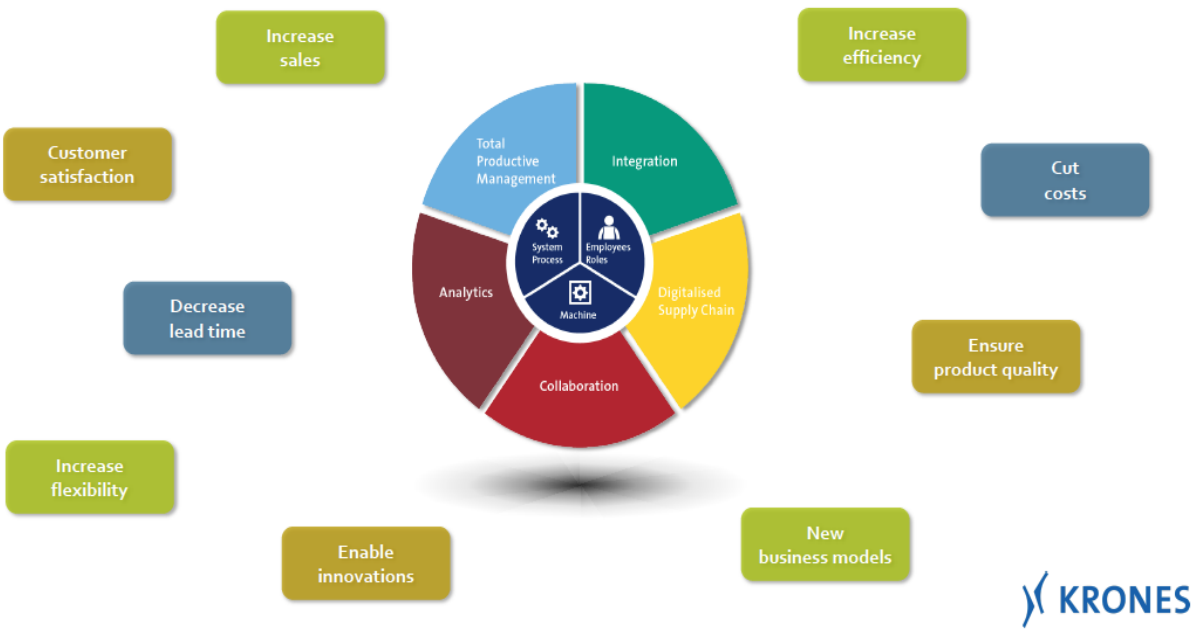
By using intelligent sensor technology and prefabricated IT components, System Logistics gets older machines fit for digitalization that were previously unreachable for data acquisition. In this ways clients can obtain information from machines and systems and the barriers between the information levels are eliminated. The warehouse of Coca-Cola Iberian partners, called DSL, is composed by 67.000 pallets and 10 stacker cranes. In one day the maximum capacity is 360 pallets incoming and 490 pallets that are delivered by camions. The turnover of one package of material is about 48 hours and they have a logic of just in time shipping and an automatic refilling way of picking materials.

With their smart machine are fully prepared for digitalization, and their IT solutions, which cover the categories of production, filling and packaging plus intra-logistics, they create the requisite basis for digitalization: namely to make digital data available for the entire processes in a factory, thus enabling them to then be utilised from the viewpoint of the entire value added chain. Data are available in sufficient quality and quantity. In the all warehouse there are computer to control a certain area of the centre and is all monitored both by technicians both by informatics by remote. The material supplied and the production lines are always organized in an efficient manner, the orders are processed according to the demand in order to avoid wastes.

They are able to calculate the consumer load and suggest the residual quantities for return transfers of processing and operating materials. Traceability is assured by identification codes that are applied on every lot. All operational tasks can be handled with a tablet that every operators had and enable them to easily validate and coordinate materials for all active and upcoming orders. Computers and tablets provide an easy and quick way to capture material information and allow mobile material requests. All

orders and material information generate a complete track and trace report and enables recall actions as well as measuring supplier quality. Thanks to the technologically advanced procedures, the operators' workload on the line is increasingly reduced. Man and machines work in synergy and the efficiency of the daily work routines is enhanced. The machine networks and the IT systems are linked with the company's staff on a central platform, thus creating a comprehensive pool of knowledge that makes available, any time, any place, all relevant information on the lines, and on request as an IoT solution in the cloud as well, if the client so desires. The events in the process of operations can be tracked in real time, in mobile mode, independently of the location involved. If a malfunction happens, operators and technicians can intervene to solve the situation.

Figure 12



Source: Krones group

One of the most interesting things that I notice during the visit is the scarcity of the people involved in the centre of distributions. Thanks to the automated picking material a lot of jobs are not more necessary. For instance the warehouse workers are not anymore needed because now is all automated and there are the stacker cranes for doing that job. Thus manual jobs are always less requested and substitute with more multi-task jobs. In the centre of distribution I saw more or less ten technicians checking that the

procedures are carried out correctly and only in case of some mistakes they intervene. These technicians are becoming supply chain "orchestrators", seeing, managing and optimizing the whole chain. Achieving this will also require a shift to a fast-learning and open digital culture that promotes communications across different user groups. They need to develop their talent and skills to build their technological expertise and carry out the new supply chain operations.

2.13 Grocery retail and food service

After having explained the influence that technology of the fourth industrial revolution has on the agriculture stage and on distribution one, let's see the effects on the retail phase of the supply chain. Now retailers must consider the opportunities that digitalization offers for engaging with customers and gain more revenues. Digitalization is revolutionizing the service sectors, and we can experience a product that is sold or delivered to the customer with a big component of service. Product, services and their business models are changing. There are market's conditions that force the large scale's retailers to augment their efficiency and a lot of companies have already started to change[73]. This choice is linked to a matter of survive especially in the food and beverage sector. Every company want to guarantee a range of newer, fresher and higher quality products and at the same time ensure a great service to customers. Thus food and beverage companies are continuously innovating in the socio-technological context. Also the consumers' shopping behaviour is changing and this influences the strategic choice of retailers. Delivery performances need to be improved and must be more customer-driven[74].

Central to this shift there is the new digital platform rapidly emerging in the most industrialized nations. First of all, the grocery retailing is always been a business with

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[73] Crowe, E. (2018) How technology is shaping the future of food retail, Smartbrief.
Available on: http://www.smartbrief.com/original/2018/04/how-technology-shaping-future-food-retail [Consulted in 12/2018].
[74] Grewal, D., Roggeveen, A.L. and Nordfalt, J. (2017), *The future of retailing*, Journal of retailing, 2017.

its complexities like perishable products with different handling requirements and different temperature requirements. Then the sector is always characterized by thin margins and high fixed costs[75]. In the retailing environment, costumers' preferences are still driving their purchasing decisions. The online grocery industry is characterized by the need of reducing transportation costs and to deliver always more rapidly. Thus companies are trying to upgrade their warehouses, distribution, production and information management strategies.

Now new technologies (robots, Internet of things), new business models and big data analytics suggest that the shopping process is changing. For instance, companies such as Amazon and Walmart are adopting strategies towards the use of new technologies in order to take advantage of it and remain at the state of the art of their competitors. Walmart creates a push model that ships goods to Walmart shops across the whole country and it offers everyday low prices[76]. Amazon, instead, operates with a pull model that answer directly to the customer's needs and they ship packages rather than pallets of goods. Amazon created a new subsidiary called Amazon Fresh[77], providing services of grocery delivery and it is currently available in some US states, London, Tokyo, Berlin, Hamburg and Munich. It is targeting specific parts of various metropolitan areas and it is making partnership with some local specialised stores in order to deliver local items. It is a delivering service that lets users shop online, reserve items to pick up the groceries and have them loaded into their cars at home.
The digital reframing of the retail business changes the customer's shopping experience from older placement to delivery. The conventional grocery shops are facing an incredible threat by this new business model and in order to remain competitive they must adapt. The new competitive model gives to consumer the opportunity to facilitate

[75] McKinsey (2018), The future of grocery in store and online.
Available on: https://www.mckinsey.com/industries/retail/our-insights/the-future-of-grocery-in-store-and-online [Consulted in 12/2018].

[76]Laseter, T., Lauster, S. and Hodson, N. (2017), *A strategist's guide to the digital grocery*, Strategy business magazine.
[77] Amazon, definition di Amazon Fresh. Available on:
https://www.amazon.com/AmazonFresh/b?ie=UTF8&node=10329849011 [Consulted in 06/2018].

their decision choices and have even large options for pickup and delivery, all with less costs and much convenience[78].

With the increasing focus of Walmart and Amazon on selling fresh food, the e-commerce shopping will considerably increase especially in the big cities. According to Coca-Cola president of North America, Sandy Douglas, this represents a strong opportunity for food and beverage makers. With more sales revenue moving online, the drinks giant has made digitalisation its top priority. The top executive conceives a future in which people can made online shopping.

Furthermore, e-commerce represents an opportunity for companies to growth for both food manufacturers and grocery retailers. A study published in 2016 by the Food Marketing Institute[79], an American food marketing organization, showed that in the 2007 there were a 67% of shoppers in US states that chose a supermarket as the primary way to purchase food. However, this number falls down at 49% nine years later. And for certain would continue to fall in the future years. Moreover, Euromonitor International[80], a global market intelligence publisher proving market research reports and statistics, predicts that Internet retailing of food and beverage in every region of the world will grow much faster than store-based grocery.

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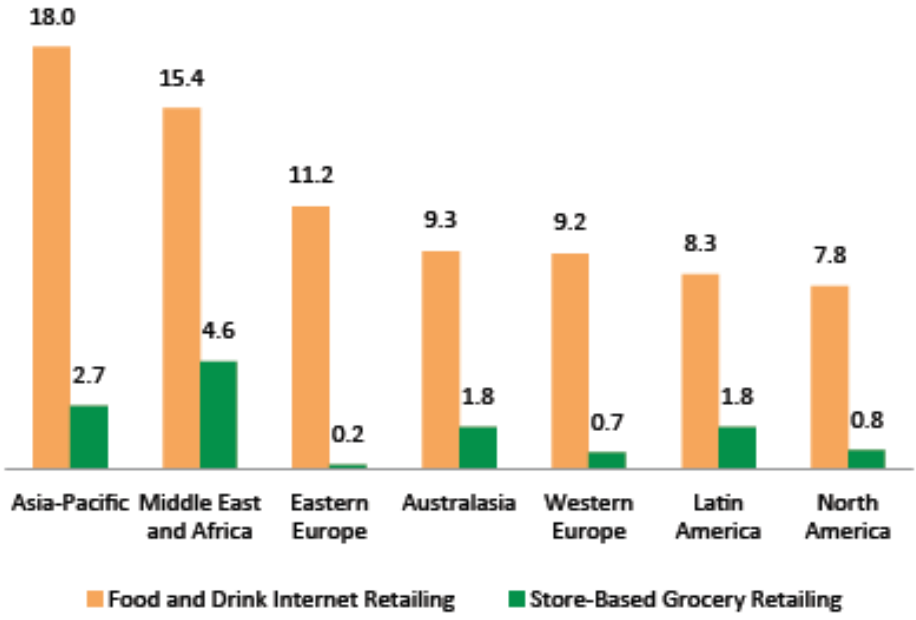
[78]Dello Stritto, G. and Schiraldi,M.M. (2013), *A strategy oriented fremework for food and beverage E-supply chain management*, International journal of engineering business management.

[79] Food Marketing Institute (2016), US Grocery shopper trends 2016.
Available on: https://www.fmi.org/our-research/research-reports. [Consulted in 12/2018]

[80] Euromonitor Communications (2017), E-Commerce Is the Fastest Growing Global Retail Channel Through 2022, Euromonitor International. Available on: https://blog.euromonitor.com/e-commerce-is-the-fastest-growing-global-retail-channel-through-2022/ [Consulted in 12/2018].

Figure 13: Food and drink internet retailing vs. store based grocery CAGR (%), 2015-2020E



Source: Euromonitor International

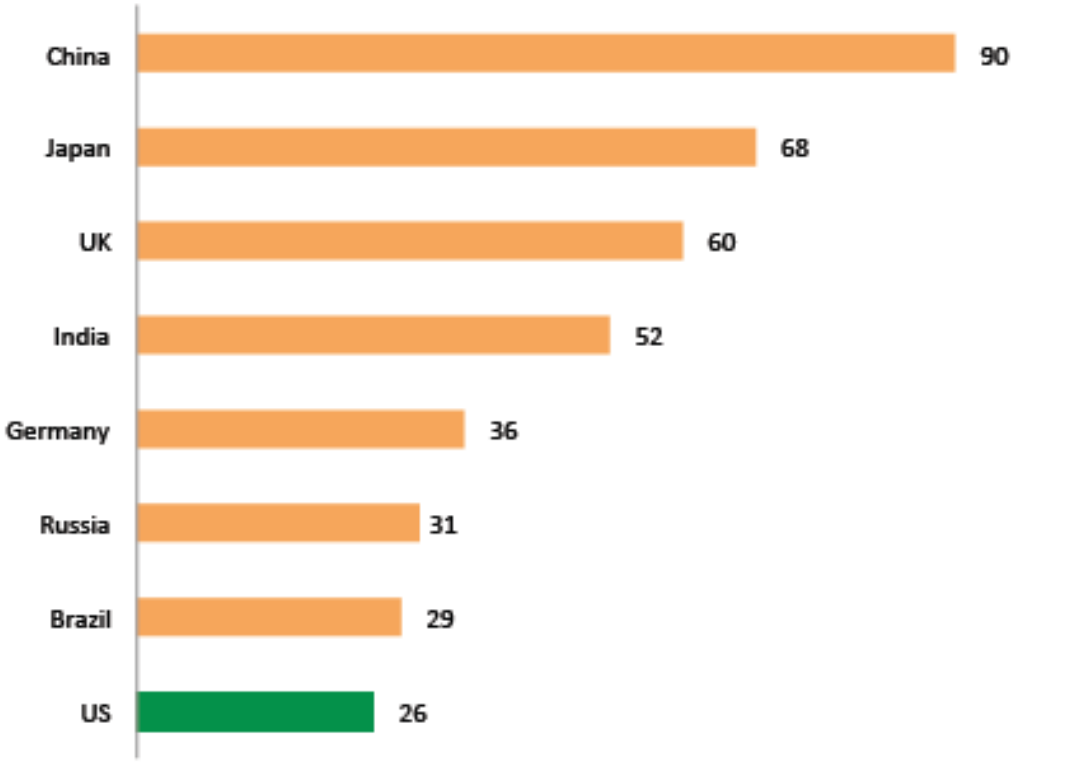
They used the compound annual growth rate (CAGR)[81] to measure the importance of the Internet retailing in food and beverage. The compound annual growth rate is the average annual growth rate of an investment over a period longer than one year. The value of an investment at the end of the period is divided by the value of that investment at the beginning of the period. Despite this growth potential, e-grocery is still an underdeveloped channel and there is only a small portion of grocery e-commerce sales. These sales can be attributed to that portion of population who do no want to move to make their shopping or who could buy products that are difficult to find otherwise.

Another study conducted by A.T. Kearney [82]showed that the 26% of Internet-connected consumers in the US had bought grocery products in Internet, a low level of penetration

[81] Investopedia, definition of Compound Annual Growth Rate – CAGR.
Available on: https://www.investopedia.com/terms/c/cagr.asp [Consulted in 12/2018].
[82] Coresight research, The digitalization of food: grocery retail and food service.
Available on: https://www.fungglobalretailtech.com/research/digitalization-food-grocery-retail-food-service/ [Consulted in 12/2018].

for a western country. However in UK and in China things are different, a percentage of 60% in UK bought through e-grocery and in China this rate become even of 90%.

Figure 14 : Internet-connected respondents who said they had bought groceries online in the past three months, selected countries, 2014 (%)



Base: 10,000 Internet-connected consumers

Source: A.T. Kearney

In Italy things are different, also if the investments in digital retail are growing, still they represent only less the 1% of the annual revenue[83]. The 65% of top retailers in Italy blame a lack of a clear strategy of digital innovation as one of the problem for the

[83] Osservatori.net (2016), L'innovazione nel retail: gli investimenti in digitale crescono, ma valgono ancora meno dell'1% del fatturato. Available on: https://www.osservatori.net/it_it/osservatori/comunicati-stampa/la-innovazione-nel-retail-gli-investimenti-in-digitale-crescono-ma-valgono-ancora-meno-dell-1-del-fatturato [Consulted in 12/2018].

implementation of digitalization, meanwhile for the small retailers, high cots and lack of internal competences are the reasons for the late in the transformation.

2.14 Digitalization of competences

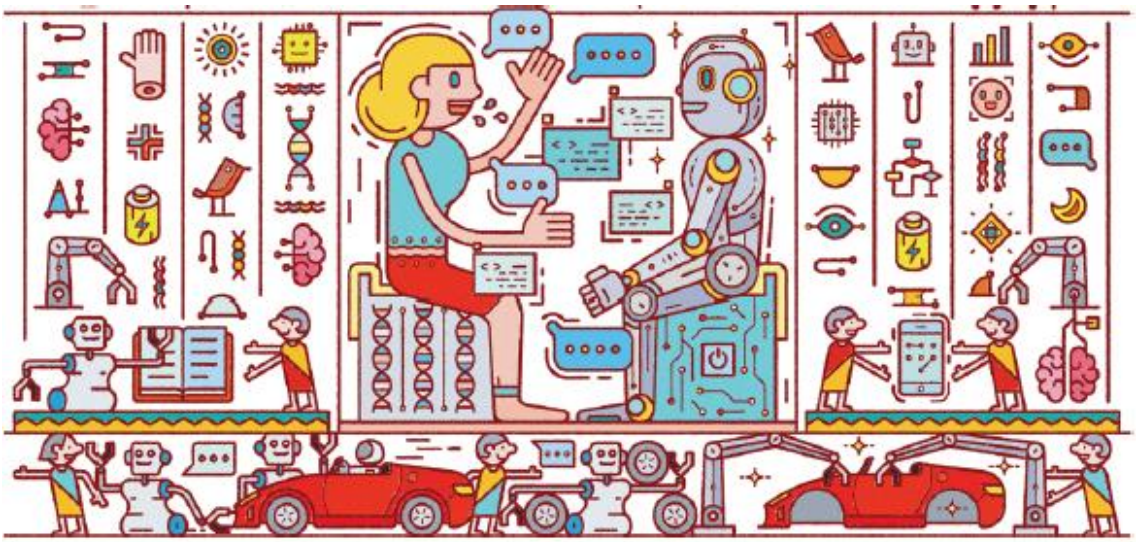
During this chapter we analyse the effects of the digitalization and of industry 4.0 on the different stages of the food supply chain. We have seen as the figure of farmer will change always more, from manual work to more skilled-enhanced ones.
Digital innovation brings about also a lot of challenges as we said in the previous chapter, and one of these is the transformation of the working world.

According to the article of Harvard Business review *"Collaborative intelligence: human and artificial intelligence are joining force"*[84] the technology's larger impact will be in complementing and increasing human capabilities but not replacing them. The companies that would displace employees to replace them with automate process will have only short-term productivity gains but in the long-term things will be different. Hence, machines and workers need to work together in order to get the best performance. Always according to this article those that would bring the most value added will result from the collaboration between workers and machines, because they enhance complementary strengths like teamwork, creativity, leadership of the former and speed and quantitative capabilities of the latter. Business needs all of these capabilities. Thus, the collaboration between machine and workers needs to be optimized through a redesign of the work in order to incorporate machines and automation. The business process also has to be redesigned to embrace machines and employees involvement. Companies need to create a solution together with stakeholders and on how they might collaborate with the machines in order to improve a process. For instance, the case of large agricultural company that wants to make use of machines and

[84]Wilson, H.J. and Daugherty, P.R. (2018), *Collaborative intelligence: Humans and AI are joining forces*, Harvard Business Review.

artificial intelligence to help farmers and the initial plan was to create an application of artificial intelligence that would make more accurate forecasts about future crop yields. However this was not the necessity that farmers required, indeed they wanted a system that could provide real-time recommendations on how increase productivity, for instance how much nitrogen to use, which crops to plant and where an so on. At the end the company developed these systems and farmers were happy about the results. So companies that want to implement machines and artificial intelligence need to consider the stakeholders needs, as in the case of the farmers, and create machines in collaboration with them, not replacing them. Furthermore digitalization can help employees to take better decisions, because it provides them several information and data.

Figure 15



Source: Harvard Business Review

Changing a business model does not only mean implement the new technologies of the fourth industrial revolution, but also requires developing the skills of employees to better meet the machines interface and work effectively together. First of all people need to delegate tasks that previously they performed manually or individually to the new technologies. People must do new and different things and to do things differently. Employees have to mix their competences with that of the machines and learn about how to use digitalization and how to interpret data that come from digitalization. For

instance, they have also to learn how to put the best questions to an artificial intelligence agent to get the right information. Thus corporations in the future will be organised around different kind of skills rather than around rigid job titles. In order to transform the business digital skills are required. These skills have a great impact when they are applied in the organization as a whole. We can summarize eight skills that are necessary for the business transformation[85]:

- Digital knowledge, refers to the ability of exploiting digital technologies in business.
- Information management, refers to the ability of reading, understanding and sharing information that come from digitalization.
- Digital communication, refers to the ability of communicate with stakeholders and maintain the relationships through the use of digital tools.
- Networking, refers to the ability to collaborate in the digital environment.
- Continuous learning, refers to the ability of improving the knowledge about the digital resources, taking part in the learning communities.
- Strategic vision, refers to the ability of incorporate digital culture in the strategic approach of the business.
- Network leadership, refers to the ability to coordinate the work teams that are spread in the digital environment.
- Customer orientation, refers to the ability of understand customer needs and interact with them in a digital context.

The actors of the food supply chain must be acquainted about these new skills in order to remain competitive in the field. Food organization must develop new business culture based on a set of digital skills, accepting the advantages related to the digital transformation. Farmers need to understand that their competences are changing and they must adapt if they want to survive. Distributors must ensure the quality and safety of food through a system of traceability and a good information management and

[85] Magro, C., Salvatella, J., Alvarez, M., Paredes, A. and Velez, G. (2014), *Digital culture and transforming organizations*, RocaSalvatella, Barcelona.

retailers need to be always more customer-oriented and satisfy the digital request of their clients. The world is changing and the food and beverage sector is feeling the consequences and the competences must follow the transformation.

CHAPTER 3: QUANTITATIVE ANALYSIS OF PARMA'S FOOD VALLEY

3.1 Introduction

The food supply chain in Emilia Romagna represents a cluster of international excellence capable to meet tradition and innovation, achieving high quality and safety standards. Regional enterprises are competitive not only for the farm productions as vegetables and animals but also due to the efficiency of the transformation and processors manufacturing and in the complementary sectors like that of agricultural mechanics and packaging for food. In Emilia Romagna there are 41 certificated products as DOP (Denominazione di origine protetta) e IGP (Indicazione geografica protetta)[86], it is the biggest number in Europe. Moreover there are famous brand known worldwide as Parmigiano Reggiano, the Prosciutto di Parma and the Aceto balsamico di Modena. Research laboratories in the region together with universities, organized in the agro-food platform, work for the quality and the safety of their raw materials, processes, machines, industrial installations, finished products and health related issues. This regional food supply chain has an high level of exports, in the 2016 they accounted for 7 billion. The reference market was Europe, followed by North America and Asia. The level of employees in the region is the higher in the province of Bologna, Parma, Modena, Reggio Emilia and Forlì-Cesena. However if we consider each sector, we can find specialization in all the provinces. Cooperative organizations also play a critical role in the food supply chain of the region. Among vegetal productions the most strong and important are cereals, potatoes, vegetables as the industry of tomato in particular, and pears, nectarine and wine. Among the animal productions of the more important we have milk followed by chicken and rabbits and then pork, beef and eggs. Also the industry of transformation of food has an important impact in the food chain, even tough there are also some related industries that represent one of the strongest points of

[86] Ervet (2015), Investire nell'agroalimentare in Emilia Romagna.
Available on: http://www.ervet.it/wp-content/uploads/downloads/2015/05/Investire-nell-Agroalimentare-in-Emilia-Romagna.pdf [Consulted in 12/18].

the entire supply chain, like that for agricultural machines and food packaging. Moreover the cold chain, efficient and rooted in the territory, contributes to preserve the high quality of regional products. The area is so important that here they organized about 14 international fair about agro-food. Two of the most important are Cibus and Cibus Tec Food Pack located in Parma. Cibus is the "Salone Internazionale dell'Alimentazione", and also in 2016 was confirmed as the major fair in Italian agro-food with a lot of discussions about food and retail. Innovation is one of the main characteristic of this fair, indeed they present conventions about the most innovative research in food and beverage field. The conventions, told by the protagonists of the sector, are about Food processing 4.0 and the enabling technologies. At the Parma fair is possible to see applications, products, and solutions of the fourth industrial revolution applied in the food and beverage industry. The food and beverage is one of the principal manufacturing sector in which these kinds of technologies can be applied and customization makes the difference in the global market. As Michele Bauli, vice-president of the Bauli group, observed "the digital transformation is really important, we are at the beginning of a new revolution, because the digital technologies permit also at the food industries, that usually are considered old economy, to realize a better product and in a more efficient way, so with a lesser cost"[87]. Made in Italy is a product sold all over the world and with these new technologies the product is optimised and can be controlled at any time. In this way they can guarantee more safety and quality. According to Bauli, the integration between tradition and innovation is the crucial key to reach the final consumers.

[87] ANSA.com (2018), Industria 4.0: da Verona a Parma, cultura distretti del food.
Available on: http://www.ansa.it/sito/notizie/postit/Industria_4/2018/02/28/industria-4.0-da-verona-a-parma-cultura-distretti-del-food-_6696008b-abf7-4590-9e93-39a9d5243d97.html [Consulted in 12/2018].

3.2 Parma's Food Valley

Parma is an area for agro-food. On the provincial territory there are indeed concentrated a whole series of connected agricultural and industrial activities forming a network that allow to define the Parma area as a district of agro-food supply chain. Alongside a myriad of micro and small businesses, some of the leading international companies in the field of milk, fruit, juices, pasta products, and bakery products also operate in the Parma area. In the same area are also identified numerous food plant companies that offer mechanical and technological support to the before mentioned activities of food production, including bottling, storage, packaging and measuring instruments. Lastly, the university research centres (veterinary, food science and technology, agro-food and business economics, industrial engineering) and the Experimental Station for the Food Preservation Industry carry out an invaluable activity to support companies and continuously make advancement in research and development. Moreover the link with the university brings about several high skilled and specialised employees. All the productions of the agro-food sector in Parma are over the 35%[88] of the entire industrial turnover of the province, and if we consider also the industrial machines for food and beverage the percentage augment at 50% of the total manufacturing sectors. According to Confindustria, the food and beverage sector in Parma account for 6.500 billion of euro in 2016 and with a number of workers of 14.400 as we can read from the figure below.

[88] Osservatori Distretti (2018), Osservatorio Nazionale dei distretti italiani.
Available on: http://www.osservatoriodistretti.org/node/10/distretto-agroalimentare-del-prosciutto-di-parma[Consulted in 12/2018].

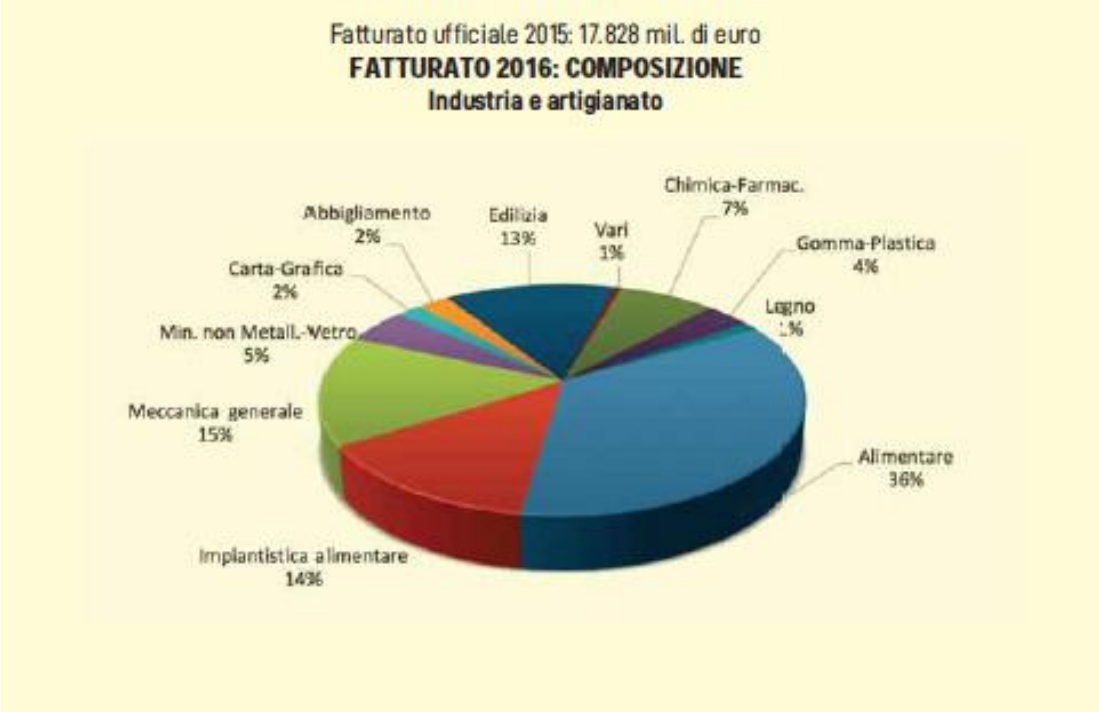
Figure 16: Manufacturing sectors in Parma

Principali settori:	FATTURATO 2016* Milioni di euro (stima)	EXPORT 2017 Milioni di euro	ADDETTI 2015**
Alimentare	6.500	1.560	14.400
Meccanica generale	2.800	1.372	11.200
Impiantistica Alimentare	2.500	1.301	9.200
Chimica e Farmaceutica	1.350	1259	3.400
Lav. minerali e vetro	900	334	2.900
Gomma e Plastica	650	204	1.800
Abbigliamento	450	284	2.500
Legno e arredamento	200	57	1.300
Carta e grafica	350	23	1.200
Altri	100	67	800
Edilizia	2.400	0	11.800
TOT. INDUSTRIA E ARTIGIANATO	**18.200**	**6.462**	**60.500**

* MEF - DIPARTIMENTO DELLE FINANZE: Fatturato 2016 stimato da UPI sulla base delle dichiarazioni IVA dell'anno 2015.

** I dati relativi agli addetti e alle U.L. sono stati forniti dall'ufficio Studi della Provincia di Parma.

Figure 17: Composition of manufacturing sector in Parma (2016)



Source: Unione Parmense degli industriali

The principal industries in the sector are Barilla Group and R. e F.lli Spa in the pasta and bakery products field, Parmalat Spa in the milk and derivates field, C.F.T. Spa, Gea Procomac Spa and Sidel Spa in the industrial machines for food and beverage.

Also for those that regard exports the food and beverage sector is good located. In 2017 they made exports for 1560 billions of euro[89], especially in France, Germany, United States, United Kingdom and Belgium. Industrial economics in Parma is indeed famous for the strong presence of food and beverage industries. Parma shows a big variety and richness of products of first and second transformation. There is always a strong productive specialization with products characterized by high quality. The food and beverage sector in this area is in the first place for turnover, number of employees and exports. In these last years the sector is increased thanks to the investments in research and new technologies, being able to mix safety and quality. In this context there is the EFSA, the European food safety authority, an important agency that deal with the individuation and evaluation of anything risk potential that might be present in the food supply chain, from production to the supply and selling to the final customers. We can divide the food and beverage sector of Parma in 6 big areas: pasta and bakery products, milk and dairy goods, animal preserves, vegetal preserves, milling, and beverages. We will describe briefly these areas.

Pasta and bakery products. Barilla born in the 1877 as a small craft shop for the production of bread and fresh pasta, today is the worldwide leader in the production of pasta, producing 1000 tons of outputs for day. The milling plant of Parma is the biggest of Europe. In the province is also present a big production of biscuits, desserts and baker goods. Changing the diets of many of the Italian population towards more precooked foods, frozen foods and ready meals, the food business has to change with the different tastes and preferences of the customers. The dynamic industry of Parma did not remain indifference to it and today it is part of this phenomenon with the production of some specialized companies. The sector could count in 2015 35

[89] Unione Parmense degli industriali (2018), Parma e le sue imprese.
Available on: http://www.upi.pr.it/docs/UPI/9/parma_e_imprese/parma_e_imprese.pdf [Consulted in 12/18].

companies with a total number of employees of 4000 and the 2016 turnover produced by pasta and bakery products esteemed by Confindustria was about 3200 billions of euro. In 2017 the principal exports towards France, Germany, United Kingdom, Switzerland and Sweden, were about 664 billion of euro, another number representing the value of Made in Italy in the world.

Milk and dairy products. In the province of Parma there are like 151 dairy companies producing in one year 1.261.470 forms of the famous cheese Parmiggiano-Reggiano-Dop. The milk and derivatives sector instead is almost totally represented by Parmalat (Lactalis Group). It is the first company in the world for the milk production and one of the most important for that bulk, pasteurized that is the 22% of the national market, condensed, in powder, as well as all derivatives like desserts and yogurt (4% of the national market). Moreover the company holds important positions in one quantity of other food productions such as fruit juices that represents the 11% of the national market. Employees and turnover account respectively for 1600 in 21 companies, and 250 billion of euro in 2016. For those that regards exports in 2017 are 248 billion of euro and the principal countries in which they export are United States, France, Germany, Spain and Canada.

Animal preserves. Today between the 250 delicatessen companies in the province, 145 are dedicated at the production of the typical Prosciutto di Parma Dop. They produced 8,2 billion of pieces in the 2017. With the prosciutto there is also the production of other typical cured meals like Culatello d Zibello Dop, Salame di felino IGP, Coppa di Parma IGP, Spalla di San Secondo and other products of cured meals in general. In the last years also the market share of baked ham increased a lot until to become the product of cured meals more consumed in all the country. At more traditional cured meats have been added in the last years some products, always based on meat, dietetic and in innovative formats, regional specialties as well ready-to-eat foods such as roasts. They are not missing in addition, ready-made products based on white meat such as chicken and turkey. The turnover in this sector was of 2100 billion in 2016 and it counts 111 companies with 3600 employees in total. Also this product is large exported especially

in France, Germany, United Kingdom, United States and Belgium for a total of 367 billion of euro in 2017.

Vegetal preserves. The transformation of tomato and the production of tomato conserve in Parma started approximately in the 1870 with a craft way of production. In the '80s the use of new and more efficient packages of tomato permitted to the big company Parlamat to enter in the tomato preserves sector and it became one of the leader of the market. In the province there are different industrial plants dedicated at the transformation of tomato and other fruits. The total daily output capacity is over 1 billion of tons of fresh tomato. Vegetal preserves are exported in Australia and Europe for a number of 190 billions of euro. The turnover on 2016 was about 400 billions of euro with 12 companies operating and 1400 workers in the field.

Milling products. This sector is closely related at that of pasta and bakery products and it counts for only 5 companies in the province with a total of 200 employees working in the field. Even tough these five enterprises produce 8500 quintals of flour every day.
The production is divided into soft wheat flour (intended for the most part to production bread, pizzas, sweets and domestic uses) and semolina of durum wheat destined almost entirely to production of pasta. The annual turnover in 2016 was 250 billions of euro. Milling products are exported in Germany, France, United States, Denmark and South Africa. In 2017 exports in the sector were 27 billions of euro.

Beverage goods. Another important products in the Parma's food valley is carbonated soft drinks that in recent years is growing always more in market share and technological innovation. Today in the food valley operate in this sector industries with bottling plants that produce over 200 billions of bottles of mineral water and drinks in a year. Moreover, in recent years an augment of wine production and a qualitative improvement has been registered. The wines of the region (Lambrusco, Fortana, Malvasia and Sauvignon) are characterized by a low alcoholic degree and are produced by twenty small and medium enterprises. These wines are much appreciated by consumers and even tough they are not the famous Italian wines, they win in recent

years international premium. Furthermore, acquiring the brand of "Colli di Parma", these wines obtained the DOP (denominazione di origine protetta) acknowledgement.
Then there are companies of big dimensions and some others with a handicraft dimension for production of liqueurs derived from the distillation of the marc and from the processing of particular fruits. Also here there are 5 big companies with 100 employees. The turnover is about about 50 billion of euro in 2016 meanwhile the exports, espacially in Germany, Bulgaria, Belgium, Netherlands, and Japan are about 12 billions of euro in 2017.

3.3 Digitalization in the district

When we talk about industrial districts, we refer to a "production system consisting of a group of companies, mainly small and medium-sized, characterized by a tendency towards horizontal and vertical integration and production specialization, generally concentrated in a given territory and linked by a common historical, social, economic and cultural experience "(Treccani, 2012)[90]. The main factors of the development of this production model are two according to Marshall[91]: the strong socio-cultural anchorage to a territory that favors a rapid circulation of ideas and an easy interaction between individuals, who share a "district culture" based on the sharing of technical knowledge-productive, from the entrepreneurial culture and the identification in the values and interests of the district; a second factor of development is the existence of a systemic approach in inter-company relations according to the logic of flexible specialization. Training of industrial districts has also mainly concerned industrial sectors characterized by: • Human-intensive production processes and poor automation; • Limited requirement for fixed assets (investments and equipment); • Low economies of scale at the level of the entire production process; • Innovation linked to learning by doing processes. In fact, although the companies in the majority of cases are of limited

[90] Treccani (2012), Dizionario di Economia e Finanza.
[91] Marshall A. and Paley Marshal, M. (1975), *Economia della produzione*, ISEDI, Milan.

size, they often show a medium-high technological and innovative capacity, above all thanks to the high level of specialization, which allows everyone to concentrate on a limited number of phases.

Furthermore, districts have always been incubators of innovation, able to offer small and medium enterprises possibilities of growth and integration, exceeding their size limit. The theme of innovation is therefore central to the renewal of the district, an innovation not just of product, of process or of organization, but which extends to the strengthening of knowledge and the diffusion of a new digital and business culture. What are the effects of technological innovation in geographical clusters? How innovation is spread and diffused? Technological innovation has deeply changed the way to communicate and collaborate and the effects of these technologies are even strengthening in geographical clusters due to the proximity of people and knowledge. Small firms can have gain when they are agglomerated in a given area and belong to the same productive sector.

The network, as a tool for aggregating the Italian entrepreneurial fabric, is configured as a natural evolution where the spontaneous district economy is no longer able to represent a winning competitive model. The modern districts are very different from the past, and the role of leader enterprises is become always more crucial. Digitalization and industry 4.0 bring a transformation that requires a bigger interaction with urban centres. Digital technologies are important for the Made in Italy because promote the competitive of Italian products through efficiency and transparency.

3.4 Method of analysis

After the launch of the "Piano Industria 4.0" we need to understand how companies are reacting. The literature unfortunately does not offer a complete and real picture of the effective adoption and the consequent commitment of Italian companies to Industry 4.0, as well as on the new organization of work and industrial relationships. In our case, we

want to understand if the Food and Beverage sector lends itself to this type of transformation. After having seen how digitalization can influence the various phases of the supply chain, we now try to quantify the phenomenon, choosing as a reference the industrial district of Parma. The choice to perform a district analysis is for the familiarity with the Italian territory. The district in fact represents the Italian economic model and for its peculiarities it has a medium-high technological and innovative capacity. As a survey method I chose the online questionnaire. In the period between December 2018 and January 2019 I send the online questionnaire to 110 companies operating in the industry of Food and Beverage in the province of Parma that range from small and medium-sized family-run businesses to large multinational companies.
The questionnaire was addressed to directors, presidents and production managers, the most indicated people to answer at the interview.

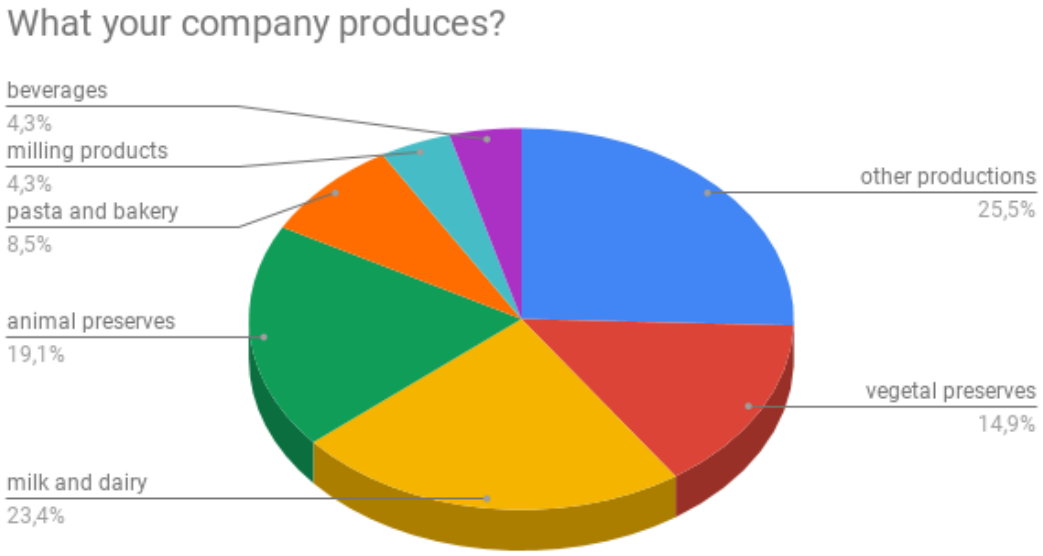
In particular, in my survey, I want to quantify the adoption of technologies, understand what are the reasons behind the non-adoption and if the sector is ready at the level of knowledge and economic resources to innovate towards the digital revolution. Furthermore, for companies that are implementing the technologies, I want to understand what transformations in the organizational field they had to face, what were the changes at the operational and worker level.

3.5 Results

From the 110 companies to which I call and send the online questionnaire, I have received the answer from 47. All these Food and Beverage enterprises operate in the province of Parma and are specialised in different sectors. I received answers from both big business that SMEs. To analyse the path of adoption or non-adoption of the technologies is important to understand the dimension of the enterprises and the number of employees. From the answers received the 23,4% of companies produce milk and dairy products, the 19,1% produces animal preserves, the 14,9% vegetal preserves, the

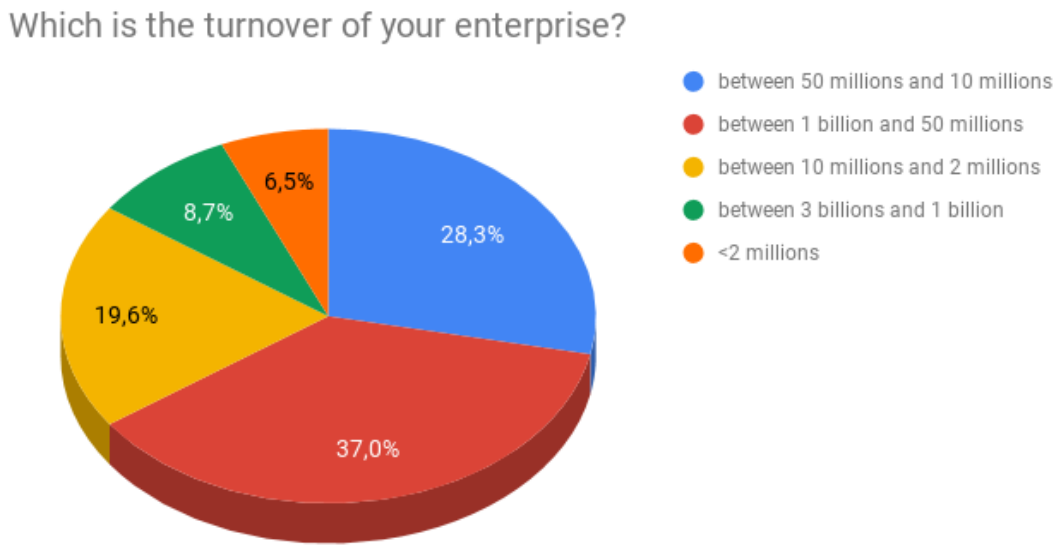
8,5% pasta and bakery products, 4,3% milling products, another 4,3% produce beverages and the remaining 25,5% produce other food products.

Graphic 1: Food and Beverage productions in Parma's Food Valley - December 2018 – Champion of 47 companies



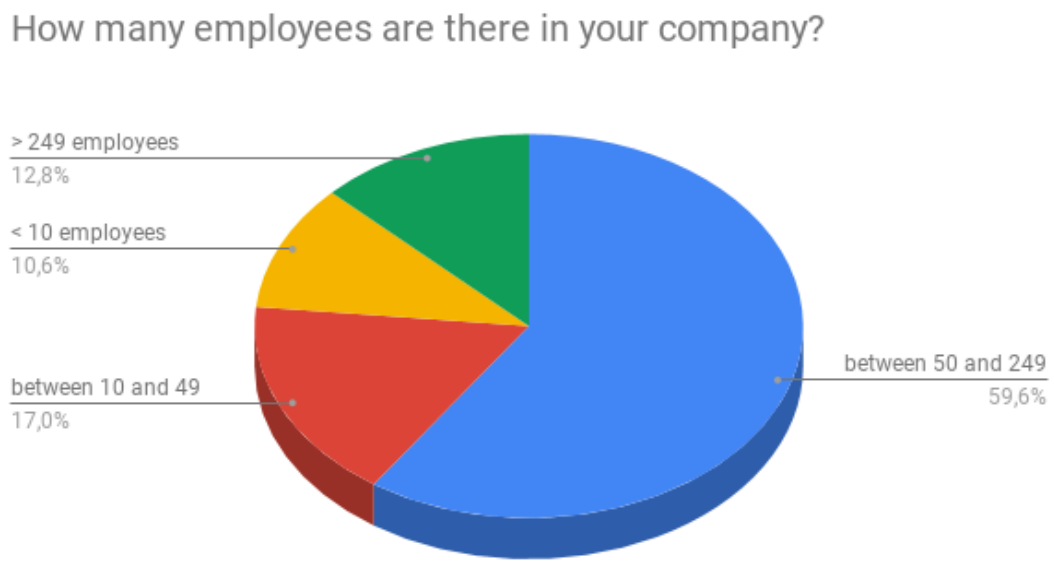
In my research I wanted to investigate and above all look for large and medium-sized enterprises, considering them as more interesting as case studies, but not neglecting the small medium-sized companies representing the driving force of the Italian economy. The 37% of companies responded have a turnover between 1 billion and 50 million and the 8,7% between 3 billion and 1 billion, combined together form the 45,7% of the companies interviewed and can be defined large enterprises. Then there are 28,3% of the companies with a turnover between 50 million and 10 million, 19,6% between 10 million and 2 million, and 6,5% with a turnover below the 2 million.

Graphic 2: Turnover of a champion of 47 companies in Parma's Food Valley – December 2018



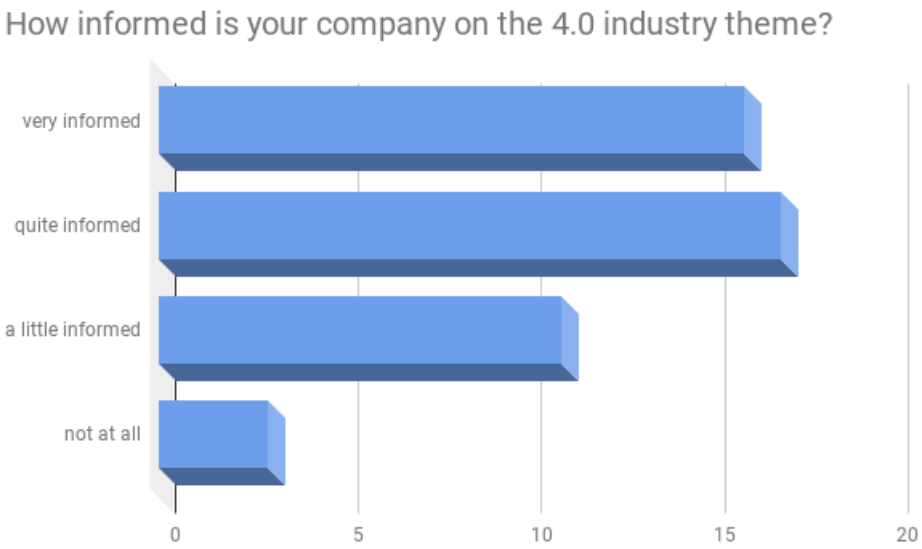
Another aspect that I want to consider is the number of employees working at the companies. From the research comes from that the majority of enterprises have a number of employess between 50 and 249, 37% of the industries interviewed. The remaining companies, 6 of them are large enterprise with more than 249 employees, 5 of them are micro enterprise (<10) and 8 of them are small enterprises with a number of employees between 10 and 49.

Graphic 3: Number of employees for Food and Beverage company – December 2018 – Champion of 47 companies



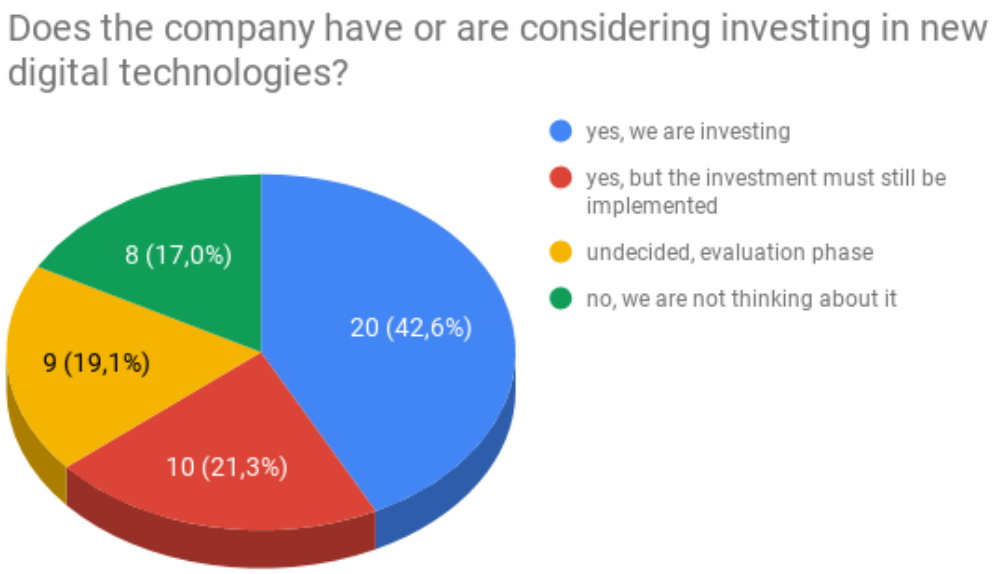
Furthermore, we can say that the situation about Industry 4.0 is quite positive , it turned out that the 70% of the companies are very informed or quite informed about the theme industry 4.0 and the new technologies.This is a clear good sign that the Food and Beverage sector is moving in that direction at least for those that regard the knowledge about the theme.

Graphic 4: Data of a champion of 47 companies



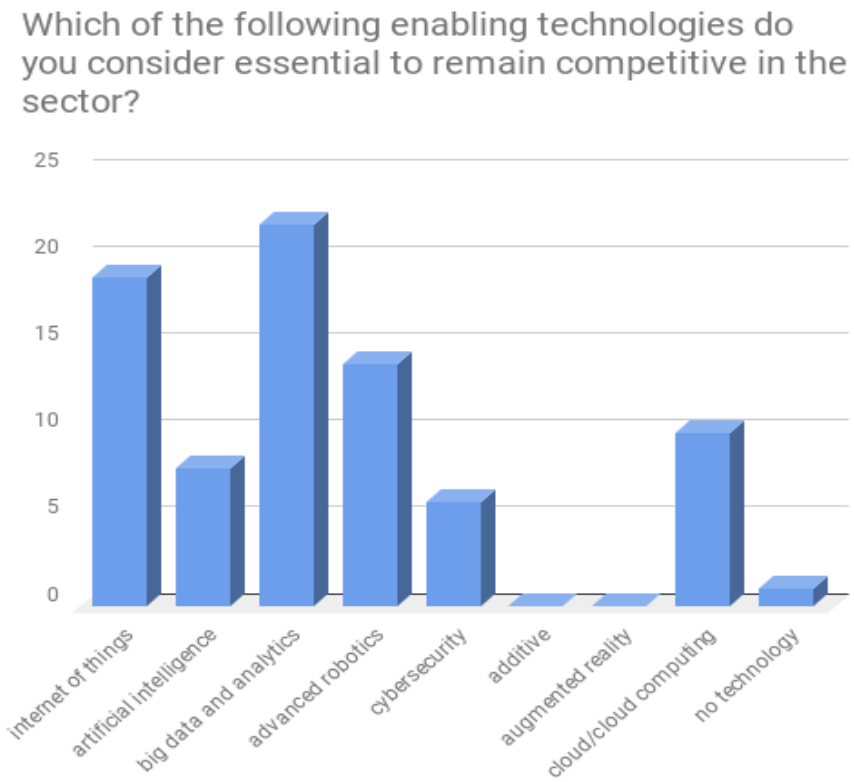
Therefore, as we can see, companies are increasingly thinking with a technology driven mind and also at operational level they are starting to make investments toward this direction. Twenty of the forty seven companies are investing in the technologies of the fourth industrial revolution, ten of them have considered investing but the technology must still be implemented. This is a good scenario. Especially in a sector that for a lot of time was considered as traditional and reluctant to innovation. Still, there is a part that doesn't want to invest or is not considering it, 8 out of 47; and 9 out of 47 is undecided and they are in the evaluation phase.

Graphic 5: Degree of investments in 4.0 technologies in Parma's Food Valley – December 2018 – Champion of 47 companies



Between the technologies of the fourth industrial revolution, the most preferred for the sector is big data and analytics followed by Internet of things and advanced robotics. We will not be surprised that along the enabling technologies additive manufaturing and augmented reality are not considered essential to remain competitive in the sector (Graphic 6). Internet of things and big data allow a clear reading and understanding of reality to better help people to make the best decisions and in a fast and complex market as that of food and beverage allow to anticipate the consumers' trends and preferences.

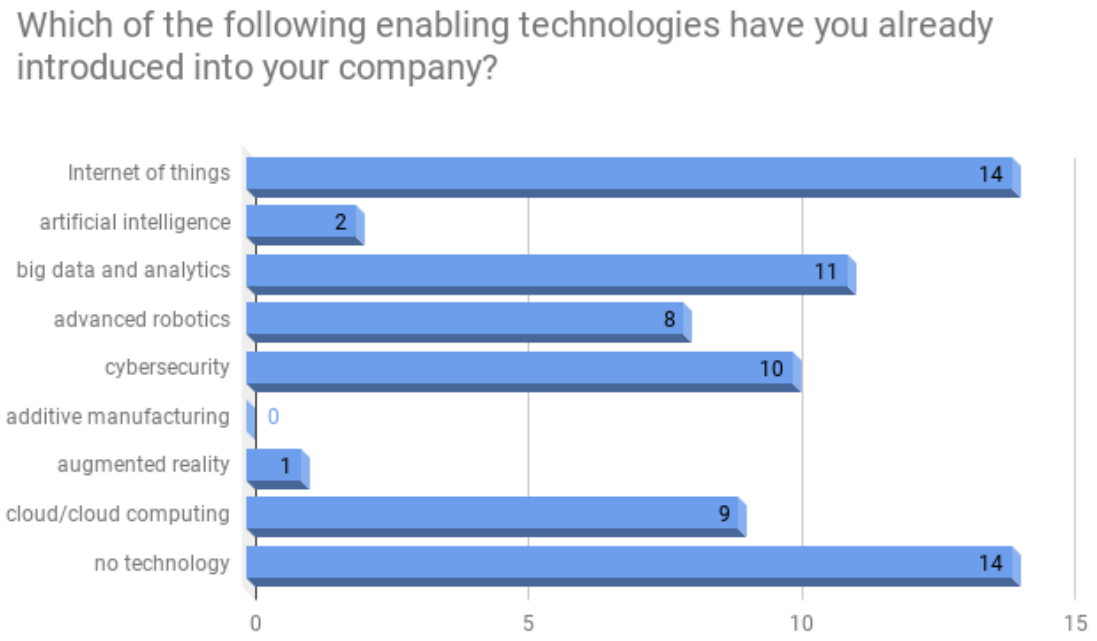
Graphic 6: 4.0 Technologies considered essential for Food and Beverage sector



Also advanced robotics and cloud computing are considered quite important to remain competitive in the sector. Six of the companies interviewed think that cybersecurity is a factor of competitive advantage, in order to keep secret the strategic information of the enterprises. Only one the champion of analysis retain that no technology is necessary for a good business and to mantain competitive advantage. Now that we analyse what are the preferred technologies, we want to show what is the real degree of adoption of these technologies. It turned out that the the 32,6% still have no adopted technologies in their company. However, the remaining one 67,4% has introduced techonologies of the fourth industrial revolution.

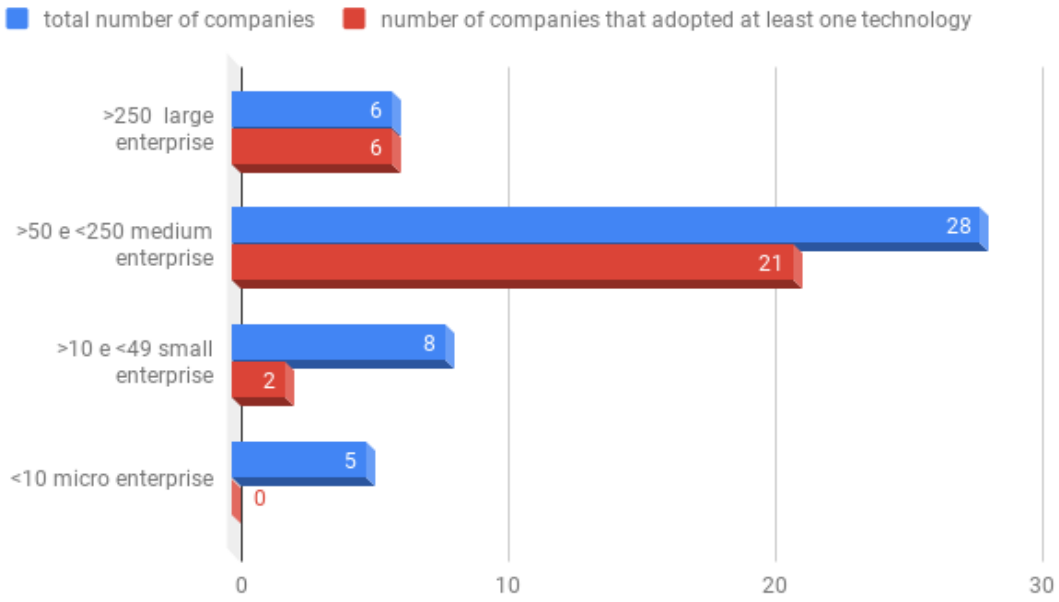
Internet of Things is the most widespread digital technology among Parma companies active in food: as many as 32,6% of them declare, in fact, that they have already adopted it within their corporate functions. The big data and cyber-security follow, implemented by 25,6% and 23,3% of medium-large food companies, while cloud computing and collaborative robotics involve respectively 20,9% and 18,6% of companies (graphic 7).

Graphic 7: Degree of adoption of the technologies of Industry 4.0 – Champion of 47 companies of Parma's Food Valley – December 2018



The technologies of augmented reality and additive manufacturing are much less common, probably they are not adapt to the sector and do not help in the critical aspect of the sector. In general, we can say that the investments related to Industry 4.0 within the Parma agro-industrial chain are therefore mainly linked to mechanisms to manage the network of big data that comes from physical objects, equipped with Internet connection and able to collect and exchange data from the environment in which they are placed. Thus, managing the data is one of the main scope of processing industries that work in the food chain. The objects are be equipped with sensors, software, actuators and capacities computational. Food processing companies are also striving to protect the intellectual property and big data of the company through cyber-security. Cloud computing and collaborative robots have been adopted by respectively 9 and 8 companies of the Parma's food valley.

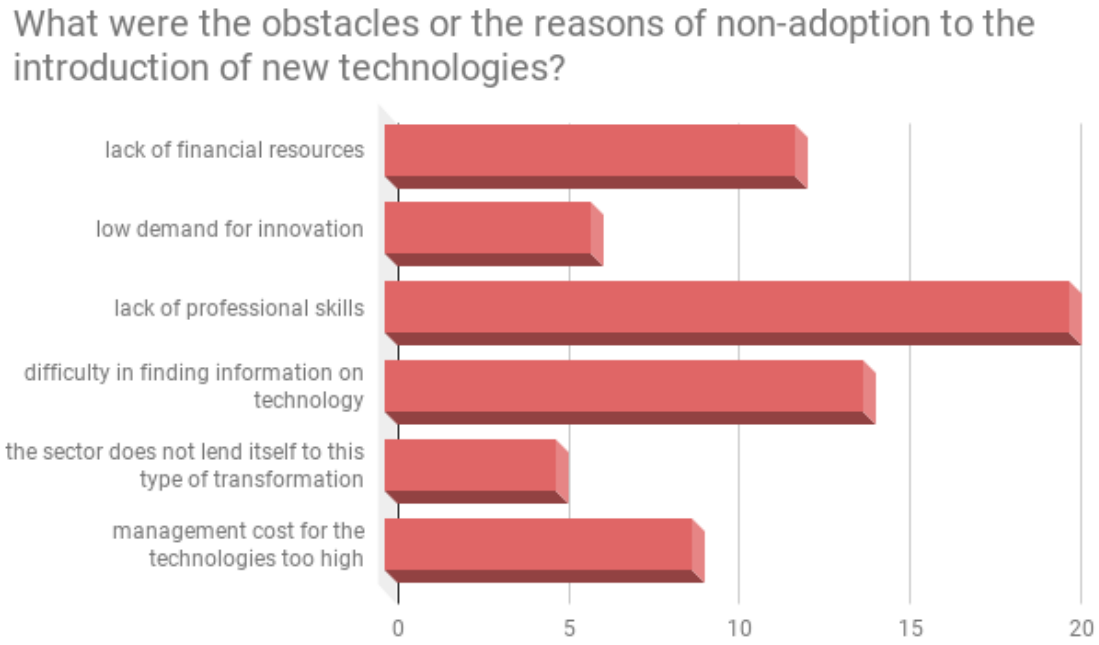
Graphic 8: Size of the adopting companies based on the number of employees – Champion of 47 companies of Parma's Food Valley – December 2018



Furthermore, it is clear that in the choice of adoption the company dimension, in this case measured in terms of employees, plays a crucial role. In fact, according to the findings of the survey (graphic 8), it is especially the medium-large enterprises that follow the path of digitization. These with a number of employees ranging from 50 to 249, represent the majority of respondents but also of the adopters. Moreover, the totality of large companies interviewed have adopted 4.0 technologies. Only two of the small enterprises have adopted technologies 4.0 and none of the micro enterprises. The last ones probably do not have the infrastructures and the financial resources to implement the digitalization.

Moving attention to the obstacles and the reason of non-adoption, the analysis first of all reveals that the lack of professional skills (46,5%) in the company represents one of the main constraints on the implementation of the enabling technologies of Industry 4.0 (graphic 9).

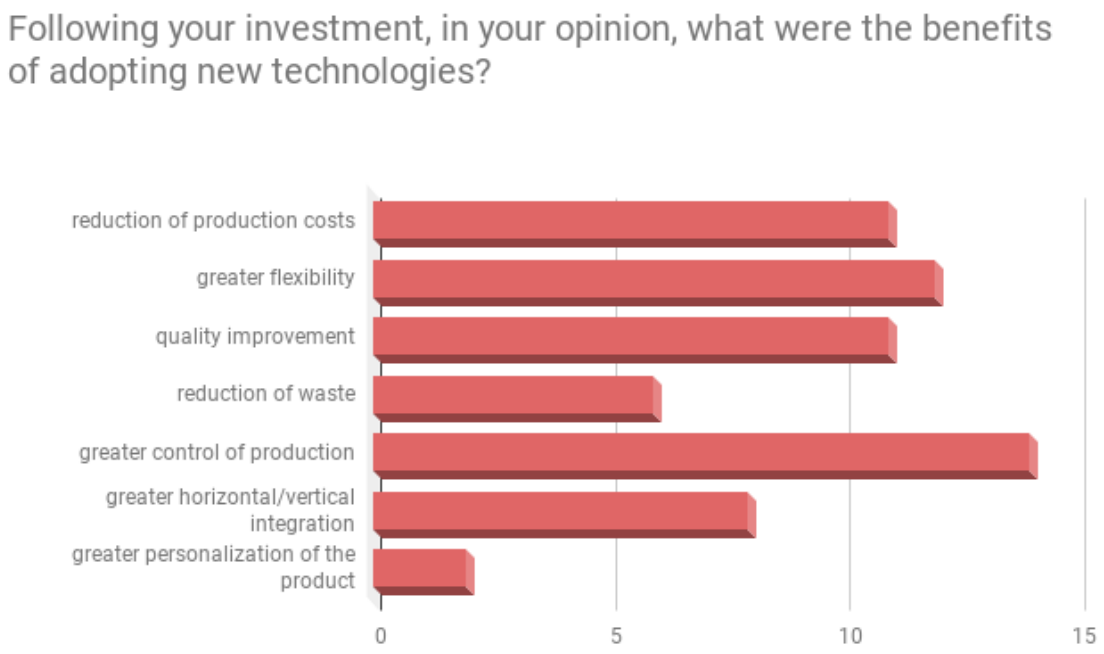
Graphic 9: Obstacles and reasons of non-adoption - Champion of 47 companies of Parma's Food Valley – December 2018



This suggests that in the coming years in the Italian agro-industrial supply chain there will be an increase in the demand for skilled and specialized workers that can be satisfied both by hiring new staff and by training and retraining the human resources already employed in the company. Other factors that limit the implementation of digital transformation in the company are attributable to the insufficiency of financial resources (27,9%) and to the difficulty in finding information on 4.0 technologies (32,6%).
The 11,6% of the respondents believe that the characteristics of the business sector does not lend itself very much to the technologies of Industry 4.0 and others believe that there is too less demand for innovation in the sector and that the costs for managing these technologies are too expensive.

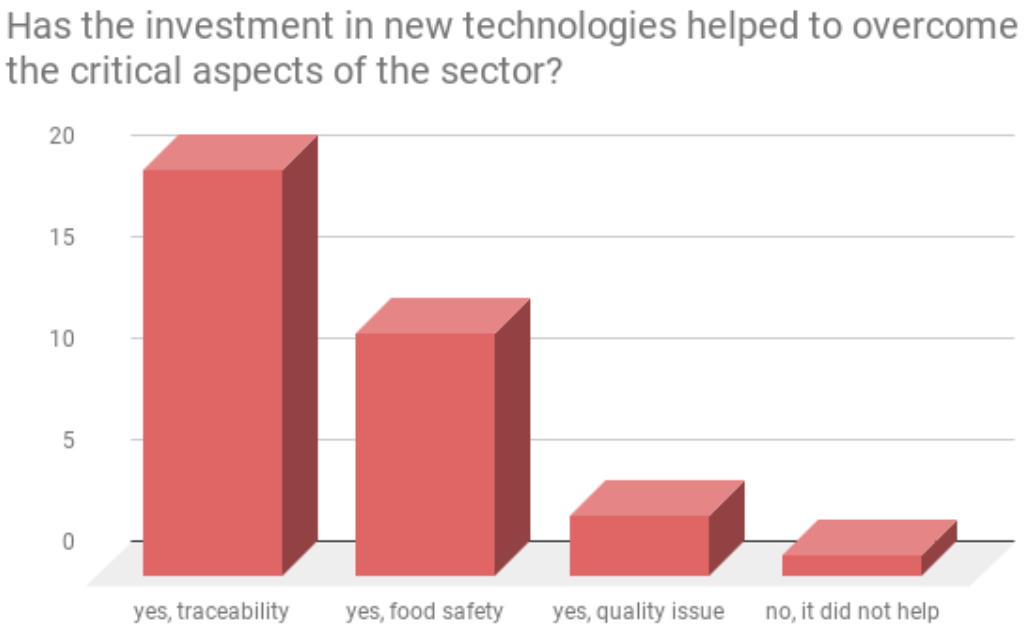
At this point in the analysis, it seems reasonable to ask what are the benefits of adopting these technologies? We asked the companies in the Parma's food valley.

Graphic 10: Benefits brought by technologies 4.0 - Champion of 47 companies of Parma's Food Valley – December 2018



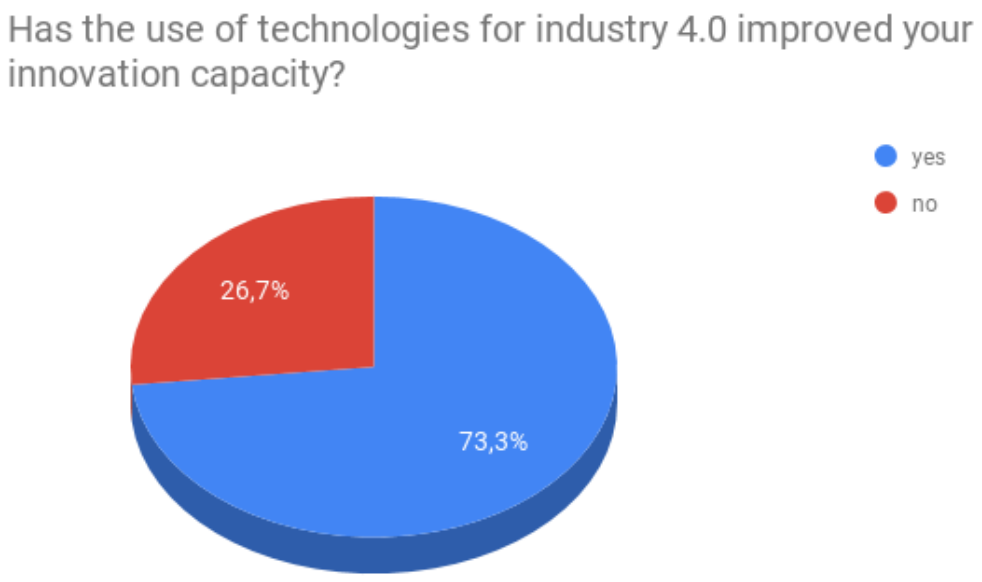
In response, overall, companies underline the great impact of Industry 4.0 on their economic performance. This economic success can be achieved by reducing production costs(33,3% of the respondents), greater flexibility (36,4%) and greater production control (42,4%); all factors that put together improve company performance (graphic 10). Another proportion of adopters claims to have found, following the implementation of the enabling technologies Industry 4.0, also benefits inherent in the range of products offered: think about improving their quality (33,3%) or their personalization (6,1%). Moreover regard the benefits I asked if the implementation of the technologies helped in solving the critical aspects of the sector as traceability, food safety and quality issue. A lot of times, in fact, the major issues that concern Food and Beverage business are related to the pressure to meet the stringent food quality and regulations. In general seems that Internet of Things, big data and the others technologies help in the traceability problem, 65,5% of respondents, and food safety 41,4% of respondents.

Graphic 11: Has the investment in new technologies helped to overcome the critical aspects of the sector? Benefits brought by technologies 4.0 - Champion of 47 companies of Parma's Food Valley – December 2018

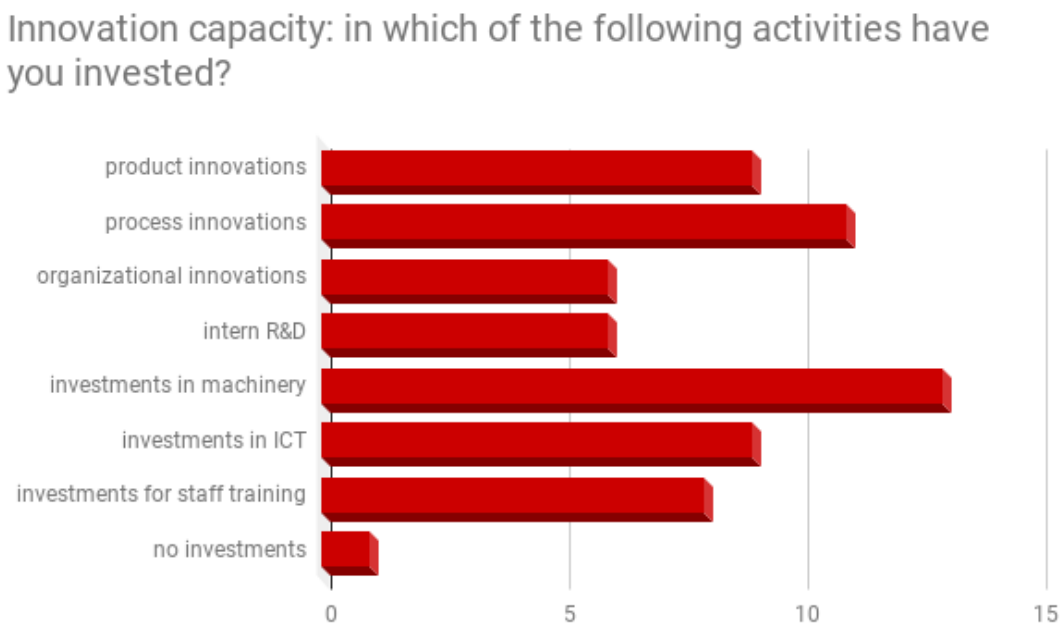


Other particular aspects that I want to analyze are the effects that the industry 4.0 has brought on innovation and investment, and employment. From the data it is possible to analyze the effects that the implementation had, at least so far, on the innovation and R&D processes. Indeed, the 73.3% of respondents said that the use of technologies for industry 4.0 has improved their innovation capacity (graphic 12). Regarding the activities in which they invested (graphic 13), we can seen that there is not a real path among the companies. It turned out that the biggest investment are in machinery (41,9%) and process innovation (35,%). However, there is no shortage of investments regarding product innovation. This suggests that the adoption of 4.0 technologies brings with it quality improvement as we seen previously.

Graphic 12: Innovation capacity of adopters - Champion of 47 companies of Parma's Food Valley – December 2018



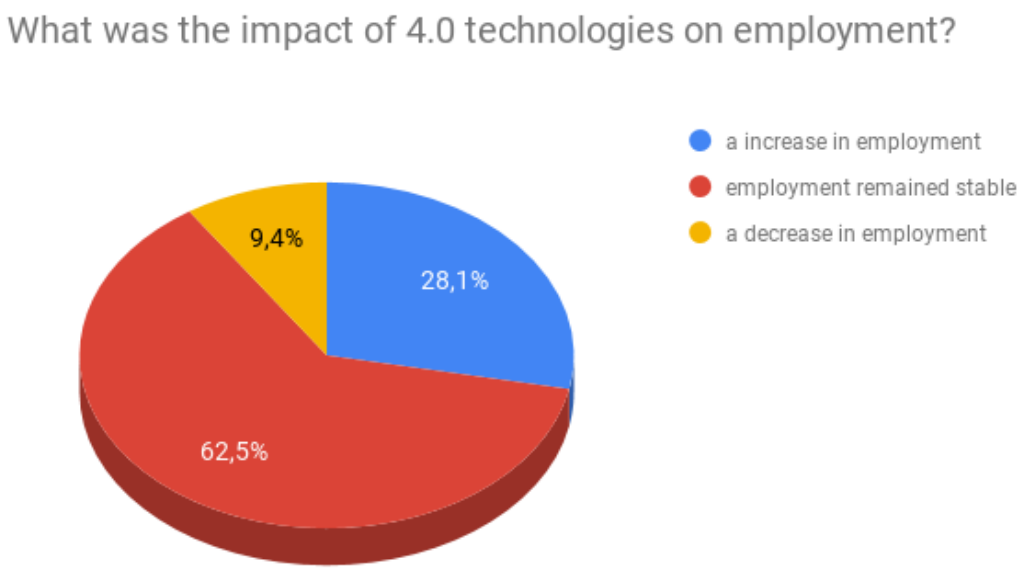
Graphic 13: Innovation capacity of adopters – Activities in which they invested - Champion of 47 companies of Parma's Food Valley – December 2018



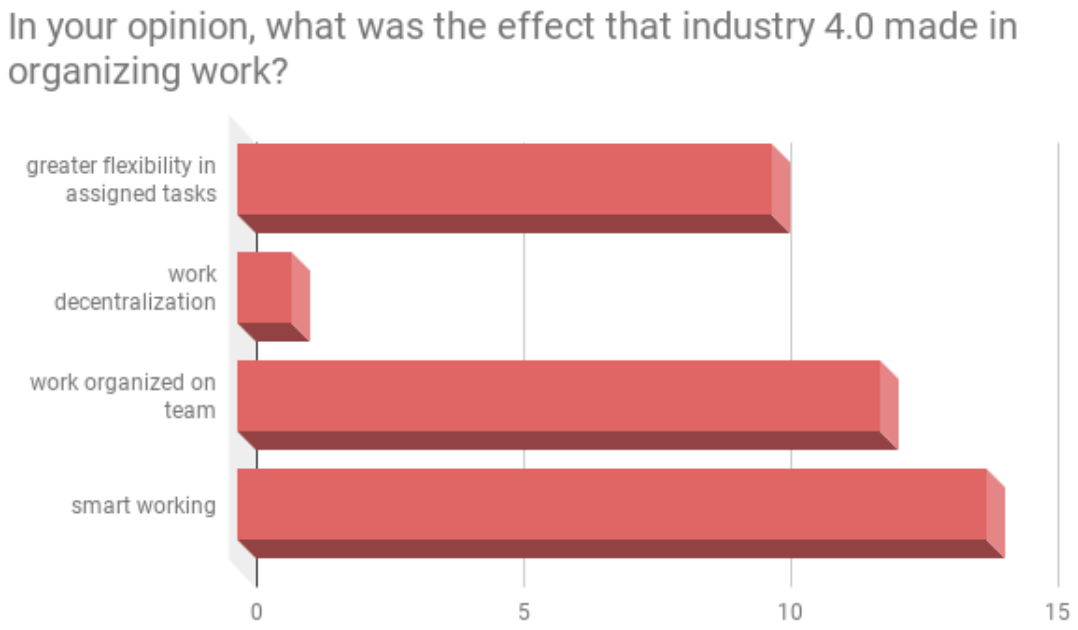
Moving the attention to employment, there is a strong tendency to believe that the effect on employment is not clearly positive but certainly not negative. In fact for the 62,5% of respondents employment remained stable, for the 28,1% there was the necessary to hire more people in the staff, especially with the specific competences to manage the new technologies. The remaining 9,4% think that digitalization brought a decrease of employment, probably activities that first were conducted by men, now are replaced by machines or robots. In the survey I also analyse how can change the organization of work and the competences requested from the companies that had introduced digitalization in their production process.

The 43,8% of them in fact think that smart working would be the next way to organize and manage work and the 37,5% think that digitalization brought more work organized by team and in general with a greater flexibility in the tasks assigned (graphic 15).

Graphic 14: Impact of 4.0 technologies on employment - Champion of 47 companies of Parma's Food Valley – December 2018



Graphic 15: Effects in organization of work - Champion of 47 companies of Parma's Food Valley – December 2018



Thus, the business model change and with that also the design of work and of human capital characteristics. From the results, we can say that new technologies can drive business growth, innovation, job creation and demand for specialist skills but they can also displace entire roles when certain tasks become obsolete or automated.

Conclusion

Even if, from the quantitative research that I have conducted, we cannot draw general conclusions on the phenomenon, given the scarcity of the sample used, we can certainly give an illustrative picture of the adoption of the 4.0 industry.

In general from my thesis we can state that Industry 4.0 offers great opportunities for the Food and Beverage sector, both in terms of economic performance, both in terms of product quality, food safety and traceability. Technology has made possible to produce food and beverage products in a cost saving manner; labour productivity is augmented, internal operating costs are reduced, flexibility and efficiency are reached. Real time management of data and Internet of Things are the main drivers of growth and innovation. In the food sector, in particular the management of data become an instrument to demonstrate the food safety and quality and the respect of the societal expectations. Companies are also looking to the Industrial Internet of Things and data collection to better manage production schedules, resources, labour and maintenance.

From the agriculture phase to the transformation one, the one that transform food into products, the network of data and the real time cooperation benefit the product and optimize the flow of goods and information between these two phases of the value chain. Industry and innovation come together to create a safer and cheaper food product. According to my results, it is a challenge that is mainly adopted by medium-large companies with financial resources, infrastructures and the right personnel to accommodate the new digitization. By contrary for small businesses, there are still many steps to take. First of all, they should make sure that they have the qualified staff to manage new technologies. Institutions and universities are essential to update and educate these small businesses on topic 4.0. Many of them, in fact, show, from the research conducted, little information about the subject. In my opinion, in order to bridge the skills gap, the educational system should provide students with basic digital and ICT skills. Furthermore, there is a widespread belief among them that the food sector, very attached to its traditions, does not lend itself to this type of transformation. Informing and educating through universities and institutions would be a springboard to make it clear that these new technologies would not undermine the tradition of the

product, but rather improve the quality through the staff who interact with the production process.

Among the challenges posed by the industry 4.0 , there is the finding of the necessary resources to transform the production site into a smart factory. These technologies, indeed require an initial investment and they could seem too much complex and discourage their adoption. Awareness is essential for the understanding and the adoption of them and also training can be a specific tool in order to enhancing the competences of the workers, so that also reach small and medium enterprises. In the same way that workers have adapted to technological upheaval in the past by developing skills that are complementary to new technologies, so the workers of the future will have to adapt as well and collaborate with the machines to create a better product. The technology will supplant as it has been until today other professions with low technical and professional content, leading to the gradual disappearance of many operational activities. It will therefore lead to the need for increasingly skilled and professionalized staff, and instead of a decreasing in employees, we will see a change in the task performed and in the competences required. The greater specialization of work, which I think will lead to an improvement in employment, must start with an improvement in school and university education with more funds allocated to training institutions to be able to keep up to date.

In conclusion, we can say, that the adoption of these technologies at this precise moment in history is essential for the industrial revolution that is taking place and the food and beverage sector cannot escape this revolution, above all because, given its peculiar characteristics, it can reach a great economic and qualitative advantage. Consumers have always bigger request in terms of sustainability, security and quality of the food product and the 4.0 technologies represent a way to satisfy these needs and thus to remain competitive in the sector. Ignoring these technologies would be a serious strategic mistake, given that in a few decades what we now call "4.0" will be the standard.

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