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Digital transformation of agri-food SMEs in the North East of Italy

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INTRODUCTION

Today there are 4.8 billion users who have access to the Internet. 93% of companies consider innovative technologies as essential to achieve their digital transformation goals. In addition, 10 out of 10 of LinkedIn's most in-demand hard skills have to do with technology. These are just a few random, ever-changing data proving we're in the middle of a digital transformation process.

Without needing to report further data, it's clear to a little bit of everyone how technological innovation has radically impacted the lives of all of us. If the extent of this process is clear for all to see, it becomes very interesting to investigate in depth the real drivers of this digitalization trend. Many studies and publications explain that the true driver of innovation, in general, is economic activity. Competition between companies, and the continuous push for improvement, constantly raises the bar, resulting in greater access to digital technologies. Some sectors are acknowledged more than others as vehicles for innovation. Certainly telecommunications, the software industry or even mobility are industries rapidly evolving and in continuous innovation. The sector this thesis will focus on, the agri-food industry, has instead historically featured a strong artisanal connotation. That is because agriculture and breeding have always been part of human history and are deeply rooted in the culture and traditions of the various populations. However, even if some ancient food production methods and techniques have been maintained over time, the entire sector has recently experienced a strong increase in its innovation level. For example, machines are now evolved and interconnected, new methods of communication in the supply chain have been introduced and online sales-channels have become increasingly popular. In short, agribusiness, like other sectors, is undergoing a process of digital transformation. However, as we will see, the agri-food is a very particular sector, mostly composed of micro enterprises. The vast majority of food producers are still small to medium-sized farms with limited access to large amounts of capital. This leads

to great difficulties in the integration of new tools, digital technologies and their relative technical competencies. In light of these essential considerations, comes the desire to analyze and explain the real state of digital transformation process undergoing in the agri-food sector. The following work has indeed the objective of providing a cross-section about digital transformation in the food industry, through data coming from existing reports plus new personal elaborations. The focus will then eventually be shifted on the scenario of northeastern Italian agri-food SMEs. Turning to the contents: after a broad introduction of the "words" of digital transformation, a presentation of the new upcoming technologies in the food sector will follow. The agri-food will therefore be analyzed by an industrial perspective, both from a European and an Italian dimension. The third chapter is dedicated to the scientific literature consulted in preparation of the thesis itself. Finally, as mentioned above, last chapter will propose an analysis of newly collected data, concerning the specific sub-area of Triveneto. This thesis is in fact written in collaboration with a larger project of the Agrifood Management & Innovation Lab, the observatory born within the Management department of Ca' Foscari University of Venice. The project "*Osservatorio il futuro del food tra digitale e sostenibilità"* consists of a collection of quantitative and qualitative data on a representative sample of agri-food Triveneto SMEs. Part of the material collected for the purposes of the project, including desk data, a questionnaire and various interviews with selected companies has therefore been used for the purposes of this thesis. The elaboration of these data aims to bring the industrial analysis of the first chapters to a deeper level through quali-quantitative considerations on the sample at hand. All the information about the general project is available on the Agrifood Management & Innovation Lab webpage.

By the end of the dissertation, the reader should have acquired a clearer understanding of the trends regarding digital transformation in the agri-food sector. At the same time, through the final elaborations and interviews outputs, should have figured out which technologies and innovations the food companies of Triveneto consider most valuable.

1. CHAPTER 1: INTRODUCTION TO DIGITAL TRANSFORMATION

This first chapter will first theoretically introduce the reader towards the concept of digital transformation. All the terms that are commonly used when referring to digitalisation will be sequentially defined and explained. The different meanings of terms “digitization”, “digitalization” and “digital transformation” will therefore be expressed. Once the different nuances of the word digitization have been clarified, the commonly used index of countries' level for digitisation will be introduced. In order to give a framework to the following chapters, the meaning of the term Industry 4.0 will be finally outlined.

1.1 What is “digital transformation”

In this day everyone has a vague idea of what digitalization means. It's clear to everyone that the process underway is impacting not only the business of companies but more generally the lives of all of us. However, even if there is a more or less clear idea of what digitalization is, we cannot say that everyone is able to distinguish the various specific terms associated with it. Terms such as "digitalization," "digitization," and "digital transformation" are often mistakenly used synonymously. This creates quite a bit of confusion. In the following paragraphs we will try to give a single meaning for each of the following terms, reporting some of the most famous definitions provided by the literature.

1.1.1 Digitization

The first term we will consider is "digitization". Digitization is the process of transforming information from analog to digital format[1](OED, 2012). Making something digital therefore means being able to read/play the content through a computer. Some simple examples of digitizable information or content are documents, photos, signatures, or maps. This definition is widely accepted, in fact in 1977 Feldman defined digitization as *"a technical process of converting analog streams of information into digital bits"*[2] (Feldman, 1997). Confusing the term digitization with digitalisation is therefore not only a lexical error but also a conceptual one.

1.1.2 Digitalization

The second term we are going to analyze is digitalization. It is important to consider it after the term digitization because digitalization is a result of digitization itself. Starting again with a literal definition, digitalization is nothing more than the adoption or gradual increase of digital technologies. With changing technologies then, digitalization becomes a more varied and evolving concept. Looking now at the concept of digitalization in economic terms, Gartner's defines digitalization as *"the use of digital technologies in order to change a business model and provide new revenue or value-producing opportunities"*[3] (Gartner, 2021). In fact, thinking about it, digitalization usually affects all aspects of a business, from production, to the product, to the business model itself.

1.1.3 Digital transformation

Regarding digital transformation, many authors have given their own definition. The concept of digital revolution, however, does not yet have a clear and univocal definition. Some authors talk about digital transformation in generalist terms. For example, Stolterman and Fors have described it as *"the set of changes resulting*

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[1] Oxford English Dictionary. 7th ed, *Oxford: Oxford University Press*, 2012
[2] Feldman T., *An Introduction to Digital Media*, Psychology Press, 1997
[3] Gartner, Information Technology Gartner dictionary, 2021, Available at: https://www.gartner.com/en/information-technology/glossary/digitalization

from the application of digital technologies in all aspects of human society"[4] (Stolterman & Fors, 2004). Other authors, however, link the concept of digital transformation to more business concerning aspects. Digital transformation becomes here the evolution of business through the adoption of digital solutions which can create greater value for the organization (Boyer, 2018). In any case, digital transformation is much more than the introduction of some technologies in the business. In fact, it *"represents a fundamental change in the organization's underlying mindset, systems, and tools needed to reposition parts of, or the entire business design"* (Gudergan & Mugge, 2017).

1.2 DESI Index

We have clarified in the previous paragraphs what is meant by digital transformation and the terms associated with it. It is clear, however, that a company's ability to absorb and integrate new digital technologies depends also on its country's overall level of digitalization. Although it is not easy to unambiguously define the level of digitalization of an entire country, the European Commission has proposed, since 2014, an index that monitors Europe's overall digital performance. This index tracks the progress of EU countries regarding their digital competitiveness[5]. The name DESI Index in fact stands for Digital Economy and Society Index. This measure is based on 4 fundamental parameters: human capital, connectivity, integration of digital technologies and digital public services. *Human capital* refers to the average level of digital skills in the population. The *Connectivity* dimension refers to the diffusion of fixed and mobile broadband deployment available in the states. The *Integration of Digital Technology* states the digitalization inside companies and e-commerce activities. Finally, last dimension: *Digital Public services* is a measure of the government's

[4] Stolterman E., Fors A., *Information Technology and the Good Life*, International Federation for Information Processing, 2014
[5] European Commission, Digital Economy and Society Index, 2021

digitalization, so it considers the e-services offered both to the citizen and the companies.

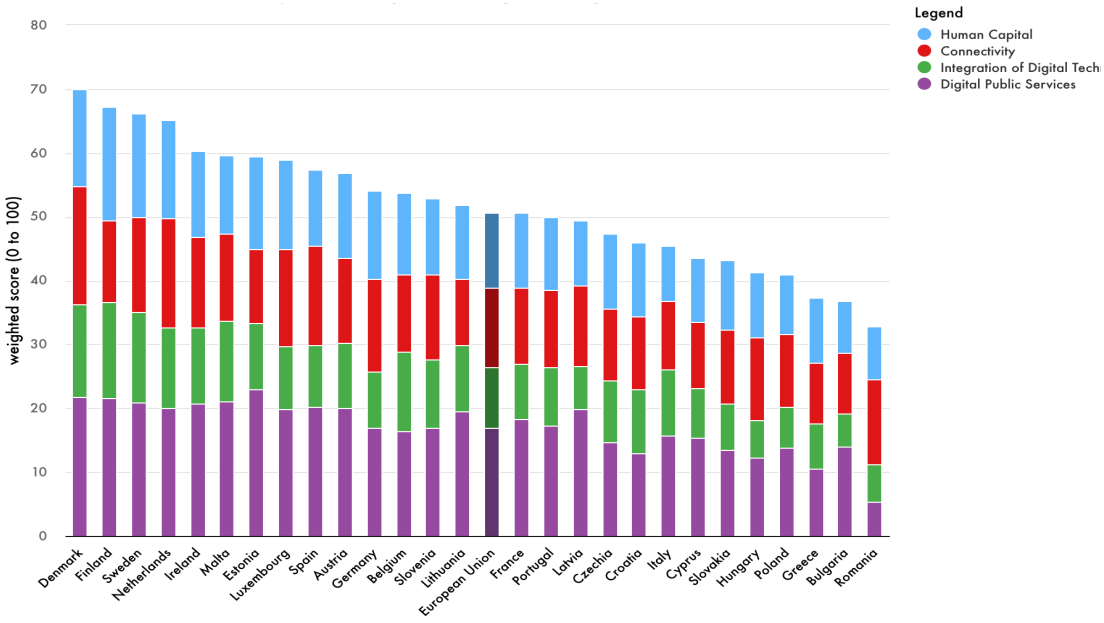

Figure 1 Digital Economy and Society Index, 2021

(European Commission)

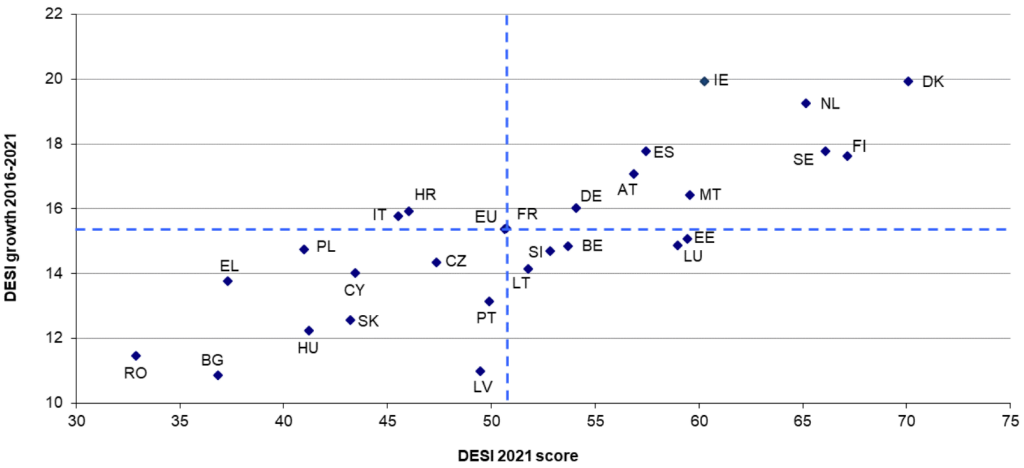

Figure 2 DESI Member State's progress 2016-2021

(European Commission)

From the graphs shown above, it is possible to notice the general ranking based on DESI Index and each countries' progression over the last 5 years. Focusing now on Italy, it occupies the twentieth position out of 27 states considered. Compared to the year 2020, Italy has recovered 5 positions, however the level of digitalization (considering the index itself) is well below the European average. If

the integration of digital technologies is the area in which Italy performs best, thanks to a good adoption of e-invoicing and the cloud, there are clear gaps in the area of public digital services. Indeed, the percentage of Italian online users who make use of e-government services is still just over half the EU average. In this regard, the Recovery and Resilience Plan (or RRP) launched by the Italian government could represent a solution to bridge the gap with the greatest countries of Europe. In fact, the Italian recovery plan is the most substantial among those of the EU countries and provides for around €49.2 billion to be allocated towards digital transition. We will, however, look more in detail to this plan in the following paragraphs, speaking about the agri-food sector.

1.3 Industry 4.0

Going deeper into the topic of manufacturing and industry, it's impossible to ignore the evolution of Industry 4.0. Very briefly, the history of industry consists of 3 industrial revolutions. The first (1760-1840 a.d.) was marked by the introduction of steam power. The second (1856-1878 a.d.) was characterized by the mass diffusion of electricity in factories. The third instead (from 1950 a.d.), has to do with the spread of electronics and information technologies. The current period has been identified by most with the term "fourth industrial revolution". Hence the term Industry 4.0 has to do with a new tendency of the industrial automation towards the use of new productive technologies which can improve working conditions, create new business models, and increase productivity. The concept of using technologies to enhance not only production, but in general the entire business model functionality, is strongly linked with the idea of digital transformation. More generally, then, the difference with previous industrial revolutions concerns the impact that Industry 4.0, through new technologies, has on jobs and society in general. In this regard, the framing given by Parrott, A. and Warshaw, L. makes much sense:

"Today, a fourth industrial revolution is transforming economies, jobs, and even society itself. Under the broad title Industry 4.0, many physical and digital

technologies are combining through analytics, artificial intelligence, cognitive technologies, and the Internet of Things (IoT) to create digital enterprises that are both interconnected and capable of more informed decision-making."[6]

So, we're talking about a process that is still ongoing, and as a result, most of the research on Industry 4.0 are forecasts on the effects it will have in the future. One piece of research in particular got a big play: Word Economic Forum's *The Future of Job* research. The study explains how in the coming years, due to some technological and demographic factors, the working market will see a big evolution. The cloud, blockchain, augmented reality and artificial intelligence are just some of the technologies that will drive change. As a result of changes taking place, 2 million new jobs will be created. At the same time, however, 7 million of others will disappear[7].

Now that the concept of Industry 4.0 has been broadly defined, let's look at its cornerstones in more detail. To do this, we can refer to the Boston Consulting Group report *"Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries"*[8]. This article outlines 9 building blocks of Industry 4.0 exploring their potential technical and economic benefits for manufacturers and suppliers. It's important to be aware of these 9 cornerstones in order to understand which emerging technologies characterize the digital transformation process industry is experiencing. Later in the chapter, each of these will then be analyzed in relation to the specific food-industry sector.

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[6] Parrott A., Warshaw L., *Industry 4.0: Are you ready*?, Deloitte Insights, 2017, Available at: https://www2.deloitte.com/us/en/insights/deloitte-review/issue-22/industry-4-0-technology-manufacturing-revolution-2018.html

[7] Schwab K., *The Fourth Industrial Revolution*, World Economic Forum, 2015

[8] Rüßmann M. et al., Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries, Boston Consulting Group, 2015, Available at: https://www.bcg.com/it/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries)

Let's list them one by one:

Figure 3 Nine pillars of Industry 4.0
(Univeristy of Liverpool)

1. *Big Data and Analytics:* Big data collection plus big data analysis. Companies of all sizes can use this data analysis for further actions and improved processes[9]. For example, data analysis can be used for financial, consumer care, or forecasting purposes.
2. *Autonomous Robots:* Robots today provide a broad range of services and are becoming more autonomous, flexible, and cooperative. They have always been connected to manufacturing, but they can also be used in customer services and other areas. They can work between each other and

[9] Virtual Engineering Centre, *The Nine Pillars of Industry 4.0*, University of Liverpool, 2016, Available at: https://www.virtualengineeringcentre.com/news-views/2017/the-nine-pillars-of-industry-4-0/

safely with humans. High-end sensors and control units they are enabled with indeed, allow close collaboration with humans.

3. *Additive Manufacturing:* Additive manufacturing is the use of a virtual model, such as 3D CAD, in order to create a new product from scratch. Examples of additive manufacturing include 3D printers and similar technologies. This type of technology is often used in very specific sectors such as aeronautics or aerospace for the creation of lightweight components. The evolution which many experts anticipate in the coming years is that 3D printing could be applied to the production of microchips and more complex electronic components.
4. *Simulation:* Simulation is a method of imitating a situation, process, or environment. It is strongly linked with Augmented Reality and Additive Manufactory. Many companies around the world, in different range of industries, are beginning to use virtual reality for their business purposes, including the medical sector.
5. *System Integration:* System Integration refers to the connection of different IT systems in order to ensure effective communication and data transfer. This type of software works as a coordinator between different machines and devices. It is a technology particularly adopted in factories in order to coordinate the production lines.
6. *Cloud Computing:* Cloud has to do with using a network of remote servers to store, manage and process data. Therefore, it can be useful for all types of businesses. Cloud computing enables the delivery of computing services such as servers, storages or databases through the internet.
7. *Internet of Things:* The Internet of Things involves connecting the Internet to everyday objects so then they can send, receive and process data. This can result in more functional management of production time, help with risk management, and save time/money.
8. *Cybersecurity:* Cybersecurity stands for the provision of sophisticated identity and systems access control to ward off any type of security-related cyber threat. All businesses need to protect their most valuable data regarding intellectual property patents, customer data, products info etc.

9. *Augmented Reality:* Augmented reality (AR) has to do with technologies that manage to display digital content in real settings through a device, such as a cell phone or special glasses[10]. It's a relatively simple and affordable technology which a lot of companies offer as a supplementary service to their clients (e.g., interior design, grocery shopping, etc.).

[10] Senn C., *The Pillars of Industry 4.0*, Dashboards, 2019, Available at: https://www.idashboards.com/blog/2019/07/31/the-pillars-of-industry-4-0/

2. CHAPTER 2: DIGITAL TRANSFORMATION IN AGRI-FOOD

2.1 Digitalisation in food industry

In the previous chapter we outlined the major areas of Industry 4.0. Let's now focus on the industry of interest of this paper: the agri-food sector. As already mentioned in the introduction, this particular sector is, on average, slower than others in the absorption of technological innovations. Partly because of companies relying on old methods of food production, partly because the less laborious the production of food, the more consumers appreciate that food. As we will see, however, the digital transformation of this sector does not only have to do with production, but rather with the entire management of the company. In order to understand the progressive integration of innovative technologies in the agri-food sector, one can consider the different eras related to agriculture history.

2.1.1 History towards agriculture 4.0

Let us now briefly look at the recognized periods in agricultural history. Agriculture 1.0 is generally placed from ancient times to the early 1900s[11]. Farming in this period was a lot of manual labor and still rooted in traditional ways. This traditional agricultural era was dominated by human and animal resources. A good part of the population was dedicated to agriculture and the work was intensive. Agriculture 2.0 is characterized by the so-called "green revolution" in the 1950s. The introduction of chemical fertilizers and pesticides allowed a high increase in productivity, but also had negative consequences, if we

[11] Saltini A., *Storia delle scienze agrarie*, Edagricole, 1984

consider pollution[12]. The next step was Agriculture 3.0, which is the era of high-speed development of automatic agriculture. Phase 3.0, also known as Precision Agriculture took off first of all thanks to the introduction of satellite geolocation tools, which can monitor and guide the work of agricultural machinery. The first self-driving machines in agriculture were indeed introduced as early as the late 1900s. Adding a more specific data management and the widespread use of internet to the precision agriculture, we finally arrive at the version 4.0 of agriculture. As you can understand, the concept of Smart Farm (A4.0) is strongly linked to the broader concept of Industry 4.0. Agriculture 4.0 is therefore conceived as a smarter and more efficient industry which makes full use of big data and technologies for the benefit of the entire supply chain. Coming into further detail about the technologies we're talking about, it is possible to consider CEMA's 2021 report on "Precision farming"[13]. *"CEMA is the association representing the European agricultural machinery industry. With a total of 11 national member associations, CEMA network represents both large multinational companies and numerous European SMEs active in the sector"*[14]. In this report, CEMA has listed the most important technologies applied to Precision Farming practices.

- *High precision positioning systems:* (like GPS and Galileo) Key technologies in order to achieve accuracy when driving in a field.
- *Automated steering systems:* Technology which enable to take over specific driving tasks like auto-steering, overhead turning, following field edges and overlapping of rows.

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[12] Doldi M.L., *Agricoltura 4.0: di cosa stiamo parlando?*, Agricoltura News, 2017, Available at: https://www.agricolturanews.it/agricoltura-4-0-di-cosa-stiamo-parlando/

[13] CEMA, *Precision Farm report*, 2021, Available at: https://www.cema-agri.org/index.php?option=com_content&view=article&id=50:precision-farming&catid=10&Itemid=170

[14] CEMA, *About CEMA*,2021, Available at: https://www.cema-agri.org/index.php?option=com_content&view=article&id=19&Itemid=105

- *Geomapping:* Technology used to produce maps including soil type, nutrients levels etc. in layers, assigning the specific information to the particular field location.
- *Sensors and remote sensing:* Technology which, through sensors, collect data about plants in order to evaluate soil and crop health (moisture, nutrients, compaction, crop diseases etc.).

2.1.2 Technologies application in the agri-food

In the first paragraphs we have considered the 9 pillars of Industry 4.0. Let's see now how these are configured within the agri-food sector. Noor Zafira Noor Hasnan, and Yuzainee Yusoff in "*Short review: Application Areas of Industry 4.0 Technologies in Food Processing Sector"* have tried to outline the application areas for some of the pillar technologies in food and beverage manufacturing[15]. Let's see them below.

Intelligent Manufacturing: Today, manufacturing can be structured in such a way that various machines are automated and can communicate with each other. In addition, machinery can develop a kind of memory that allows it to understand some level of production problems and, with minimal human involvement, solve them. Artificial intelligence technology allows machines to learn from past experience through their collected data set[16].

Quality Control: Industrial robots that can notice and so react to different situations based on defined parameters. They are commonly used in quality control. For example, they robots can distinguish different food products on the same processing line and subsequently perform different tasks. Special cameras can also provide various real time data about shape, color or even presence of

[15] Hasnan N., Yusoff Y., *Short review: Application Areas of Industry 4.0 Technologies in Food Processing Sector*, Department of Process and Food Engineering, Universiti Putra Malaysia, 2018

[16] University of Kassel, Development of a robotic-solution for slug control in agriculture, 2016, Available at: https://www.uni- kassel.de/fb11agrar/en/sections/agrartechnik/research/2016-msr-bot.html/

foreign bodies (as small as 1.5 x 1.5 mm pieces of glass or plastic). We are therefore speaking of technologies linked with the concept of additive manufacturing and simulation.

Food Traceability: Traceability is the ability to locate a product, animal, or ingredient, understanding its history in the supply chain forward (source to consumer) or backward (consumer to source). In this case, The Quick Response (QR) code and Radio Frequency Identification (RFID) are used in the food supply chain to speed up the identification and traceability of food materials. An example of RFID application is chicken meat, where the system is applied through the full chain (from the farm, through the slaughterhouse, to the retailer). Traceability data is usually collected and recorded through RFID readers and sent to a central database. Other foods that have been applied with the RFID system are dairy products, beverages, pasta, etc. The alternative is the QR code, with whom consumers can obtain information about the food product by scanning the code.

Gastronomy: In addition to manufacturing, the use of robots is also making a splash in the food service industry. In fact, there are examples of Chef Robots and serving robots. Some Chef Robot models can learn and reproduce movement for food preparation by mimicking the movements of a human chef through a 3D camera[17].

Marketing: Augmented reality (AR) is a technology that has been widely adopted in marketing in the food industry. AR allows consumers to interact with the product virtually, so they can examine it "up close". This gives the consumer access to information on price and various nutritional values. They are also able to play with the food, conduct experiments and inquire about available promotions. The technology is doubly beneficial: for marketing, but, at the same time, as a tool to store instant data on customer behavior and feedback. Additionally, the use of AR gives companies the ability to educate consumers about their food products.

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[17] Gibson M., The Robot Chef That Can Prepare Your Dinner, Time, 2015, Available at: https://time.com/3819525/robot-chef-moley-robotics/

Food customization: Additive manufacturing technologies or 3D printers have also been applied to food manufacturing. Some products can be manufactured by food 3D printers, where raw ingredients are deposited in layers in a sequential process. The latest generation of 3D food printers is much more high-tech with nozzles, lasers, syringes and robotic arms working on powdered material to produce various types of food[18]. Other possible customizations include taste, nutritional content, texture, and color.

2.1.3 Upstream and downstream approach

AgFunder, one of the most active foodtech and agtech venture capital firms in the world, publishes every year an annual report on the agri-food industry[19]. AgFunder's main area of research is innovation investments in the industry. It is interesting to take into consideration the AgFunder report because it proposes a double division of agrifood technological trends. It identifies under the *Upstream* category the technologies that have to do with farming and food processing. *Downstream* instead are all the trends that concern food delivery and consumption[20]. Let's see them in the table below. It's a particularly sensible division because it helps us realize how innovations in agri-food are not just limited to production but are instead evolving in all areas of the food value chain, from the field to the table at home. Upstream trends include *Agricultural Biotechnology*, *Agribusiness Marketplaces*, the use of *Bioenergy & Biomaterials*, the use of *Farm Management Software*, *Sensing & IoT*, *Farm Robotics*, *Mechanization & Equipment*, *Midstream Technologies*, *Novel Farming Systems* and *Miscellaneous*. On the other side Downstream trends include *In-Store Retail & Restaurant Tech*, *Restaurant Marketplaces*, *eGrocery*, *Home & Cooking Tech*, *Online Restaurants & Mealkits* and *Cloud Retail Infrastructure*.

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[18] Sun J., et al., An overview of 3D printing technologies for food fabrication, Food Bioprocess Technol, 2015
[19] AgFunde website, 2021 (https://agfunder.com/)
[20] AgFunder, *Agri-food Tech Funding Report*, 2021, Available at: https://research.agfunder.com/2021/2021-agfunder-global-report.pdf

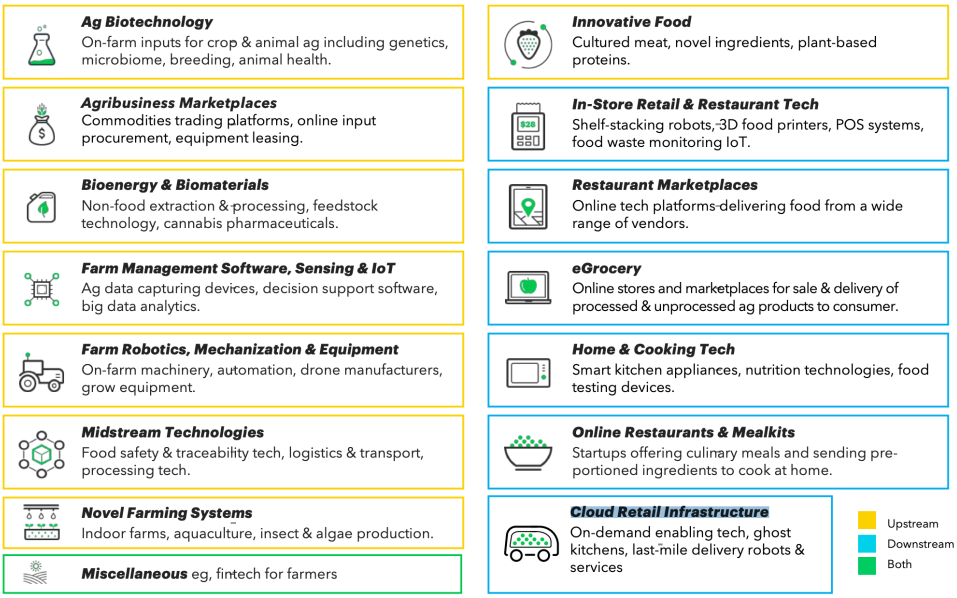

Figure 4 Agri-Food tech category definitions
(AgFunder)

Following the next graph, again provided by AgFunder, it can be seen that in both cases there is an increasing trend in investments year after year.

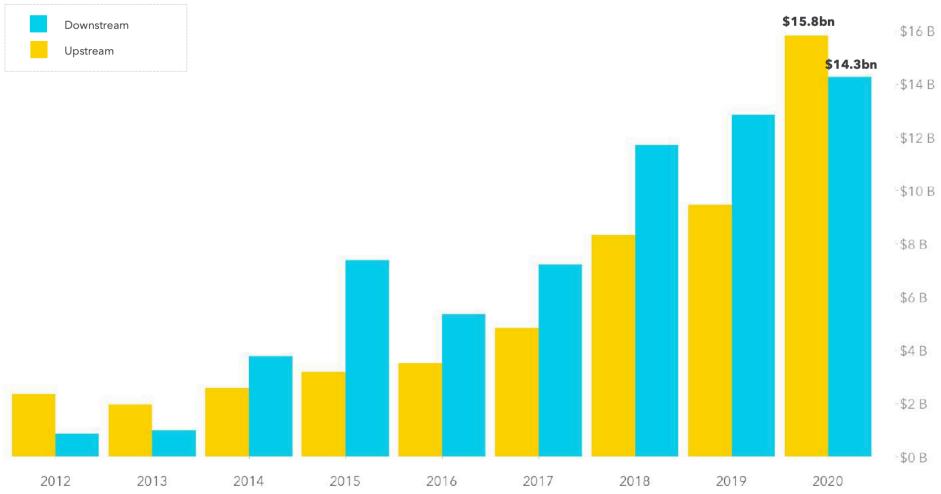

Figure 5 Annual financing of technologies
(AgFunder)

Even in the last year (2020), which generally saw declines in investment in several sectors, the growth trend remained constant. Further data will be provided in the following paragraphs, in order to outline the industry as much as possible.

2.2 Agri-food industry data

Having outlined the most relevant aspects of digitalization and technology integration in the agri-food industry, we will now look at this sector through data. First, we will consider the situation of the food industry in Europe in general, then we will focus only on Italy.

2.2.1 Europe: Agri-food sector in data

The agri-food sector has always been highly prominent in Europe. As well as being an economic sector, food is first and foremost an integral part of the social and cultural fabric of every European country. Food distinguishes the various populations and it is part of their traditions. Within the same European countries is it possible to spot relevant differences in the use of raw materials and preparation methods. The agri-food sector also employs a large proportion of workers in all European countries. In addition, agri-food products are among the most exported goods in the world. As well as being a source of livelihood, agri-food products are also source of wealth. Let's take a look, through some data and graph, at the impact of the agri-food sector in Europe from an economic and social point of view. Every year the European Commission publishes a report on the status of Food & Drink industry. Also, last report published in 2020 confirmed F&D industry as the biggest manufacturing sector in terms of jobs and value added in EU[21]. *"The EU boasts an important trade surplus in trade in food and EU food specialities are well appreciated overseas. In the last 10 years, EU food and drink exports have doubled, reaching over €90 Billion and contributing to a positive*

[21] European Commission, *Food & Drink industry*, 2020, Available at: https://ec.europa.eu/growth/sectors/food-and-drink-industry_it

balance of almost €30 Billion." Analyzing data in more detail, we can consider the FoodDrink Europe annual report *Data & Trends EU Food & Drink Industry 2020 Edition*[22]. The report provides detailed industry analysis, charts and data. The analysis is achieved by matching analyses from Eurostat, UN COMTRADE and other European Commission studies. All the graphs displayed from now on sourced the FoodDrink Europe report.

Starting with the contribution to EU economy, we can easily say that the F&D industry is a major contributor. Indeed Food & Drink industry has been capable of generating a turnover of € 1,205 billion in 2017, with a value added of €246 billion. The contribution of the sector to the the EU total gross value added is 1,9% , as can be observed from the graph below.

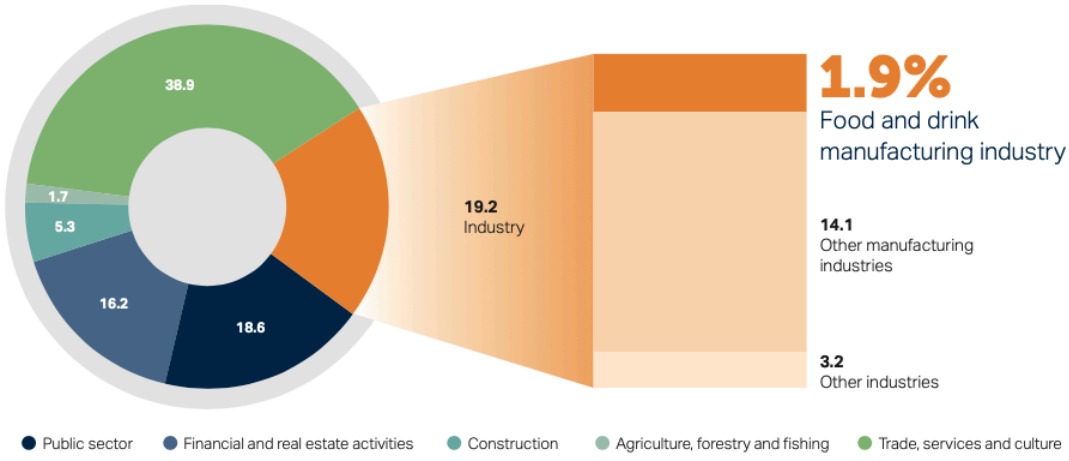

Figure 6 Contribution of F&B to EU economy (2017, %)

(FoodDrink Europe 2020 Report)

In general, it is fair to say that the sector maintains the characteristics of a resilient and stable economy, indeed with a total investment of € 43 billion, it is the leading manufacturing sector in terms of capital spending (15,6% of total

[22] FoodDrink Europe, *Data & Trends EU Food & Drink Industry 2020 Edition*, 2020, Available at: https://www.fooddrinkeurope.eu/resource/data-trends-of-the-european-food-and-drink-industry-2020/

investments). The volume of total production has been growing slowly, but gradually in recent years. Since 2008, production has increased by almost 10%.

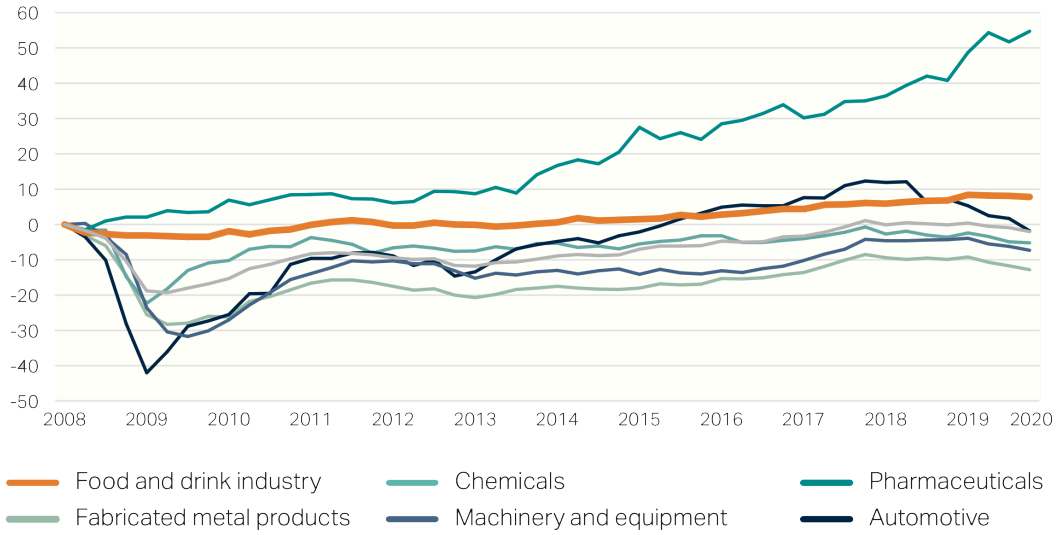

Figure 7 Production volume in EU (%)
(FoodDrink Europe 2020 Report)

Considering consumption F&D is the second largest household expenditure in Europe. € 1,786 billion has been spent by EU households on agri-food products in 2020 (Eurostat). Out of home consumption is one third of the total expenditure. The countries in which people spend the most higher part of their wage in food products are Greece, Estonia, Spain and Portugal.

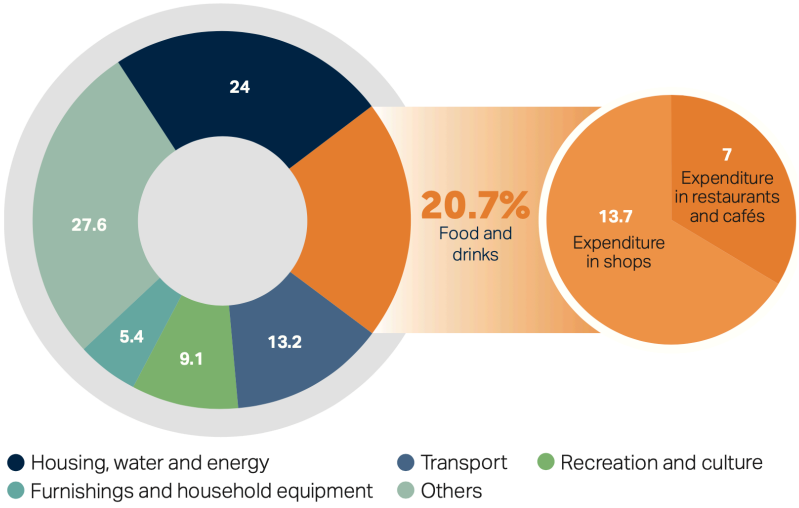

Figure 8 EU household expenditure consumption (%)
(FoodDrink Europe 2020 Report)

Let us now focus on the social impact that the agri-food sector has. As you can see from the graph below, the sector is the first industry employer in the EU. A total of 4.82 million people were employed in the agri-food sector in 2020, 15.5% of total manufacturing employment.

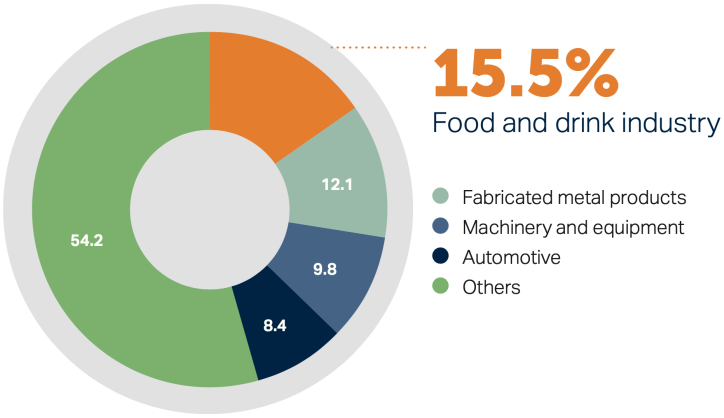

Figure 9 Employment in EU manufacturing industry (%)
(FoodDrink Europe 2020 Report)

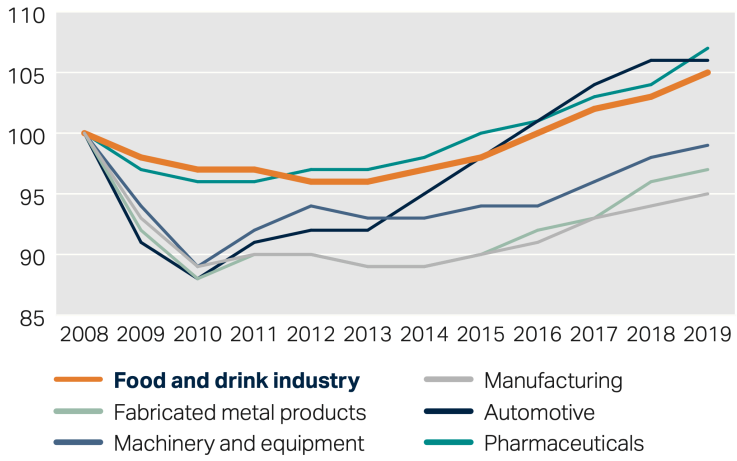

Figure 10 Employment growth in EU manufacturing industry
(FoodDrink Europe 2020 Report)

As can be seen from the graph above, after a decline attributable to the 2008 financial crisis, the employment level of F&D has gradually increased more than other sectors, reaching lhigher levels than pre-crisis. Moreover, companies in the

agri-food sector employ 17 people on average, about 2 more than the average of other manufacturing companies.

A table showing the most relevant statistics for all 27 EU countries is now provided.

	Employment ranking in manufacturing	Turnover (€ billion)	Value added (€ billion)	Number of employees (1,000)	Number of companies
Austria	-	25.5	6.5	88.3	3,870
Belgium[2]	1	54.9	-	94.6	4,239
Bulgaria	1	6.2	1.2	95.3	6,185
Croatia	1	5.7	1.3	51.2	2,483
Cyprus	1	1.7	0.4	13.6	926
Czech Rep.	4	14.8	3.2	115.3	11,028
Denmark	2	23.2	4.6	54	1,649
Estonia	2	1.9	0.3	14.8	723
Finland	4	11.1	2.6	38	1,772
France	1	213.1	-	674.8	54,260
Germany	2	211.1	47.2	992.9	28,800
Greece[3]	1	15.5	3.2	120.6	16,050
Hungary	2	13	2.6	107.2	6,640
Ireland	1	27.5	9.8	57	1,800
Italy	2	141.3	29	462.1	56,400
Latvia	-	2	-	23.9	1,230
Lithuania	1	4.2	0.9	41.5	1,735
Luxembourg	1	1	0.3	5.8	154
Netherlands	1	76.2	13.5	135.6	7,038
Poland	1	54.6	12.3	393	16,912
Portugal	1	17.1	3.3	115.4	11,426
Romania	1	13.2	9.3	183.3	9,937
Slovakia	3	4.6	0.9	43.4	4,173
Slovenia[4]	4	2.2	0.5	14.1	755
Spain	1	116.9	30.8	426.3	31,342
Sweden	3	18.8	4.4	51	4,648
United Kingdom	1	119.5	32.5	433	10,715

Figure 11 F&D industry data by member state
(FoodDrink Europe 2020 Report)

As can be seen from the first column of the table, the F&D industry is first in employment in most European countries. As far as turnover is concerned, the biggest producers are France, Germany, Italy and the UK. The equal situation can be found for value added in which the same four countries lead. Also, in the number of employees, Germany is the first country (almost 1 million employees) even though it has a smaller number of companies (28,800 in 2017).

Looking at the situation regarding imports and exports, Europe is the leading exporter and the second largest importer of agri-food products in the world. Imports of food and drink account for 18.8% of the total, while imports account

for 12.2%. Between 2017 and 2018, global exports increased by 1%, whereas in the previous 4 years they had only increased by 2 aggregate percentage points[23].

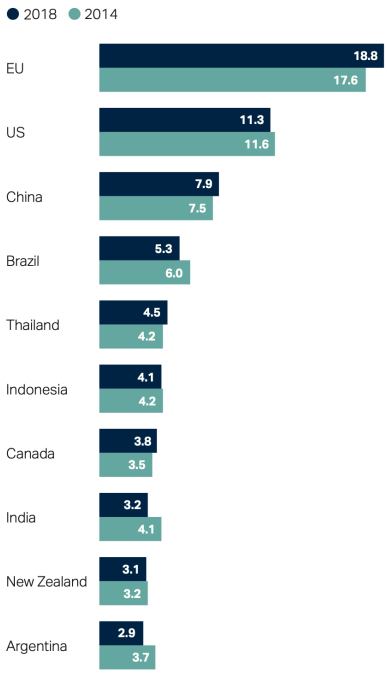

Figure 12 Share of global F&D exports (%)
(FoodDrink Europe 2020 Report)

Below you can see on the map the main countries with their import and export volumes in the EU.

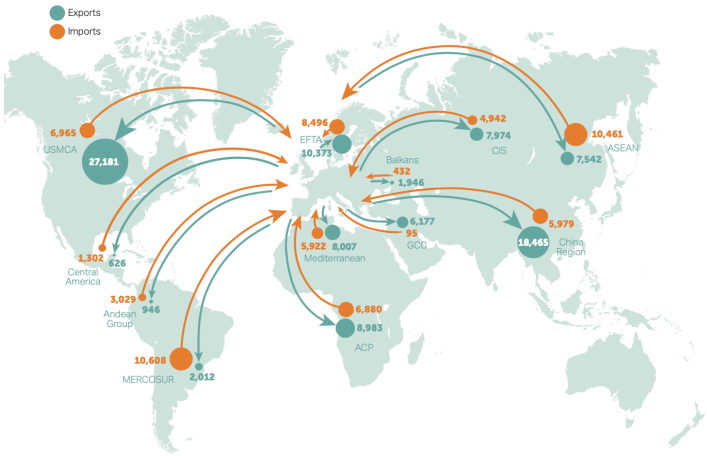

Figure 13 EU F&D trade flows
(FoodDrink Europe 2020 Report)

[23] UN COMTRADE, 2018, https://comtrade.un.org/

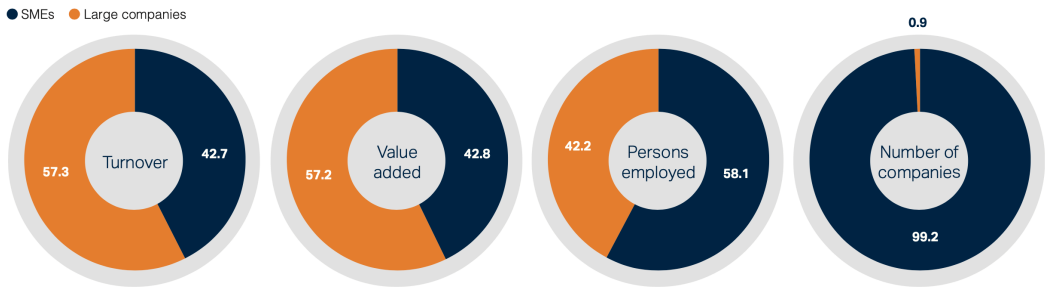

Figure 14 F&D Market stats
(FoodDrink Europe 2020 Report)

The FoodDrink Europe report also shows the degree to which small and medium-sized enterprises have an impact on the agri-food sector across Europe. SMEs have a turnover of € 515 billion or 43% of all enterprises. The value added in 2018 was €105billion, while 2.8 million people are employed in SMEs. These numbers are realized by a total of 290,000 SMEs out of a total of 291,000 enterprises, i.e. 99.2% of the total.

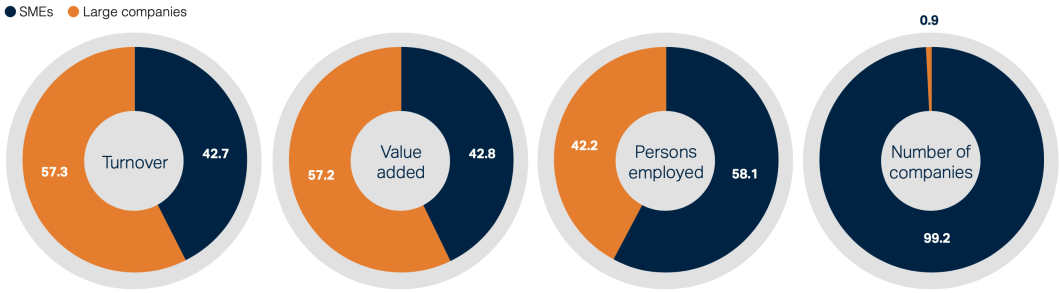

Figure 15 SMEs and large companies contribution to EU F&D industry (%)
(FoodDrink Europe 2020 Report)

2.2.2 Europe: Agri-food digitalization in data

As we have widely demonstrated in the previous paragraphs, the agri-food sector has a massive relevance in the European social and economic context. Let us now assess, through some data, the level of digital technologies adoption in the sector. Clearly, it is not easy to summarise in a few figures the situation regarding the digitalisation of a sector on an entire continent. However, let's consider some data

provided by the *Digital Transformation Scoreboard 2018*[24]. In 2018, the European Commission launched an online survey on digital transformation, sampling approximately 16,000 companies from the food and construction sectors. *"The survey captures the most recent uptake of digital technologies and digital transformation at firm level. It measures the output dimension at firm level, and results are then aggregated and segmented at sectorial levels"*. Some of the results below help to understand, more from a qualitative point of view, the awareness of food companies about digital opportunities. It emerged that 88% of companies in the food sector are fully aware of the new perspectives brought by digital transformation. However, among all companies, only 58% have the necessary competences and skills to change their business model in order to integrate new digital technologies. The effective integration of digital technologies requires significant investment both in the development of new products and in the improvement of production processes. When considering companies that have adopted digital technologies, 24% of them have experienced a significant increase in the number of employees (only 5.5% experienced a decrease). From the graph below, again provided by the *Data & Trends EU Food & Drink Industry 2020 Edition* report[25], we see in detail how the adoption of digital technologies has impacted the number of employees in food companies.

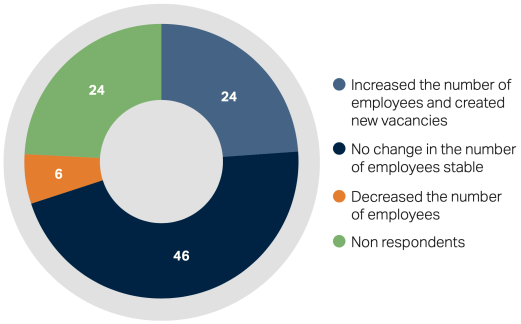

Figure 16 Impact on N°employess after technology integration (%)

(FoodDrink Europe 2020 Report)

[24] European Commission, *Digital Transformation Scoreboard 2018*, 2018, Available at: https://op.europa.eu/it/publication-detail/-/publication/683fe365-408b-11e9-8d04-01aa75ed71a1

[25] FoodDrink Europe, *Data & Trends EU Food & Drink Industry 2020 Edition*, 2020, Available at: https://www.fooddrinkeurope.eu/resource/data-trends-of-the-european-food-and-drink-industry-2020/

In overall terms, the survey shows that 48% of respondents who had undergone a digital transformation process noticed a considerable increase (20%) in productivity during the last three years. With regard to investments in digital technologies, companies invest in the development of new products and the improvement of production processes. Below is a graph in percentages that illustrates this.

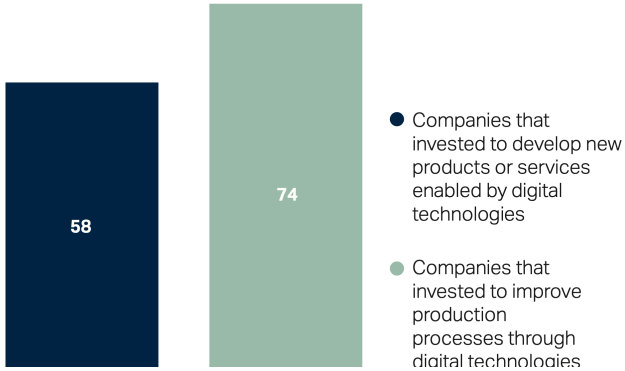

Figure 17 F&D companies purposes on digital investments
(FoodDrink Europe 2020 Report)

Let us now consider some data from the International Federation of Robotics, which clarify the adoption of these technologies by European companies. Today, the total number of robots used by European food companies is 30,000[26]. Between 2013 and 2017, there was a 52% increase in the sale of robots for growing and processing food raw materials. In particular, the countries that make most use of robots in agriculture are Germany and Italy. The two countries together account for almost half of all work robots in Europe (45% in 2017). This is followed by Spain, France and the Netherlands with percentages of 12%, 11% and 7%. As regards robot density, i.e. the number of robots per 10,000 employees, the top countries are Sweden, Denmark, Netherlands and Italy. From the graph below, you can see that robots sold in Europe to companies operating in the agri-food

[26] International Federation of Robotics, *Service Robots report released*, 2021, Available at: https://ifr.org/ifr-press-releases/news/service-robots-hit-double-digit-growth-worldwide

sector have been steadily increasing in recent years. Every year except 2015 has improved on the previous year's statistics.

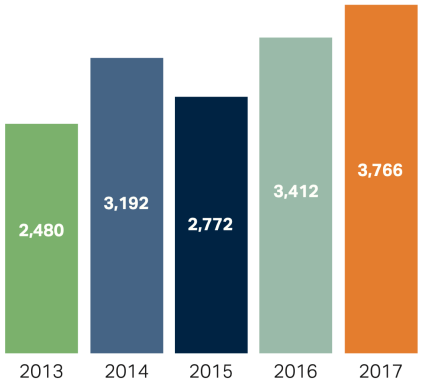

Figure 18 New robots sold in EU F&D
(FoodDrink Europe 2020 Report)

2.2.3 Italy: Agri-food sector in data

The Italian agri-food sector has always represented a typical excellence of the country. Italian agri-food products have always been synonymous of quality, sustainability, biodiversity and tradition. For several years now, Italian products have also excelled in terms of technological innovation. Italy is, in fact, a country characterised by great territorial and climatic diversity, which makes it possible to grow and produce many varieties of vegetables/fruits and agri-food products in general. These characteristics, together with the strong traditional value that food has in Italy, have historically led to the development of a large number of small, often family-run producer companies, often focused on the uniqueness of their products. Some of the distinguishing factors of the Italian food industry are the wide range of high-quality products, the close links with the territory, the high safety standards and the ability to combine tradition and innovation.

"With more than EUR 522 billion, the Italian agri-food system accounts for 15% of the national GDP: first in Europe for agricultural added value"[27].

[27] L'Abbate G., spch. *Annuario dell'Agricoltura Italiana*, 22nd January 2021, CREA, 2021

This is an extract from the speech by Giuseppe L'Abbate, Undersecretary for Agriculture Policies speaking at the presentation of the Yearbook of Italian Agriculture 2019. In fact, the agri-food system, including agriculture, forestry and fishing as a whole, is today a key sector of the Italian economy. As L'Abbate explained, production accounts for 15% of Italy's GDP, a stable average over last few years. In 2019, the value of agricultural production was €57.3 billion, in line with the previous year. This €57.3 billion is made up of 50% from cultivation, around 29% from breeding and the rest from support and secondary activities[28]. In the last decade, the Italian food industry has recorded +12% in added value (about double that of manufacturing) and +8% in the production index. There are 56.318 companies registered in the agri-food industry in Italy with a total turnover of €134 billion, and 440.000 workers employeed[29]. Certified quality label products, such as PGI and PDO, generated € 17 billion in 2020, remarkably resisting the impact of the pandemic. It can be observed from the graph that Italy is the first country for certified products, followed by France and Spain.

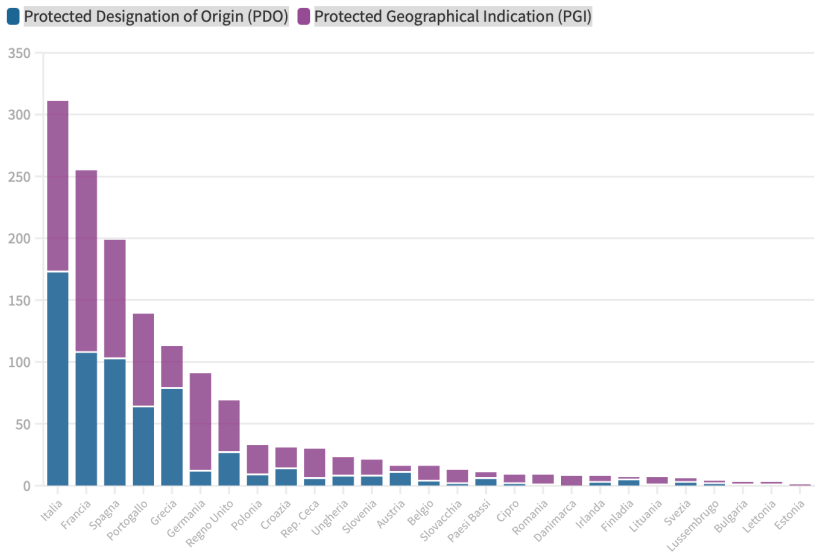

Figure 19 EU countries by certified foods (2021)

(ISMEA)

[28] CREA, L'agro-alimentare italiano settore chiave dell'economia Leader in Europa per valore aggiunto agricolo, 2021, Available at: https://www.crea.gov.it/-/crea-l-agro-alimentare-italiano-settore-chiave-dell-economia-leader-in-europa-per-valore-aggiunto-agricolo-1

[29] Ismea, L'industria alimentare in Italia: la performance delle imprese alla prova del Covid-19, Federalimentare, 2020

The Largo Consumo 2020 report, in collaboration with Nomisma, explains how in 2019, domestic food consumption exceeded € 250 billion, with significant growth in the away-from-home channel. However, the same AFH-channel suffered in from the advent of the pandemic in 2020, being practically shutted up for months. Always considering the pre-covid situation, in 2019, out-of-home consumption overcame € 85 billion, or 34% of total food consumption, with a growth of +2.7% compared to the previous year30.

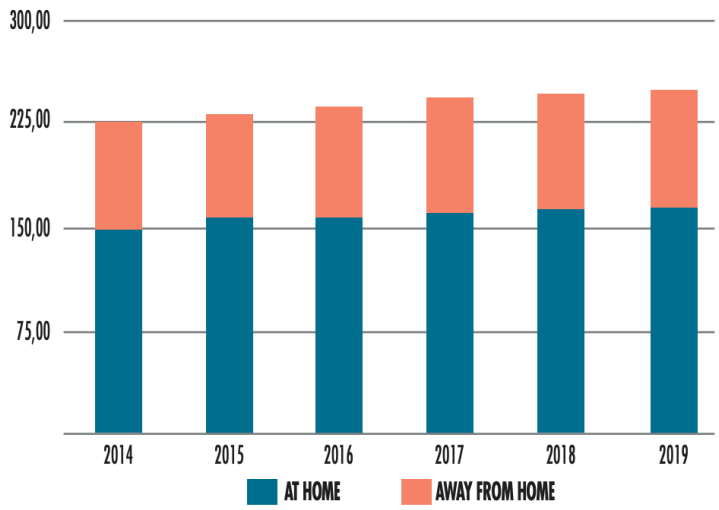

Figure 20 Food consumption trends in Italy (€ mln)
(Nomisma)

With regard to trade, here again it is good to distinguish a pre and a post pandemic situation. In 2020, the restrictions linked to the Covid-19 pandemic, and the consequent economic crisis, had a strong impact on Italian imports and exports. Imports have dropped by 12.8% and imports by 9.7%. For exports, the 2020 one is the first since the 2009 crisis (-20%)[31]. In the graph below you can see the

[30] Largo Consumo, *Mercato Italia Agroalimentare; Rapporto sullo stato delle imprese*, 2020, Available at., https://www.largoconsumo.info/042020/MercatoItaliaAgroalimentare2020FatturatiCompetitivitaProduzioneExport-0420.pdf
[31] CREA, Commercio con l'estero dei prodotti agroalimentari 2020, 2020, Available at:

decrease in exports and imports in the agri-food sector as in general on all other goods. From an export of € 48 billion and an import of € 42 billion in 2019, to €43 billion EXP and € 37 billion IMP in 2020.

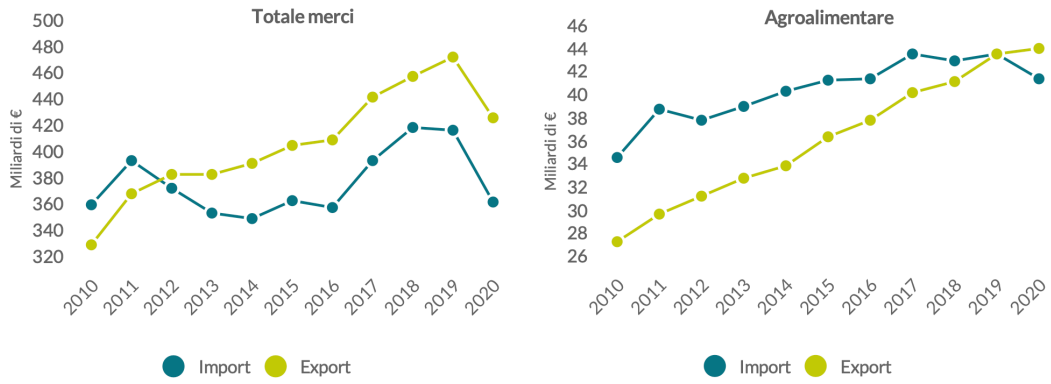

Figure 21 Italian foreign tarde

(Censis)

Fortunately, the agribusiness data for the year 2021 is more than encouraging. In fact, the first half of the year showed growth o from +2% to +10% in all segments of the sector. Moreover, Censis estimates a growth in the worldwide demand of +14.2% for agricultural products in the two-year period 2021-2022[32].

Let's now see what the geographical distribution of agri-food trade is in Italy.

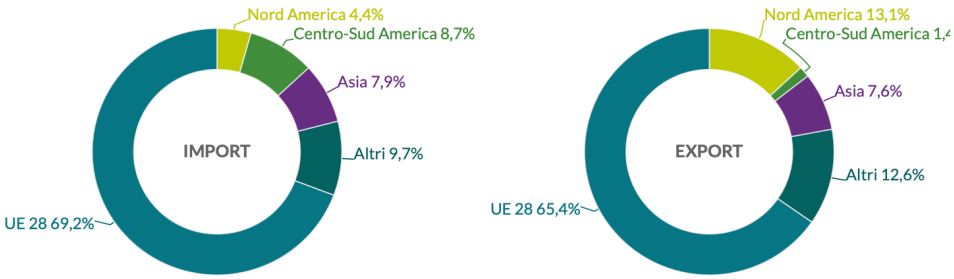

Figure 22 Agri-Food exchange areas for Italy

(Censis)

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https://www.crea.gov.it/web/politiche-e-bioeconomia/-/rapporto-commercio-estero-prodotti-agroalimentari

[32] Censis, L'agroindustria guarda alla ripresa post-covid, 2021, Available at: https://www.censis.it/economia/l'agroindustria-guarda-alla-ripresa-post-covid

The countries where the most products are exported are Germany, France and USA while those from which Italy import the most are France, Germany and Spain.

2.2.4 Italy: Agri-food digitalization in data

The Italian market for Agriculture 4.0 items is recording year after year a progressive growth. Not even 2020, a year characterized by the pandemic and lockdown has recorded a decline. On the contrary, 2020 reached a value of 540 million euros (+22% compared to 2018) of spending. Most of this spending is concentrated in monitoring and control systems (39% of the total), management software (20%) and connected machinery (14%). Then there's remote land monitoring systems (10%), mapping systems (9%) and decision support systems (5%)[33].

Today, there are 415 Agriculture 4.0 different tools offered in Italy. Companies engaged in providing digital solutions for agriculture are 160 in Italy. 77% of these are structured companies, while the rest are startups. In 2018, there were only 60 companies on this list. The digital solutions offered are mainly dedicated to Precision Agriculture and to a lesser degree to Smart Farming. They are therefore adopted mainly in the phases of cultivation, sowing and harvesting of food products. The sectors that benefit the most in Italy are fruit and vegetables, cereals and wine. Most of the innovative solutions offered in the Italian market are based on Blockchain (43% of the total). Then there's QR code (41%), mobile app (36%), data analytics (34%), IoT (30%) and Cloud (27%). Finally, digital

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[33] Osservatorio Smart Agrifood Politecnico di Milano, *L'agroalimentare è sempre più digitale: l'agricoltura 4.0 vale 450 mln di euro (+22%)*, Politecnico di Milano, 2020, Available at: https://www.osservatori.net/it/ricerche/comunicati-stampa/l-agroalimentare-e-sempre-piu-digitale-l-agricoltura-40-vale-450-mln-di-euro-plus22

solutions that exploit the Internet of Things are still a market with few investments, but with strong growth in recent years (+63% from 2018). A survey of 288 agricultural companies, conducted by the Agrifood Observatory of the Politecnico di Milano School of Management in 2020 investigated the fields in which companies invest in 4.0 solutions. According to the survey, the first reason why they invest is to improve the environmental sustainability of their crops. Then the second reason is increasing awareness of the dynamics taking place within their company and finally reducing costs and simplifying work. Although these statistics are very encouraging, it must be said that just 4% of Italian agricultural businesses are fully digitalized. In particular, only 1.3% in the south and 2% on the islands. These are mainly the result of a lack of digital skills between some entrepreneurs and a lack of digital infrastructure, especially in rural areas.

2.3 Digitalisation and Covid-19

2.3.1 Covid-19 impact on digitalization

As we all know, the Covid-19 pandemic has had an unprecedented impact on our lives, radically and unexpectedly revolutionizing our social and working habits. In particular, some specific economic sectors have suffered from the advent of the pandemic, as they have been unable to pursue their services. Although the agri-food sector is an essential one, therefore not directly subject to the restrictions, farms faced difficulties depending on their main commercial channels and the areas of localization. As we explained in the previous paragraphs, in 2020 the agri-food sector recorded, for the first time since 2016, a decrease in added value (-4%)[34]. This data is particularly relevant if we consider that in the past, the F&D industry had grown more than the average of national GDP. In 2018, it had recorded +6.9% in exports compared to 2017, while the national manufacturing

[34] Istat, L'andamento dell'economia agricola, 2020, Available at: https://www.istat.it/it/archivio/258021

average had grown by +2.7%. Taking note of these significant decreases, however, the pandemic has also brought some positive effects from the perspective of digital transformation. The pandemic indeed imposed a new shared need for digitalization among companies. The efforts have resulted in a significant increase in the awareness and knowledge of digital opportunities. Turning to our sector of interest, the food and beverage industry, the pandemic has acted as a real catalyst in the digitization process and is making new opportunities evident to companies in the whole sector. Reply S.p.a, an Italian consulting, system integration, and digital services company, conducted a study through the Trend Sonar platform, on the impacts of Covid-19 on the F&B industry. The study showed how, following the pandemic, interest in online delivery services in Europe grew by 140% in 2020. Italy achieved one of the best performances in the sample considered equal to +180%. The same positive trend was recorded in Germany (+68%), in France (+113%), and in the UK (+198%)[35].

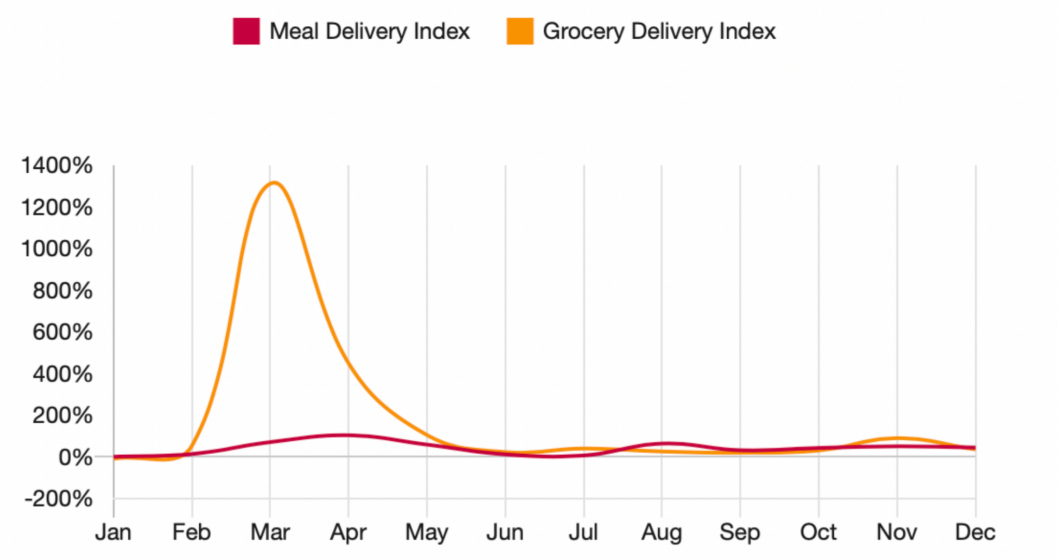

Figure 23 Food deliveries level in Italy 2020
(Reply Spa elaboration)

[35] Reply, Una nuova spinta verso la digitalizzazione del settore F&B, 2021, Available at: https://www.reply.com/it/content/una-nuova-spinta-verso-la-digitalizzazione-del-settore-fandb-food-and-beverage

On the other hand, in the first months of the pandemic, as a result of the restrictions, there was a -12% drop in food and beverage consumption at physical points of sale. It's fair to say that home delivery services have filled the gap caused by bars and restaurants forced closures. During the pandemic, digital ordering and payment features have increasingly become the norm among customers. This type of innovation not only has to do with the end consumer, but has also occurred in the intermediate sales channels of the value chain. Indeed, even manufacturing companies which do not target end consumer directly, have had to adapt to the situation. The use and knowledge of online ordering systems has therefore spread to all the different phases of the supply chain. In general, the willingness to pay online has increased. Reply's estimated that, after the pandemic, around +87% of Europeans will resort less to cash for payments in the future. As well, the use of QR code is another example of the changements taking place. Italy recorded just +34% compared to 2019, and the average percentage increase was even greater in Europe. In addition to these innovations, which are more evident in B2C than in B2B, the unexpected health emergency related to Covid-19 has also required a rapid modernization of all food production, packaging and marketing procedures, with particular attention to safety. For example, with internet-connected monitoring systems, the workers had the possibility to operate in smart working. From the data reported it's clear that the covid-19 pandemic led companies realize the growing need for digital solutions integration in their business model. In general, then, we can conclude assessing that companies at all levels of the supply chain would benefit from a new focus on digital logistics, as e-shops. First and foremost, digital logistics allows multi-channel approach. Secondly an online touchpoint throughout the supply and delivery chain can help in the B2B2C relationship.

2.3.2 Plans of recovery post Covid-19

We outlined in the previous section how Covid-19 pandemic revealed the need for a digital turnaround. Many of the improvements in the use of digital technologies are however natural adaptation to the situation the pandemic entailed. However,

let us now look at what plans has been put in place to actively address the pandemic consequences. After covid-19 became a global issue, supranational organizations, such as the European Union, took direct action to address it. Economic and social recovery plans affecting all the member states were developed. The EU recovery plan consists of funds to be distributed to the various member countries in order to tackle the pandemic by promoting a precise restart plan, which is characterized by some key common pillars for growth. The European funding available, corresponds to a total of about €750 billion, enhance the implementation of Next Generation EU (NGEU), the master plan for the post-Covid recovery of Europe. The 90% of the NGEU's availability comes from the Recovery and Resilience Facility (RRF), commonly known as the Recovery Fund, with its endowment of €672.5billion divided between €360 billion in loans and €312.5 billion in grants. The name Recovery and Resilience Facility came from the objective of stimulating investments that could drive recovery between the member states[36]. The overarching long-term vision for 2021 to 2027 investments is the idea of a greener, digital and resilient Europe. The programmes funded under the multiannual financial framework are grouped into seven expenditure categories. Each one is dedicated to a specific policy area[37]. The seven headings are:

- Single Market, Innovation and Digital

- Cohesion, Resilience and Values

- Natural Resources and Environment

- Migration and Border Management

- Security and Defence

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[36] Coopservice, Next Gen EU e PNRR, occasione unica per l'Italia, 2021, Available at: https://www.coopservice.it/-/ngeu-e-pnrr/1.8

[37] European Commission, The EU's 2021-2027 long-term Budget and NextGenerationEU, Facts and Figures, 2021, Available at: https://op.europa.eu/en/publication-detail/-/publication/d3e77637-a963-11eb-9585-01aa75ed71a1/language-en

- Neighbourhood and the World

- European Public Administration

The two most relevant points in the context of this thesis are the first and the third one: "Single Market, Innovation and Digital" and "Natural Resources and Environment". Single Market, Innovation and Digital has to do with the EU's goal of stepping up investment in areas such as research and innovation, digital transformation, strategic infrastructure, and the single market. Programs under this heading address challenges such as decarbonization, demographic change, and boosting businesses competitiveness (including small and medium-sized enterprises). The Natural Resources and Environment category includes all investments aimed at sustainability. This means investments in sustainable agriculture and maritime sectors, along with climate action, environmental protection, food security and rural development. Some of the programs under this heading support the EU's agriculture, livestock and fisheries sectors and seek to make them more competitive. Speaking of agricultural policy, the *Farm to Fork* strategy is the 10-year plan developed by the European Commission to guide the transition to a fair, healthy and environmentally friendly food system[38]. This is not a binding policy in itself, however member countries, when implementing norms and laws, will be bound to respect the objectives set by the Commission. This is the first time that the EU has attempted to design a food policy that proposes measures and objectives involving the entire food chain, from production to consumption, passing, naturally, through distribution. The aim is to make European food systems more sustainable than they have been until now. This strategy is part of a context in which the EU already protects the names of specific products to promote their unique characteristics linked to geographical origin and traditional skills (PDO, PGI, GI). Therefore, it can be said that the objective is to safeguard a European agricultural model that unites all producers. As we have

[38] Parlamento Europeo, Strategia Farm to Fork e Politica Agricola Comune nella prossima programmazione UE 2021-2027, 2021, Available at: https://www.europarl.europa.eu/italy/it/succede-al-pe/strategia-farm-to-fork-e-politica-agricola-comune-nella-prossima-programmazione-ue-2021-2027

seen, the Italian agricultural sector, but also the European one in general, is characterized by many fragile enterprises. This multitude of small farms plays an important role in protecting the territory and the environment.

Next Generation EU is clearly a great opportunity for Italian development. The National Recovery and Resilience Plan (PNRR) is the plan that the Italian government has prepared following the issuance of the EU Next Generation Plan. As per EU directive the Italian plan has as vision which consist on the green and digital development of the country. From a total of €750 billion, Italy has been allocated € 191.5 billion (70 in grants and 121 in loans)[39]. The Italian PNRR is structured around 6 main missions, consistent with the principles of the NGEU:

M1: Digitalization, innovation, competitiveness and culture.

M2: Green Revolution and Ecological Transition

M3: Infrastructures for sustainable mobility

M4: Education and research

M5: Inclusion and cohesion

M6: Health

As regards the first category, investments aimed at encouraging the digital transformation process in Italy, the plan provides for an amount of resources equal to € 46.3 billion[40].

It is divided into three distinct lines of action, each of which has an investment area:[40]

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[39] Ministro per l'innovazione tecnologica e la transizione digitale, *Next Generation Italia, approvato il piano del Governo*, Governo Italiano, 2021, Available at: https://innovazione.gov.it/notizie/articoli/next-generation-italia-approvato-il-piano-del-governo/

[40] Fiscoetasse, *PNRR: Missione 1 digitalizzazione, innovazione, competività e cultura*, 2021, Available at: https://www.fiscoetasse.com/approfondimenti/14069-pnrr-missione-1-digitalizzazione-innovazione-competivita-e-cultura.html

- Digitization, innovation and security in Public Administration.

- Digitization, innovation and communication capacity of the production system;

- Tourism and culture

On the other hand, regarding investments directly related to the Italian agri-food sector, the funds are intended for farmers and all operators in the supply chain. The objective is to support the path of innovation of production processes, and diffuse training on the use of new technological and digital tools. The funds for the agri-food sector are divided as follows:

- 800 million for the logistics

- 1.5 billion for the coverage of agricultural facilities with photovoltaic systems

- 500 million for the modernization of agricultural machinery

- 2 billion for the development of biogas and biomethane production and technology

- 880 million for reservoirs and the irrigation system

This type of support may potentially result in a great impact on the Italian agricultural sector. If well used, they can significantly improve a sector that is already at the top of Europe and the world.

2.4 Digitalisation and competences

In the previous paragraphs, we have seen how the pandemic has inevitably affected the digital transformation process of all economic sectors. We have also analyzed what is the recovery plan drawn up by the Italian government. If the latest two-year of pandemic has strongly pushed digitization in Italian SMEs, among small companies there is still today, a lack of necessary skills and tools. The urgency to survive dictated by Covid-19 has led small businesses into forced digitization. However, without the necessary skills this will not turn into a structured dimension of growth. PNRR resources are certainly a valuable aid, but at the same time a strategic vision of digital is also needed. Indeed, it would be wrong to equate digital transformation with the mere adoption of some

technological solutions in business processes. The concept of digital transformation in fact has to do with a real strategic approach to the digital. This means embodying a proper mindset aimed at the effective and efficient integration of digital into the own business model. Taking a strategic approach to digital requires to posses or develop relevant digital skills. Specialized skills are the focus of this paragraph and play a central role in the success of a digital transformation process. Giorgia Sali, the director of Osservatorio Innovazione Digitale nelle PMI (Digital Innovation in SMEs Observatory), indeed stated that:

"Despite these encouraging signs, the digital transformation of SMEs remains limited to specific services and operational tools, struggling to take off towards a strategic review of processes: in fact, the data show a situation that is still critical both from a cultural and skills point of view, both from a technological one."[41]

The focus here is precisely the lack of digital competencies. Starting from this, let's see what are the various problems that Italian SMEs face in undertaking a real digital transformation process.

2.4.1 Issues of Italian SMEs

As mentioned, the main problem blocking Italian SMEs in adopting digital technologies is the lack of skills. By skills we don't mean only digital skills and knowledge, but also more generally the awareness of digital technology potential. Let's look at those issues one by one:

- *Digital competences:* In order to get an insight into the skills of Italian SMEs, we can rely on a report by the Osservatorio Innovazione Digitale nelle PMI. In 2021 the Observatory conducted a research in collaboration with Capterra on a sample of 1038 companies' representative of the Italian

[41] Osservatori.net, Il 2020 spinge la digitalizzazione nelle PMI, ma mancano ancora competenze e strumenti, 2021, Available at: https://www.osservatori.net/it/ricerche/comunicati-stampa/pmi-innovazione-digitale-mercato

SME population. Responses from the entrepreneurs interviewed showed that in 9 out of 10 companies there is interest in digital. In addition, 6 out of 10 SMEs believe they have at least a good level of digital skills. However, 43% of them are reluctant to invest, because of reasons related to costs or because they just consider digital to be irrelevant in their sector. In addition, a large proportion of those who claim to have good digital skills show little knowledge of digital technologies and opportunities[42]. The Cerved 2020 Report can help us go even deeper into the matter. In fact, every year Cerved updates the Digital Capability Index, an index that combines official information from the Italian "Registro delle Imprese", with Cerved's scores on innovative propensity, digital culture and web positioning. Cerved's data explain that 48.8% of Italian SMEs have a high propensity for growth. However, this potential is likely to remain unexpressed due to a too low diffusion of digital skills and culture[43]. From the graph below, it can be seen in detail how the problem of poor digitalization is particularly present in micro and small enterprises. Analyzing the data in aggregate, we can see that the levels of high digitalization of SMEs are still much lower than those of large companies (9.1% vs. 31%). Over 2 out of 3 Italian companies show low levels of digitalization.

[42] AgendaDigitale.eu, PMI, il PNRR non basta per "diventare" digitali: ecco le competenze che servono, 2021, Available at: https://www.agendadigitale.eu/cultura-digitale/competenze-digitali/pmi-il-pnrr-non-basta-per-diventare-digitali-le-competenze-che-servono/

[43] Cerved, *Le PMI e la sfida della digitalizzazione*, 2021, Available at: https://know.cerved.com/imprese-mercati/le-pmi-e-la-sfida-della-digitalizzazione/=

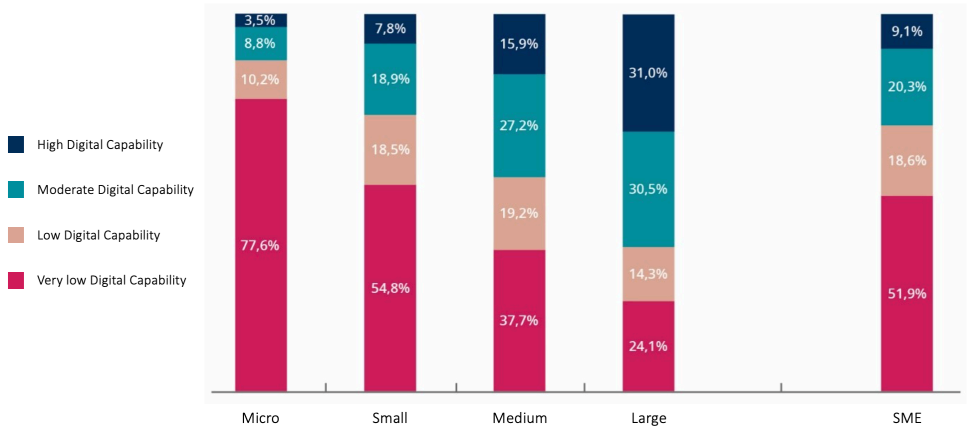

Figure 24 Italian companies digitalisation level
(Cerved)

In absolute terms, the food and catering sector is ranked third in terms of the number of digitized SMEs (1,833 companies). The chemical and mechanical sector (3,330 companies) and ICT (2,311 companies) perform better[44]. However, it must be said that there are strong differences at a territorial level. In fact, there is a strong gap in the digitalization map of Italian SMEs. Indeed, in the southern Italian provinces, the incidence of digital transformation is much lower, also due to strong infrastructural gaps. The provinces with the highest percentages of highly digitized SMEs are Treviso (14.0%), Milan (13.7%) and Rimini (12.9%). While in the south, no province manages to exceed the national quota of highly digitized SMEs (9.1%). The highest levels are recorded in Bari (7.9%), Avellino (7.5%) and Trapani (7.3%). The provinces with the highest number of highly digitized SMEs are Milan (2,440 companies), Rome (1,055 companies), Turin (591 companies) and Treviso (483 companies).

[44] Cerved, *Le PMI e la sfida della digitalizzazione*, 2021, Available at: https://know.cerved.com/imprese-mercati/le-pmi-e-la-sfida-della-digitalizzazione/=

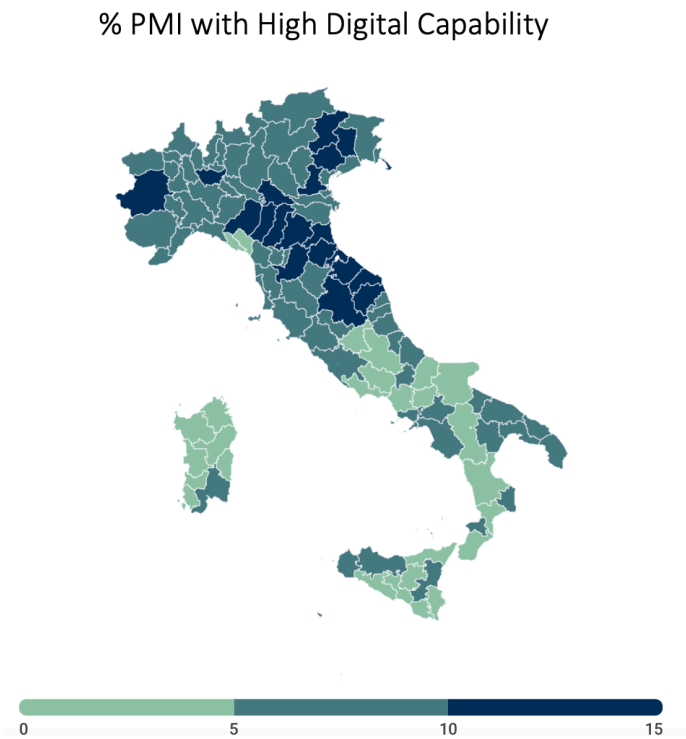

Figure 25 Digitalisation map of Italian provinces
(Cerved)

In general, however, Italian SMEs have limited digital skills compared to SMEs in other EU countries. Italian SMEs are penalized by a high percentage of the population still lacking basic digital skills. Moreover, in Italy there is a lower level of graduates in information and communication technologies. The percentage of Italian graduates in ICT disciplines is 1% vs. 3.6% of European average. Both Germany and France exceed 3% of total graduated[45]. Secondly, there is a general lower supply of ICT-related training courses to employees in Italian SMEs compared to other European SMEs. Only 19% of Italian companies offer ICT training courses

[45] European Commission, *Digital Economy and Society Index*, 2021, Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

compared to a European average of 23%. Still considering France and Germany, they have values of 20% and 30% respectively[46].

- *Digital consciousness:* Another point is the actual awareness of what digital transformation effectively means. Many companies are unaware of the enormous potential that digital can bring to their business strategy. Another point is the actual awareness about what digital transformation actually means. Many companies are unaware of the enormous potential that digital can bring to their business strategy. In general, there is a widespread unawareness of the benefits and solutions that the adoption of digital technologies can bring to a company's business model. Going digital is perceived as too expensive and unsuitable as an investment for a small business. Often, for example, it is thought that in order to establish an online digital presence, it is enough to open a website or a social page. Often, there's not a real strategy behind that. Investments in digital are therefore insufficient and occasional. The mentality behind many SME investments is directed at the immediate result and does not consider a real process of digital transformation. Instead, this process consists precisely in the progressive assumption of resources and awareness of how digital can interact with one's own business. So, let's look not at this trend through data. Consider the following statistics on investment by Italian SMEs. The European Investment Bank's annual report[47] (2020/21) explained how Italian SMEs systematically invest less than other EU SMEs in digital areas. Many Italian SMEs do not plan future investments in digital

[46] Istat, Le imprese usano il web ma solo le grandi integrano tecnologie più avanzate, 2020, Available at: https://www.istat.it/it/files/2020/12/REPORT-ICT-NELLE-IMPRESE_2019_2020.pdf

[47]European Investment Bank, EIB Investment Report 2019/2020, Building a smart and green Europe in the COVID-19 era, 2021, Available at: https://www.eib.org/attachments/efs/economic_investment_report_2020_2021_key_findings_en.pdf

solutions in the next few years, in fact 18% of them have no planned investments for the next three years. The European average is only 10% of companies. Investment in asset upgrades is poor too, in fact only 31% of Italian companies have planned investments to replace machinery, buildings and IT. The European average here is 37%. Nations like Germany and France have 45% and 38% respectively. As a direct consequence of limited digital investment is the use of less sophisticated digital technologies, hence a lower increase in productivity. Eurostat data shows that Italian SMEs are less likely than other European SMEs to adopt digital technologies (only 72% of SMEs have a website compared to 77% in Europe). In addition, Italian SMEs' websites appear on average to be less sophisticated than other countries in Europe.

- *Financial Capabilities:* As we discussed above, one of the greatest obstacles to digital innovation for Italian SMEs is they are, indeed, small businesses. As such, access to capital to be invested in innovation and development is often limited. There are many reasons for that. Primarily, we have to focus on the sources of funding for small businesses. The availability of bank credit is often an obstacle for SMEs willing to go digital. Italian SMEs usually turn to banks to meet their financing needs, including for digitization projects. Most SMEs in Italy turn to bank loans or trade credits. In fact, bank loans are the largest source of financing for 50% of Italian SMEs. In contrast, many SMEs seem to have little confidence in venture capital firms. This scenario tends to be mostly damaging since interest charges for loans to SMEs in Italy have systematically increased since the first quarter of 2020 until today. In particular, Irish and Italian SMEs have reported the largest absolute increase in interest expenses (16% and 14%, respectively, up from 12% and 9%)[48]. The situation has further aggravated due to the Covid-19

[48] European Commission, Data and surveys - Survey on the Access to Finance of Enterprises (SAFE), 2021, Available at:

pandemic. In fact, Italian SMEs have increased their level of debt by resorting to new financial support offered by the government. The increase in debt could therefore have a greater negative impact on the ability of SMEs to invest in innovation.

2.4.2 Development of digital skills

To complete this section in which we have analyzed the weaknesses of Italian SMEs in adopting digital strategies, we need to focus on the fundamental problem: the lack of digital skills. Clearly, in order to be competent and competitive in the 21st century, it is critical to possess digital competences. We can therefore say that the real challenge for Italian SMEs today is precisely the progressive adoption and integration of digital skills as intangible business assets. Digital competences are then intended as combination of technical skills and a global vision of digital transformation. This global vision must integrate the definition of a strategy with clear objectives and metrics to measure them. The challenge of creating a digital culture in Italian SMEs has mainly two paths: the acquisition of specialized external professional resources and the internal development of a digital-focused mindset. Clearly the first of the two is quicker, but at the same time costly. The second tends to be procedural. In any case, whether the company decides to internalize the process of digital transformation or relies on third parties, the real goal must be to acquire a true and shared 360° vision of digital in the company. In general, Italian economy would benefit from a more conscious and focused approach of SMEs towards digital technology. There are countless advantages that the adoption of various types of technologies would bring. Production in primes would benefit directly. It would then be easier for companies to communicate with each other, with suppliers and customers. Small companies would have the possibility to face the great markets and to better promote their product/service abroad. Lastly, Italian ICT graduates would have a greater outlet in Italian companies without the need to emigrate abroad to practice

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https://ec.europa.eu/growth/access-finance-smes/data-and-surveys-safe_en

their field of specialization. Clearly, all the discussion developed in the last paragraph refers to Italian SMEs in general, and not specifically to the agri-food sector. The agri-food sector in fact we have seen is generally more competitive than others when it comes to aspects related to digitalization. In any case, the insights reported are valid also for companies in the agri-food sector, which, despite being more competitive than others, maintains a general slowness in integrating business models with digital. In fact, establishing a true digital culture, based on objectives and proper metrics, is a necessity for companies in any industry.

3. CHAPTER 3: LITERATURE REVIEW

3.1 Introduction to literature

In previous chapters, the concept of digital transformation was introduced from a theoretical standpoint. We then looked at what technologies are now available for medium and small agribusinesses. Finally, through industrial sources, we have analyzed the situation of the agri-food sector in Europe and Italy. Now that we have a clearer idea of the context and the sector taken into consideration, this chapter will address a review of the scientific literature on the subject. We will see how the literature has treated the topic of digital transformation in recent years. Clearly, digital transformation is a fairly recent topic and consequently there is not a real publication history base to use as a starting point. On the contrary, the subject of digital transformation is in continuous evolution and consequently the literature is slowly being formed. Clearly, therefore, most of the scientific articles to which reference will be made are recently published. It is safe to say, then, that although the literature on digital transformation in general is quite extensive, the literature that focuses on the specific sector of agri-food is much more lacking. In the next paragraphs, therefore, we will first define the objectives and the purpose of this literature review. The process that led to the selection of the specific literature to which this paper refers, will then be described. A cross-section about the bibliographic information regarding the literature considered will be provided through some graphs. Moving on to the content, some publications in particular will be highlighted as in line with this thesis and interesting for the purposes of the discussion. Finally, some considerations will be made about the literature present today and more specifically about the one reported here.

3.1.1 Objectives of the literature review

Let us now therefore consider the main purpose of this literature review. The great objective of this chapter is to introduce the reader with literature that was considered in the process of studying and writing this paper. In the first part, it will be explained in detail how the scientific articles were selected. The same will then be considered in an aggregated way to make the reader understand the type and origin of the sources considered. Therefore, in the second part some relevant aspects of ad hoc selected papers will be presented. This analysis is preparatory to the chapters that follow. In fact, the hidden objective of this literature review is to bring to the surface some interesting insights about digital transformation in agri-food SMEs. We will therefore try to highlight some dynamics of the sector that the different authors have noticed. It will be interesting to verify these dynamics and concomitant causes in the following chapters. In fact, the frameworks and relevant aspects that emerged from the literature will be verified through a survey analysis and through in-depth interviews with some companies of the sector. So, the papers that will be reported have been selected because they add something more to the discourse on digital transformation made so far. In addition, as mentioned above, it will be possible to verify this dimension by dealing directly with some of the players in the sector.

3.1.2 Literature review path

Let us now look at how the reference literature was selected. In the first place, the starting research topic: the digital transformation in the agri-food industry with a focus on SMEs. It was decided at this point to avoid a double research (first about digital transformation and then on agri-food sector). Instead, the idea was to search directly for articles that responded simultaneously to both themes. In fact, the literature regarding the most varied definitions of the concept of "digital transformation" has extensively been discussed in the first chapter. For the search of scientific articles, it was decided to rely on Scopus, one of the most popular

databases of abstracts and citations for articles of research-related publications[49]. In fact, the website allows access to all scientific articles published on a given topic through a keyword search. In this case we opted for a line research that required Scopus to search only for articles that included the keywords *digital** (or *digital transform** or *industry 4**) together with *agrifood* (and similar) and *SME* (and similar). The database returned a total of 927 results, which included a variety of scientific source types as well as articles in various stages of publication. From these 927 articles, it was decided to exclude all articles whose subject matter was not directly relevant to the topics related to this thesis. Therefore, a large number of articles that had to do with Biological Sciences, Medicine, Environmental Sciences, Mathematics and other areas were excluded. Instead, we have taken into account all the articles concerning Social Sciences, Business, Management and Accounting, Computer Science, Economics, Econometrics and Finance. In addition, it was decided to consider only scientific articles and conference papers, thus excluding reviews, book chapters, and conference reviews. Finally, all sources prior to 2010 and papers still in press publication were excluded. This series of filters and exclusion brought the articles considered to a total of 303. Once this extraction was obtained, all articles were reviewed via their abstract and categorized according to their topics. At this point then, considering the compatibility with the discussion so far, a further extraction was performed. Therefore, all articles which do not give insights on the transformation of SMEs, or deal with the topic only marginally, were excluded. Thus, from this further selection, a total of 28 articles relevant to the thesis remained. These were consulted and analyzed in detail. It is possible to access the path described above via a spreadsheet that shows the 2 extractions implemented in the selection of articles for this thesis. The spreadsheet is available at the link:

https://docs.google.com/spreadsheets/d/13eHhH1OA3mRiKuQ0GzpUfZe9np2wjj-c/edit#gid=1384246550

[49] Wikipedia, *Scopus (base di dati)*, 2021, Available at: https://it.wikipedia.org/wiki/Scopus_(base_di_dati)

The insights that will be reported later in the chapter are therefore derived from some of the papers in the shortlist made available.

3.1.3 Literature review data

Having understood how the selection of scientific articles took place, we now give more detailed information on the 28 selected articles. (Most relevant of these 28 articles will be reported in the bibliography). Through some graphs we then see the main bibliographic information of these articles. In this way it is easier to understand the context of the list of considered papers. Although these statistics refer only to the shortlist of 28 articles selected for the purpose of this thesis, it is possible to draw from the graphs below a cross-section of the types of articles and research that have been conducted on the specific topic of digital transformation in the agri-food sector.

First, let's focus on the type of publication. As can be seen from the graph below, more than two-thirds of the sources considered can be categorized as *Scientific Article*, while the remainder are *Conference Paper*.

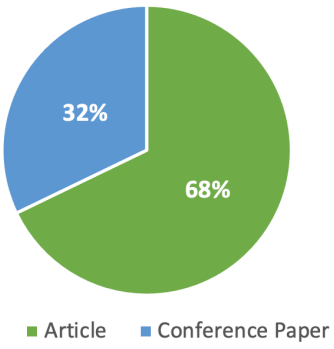

Figure 26 Type of article
(Personal elaboration)

As for the sources of the items considered, these are quite varied. 64% of the articles come from trade journals (18 articles). The second most frequent source is

Conference Proceedings with 7 articles. This is followed by 2 articles from Book Series and one from a trade journal.

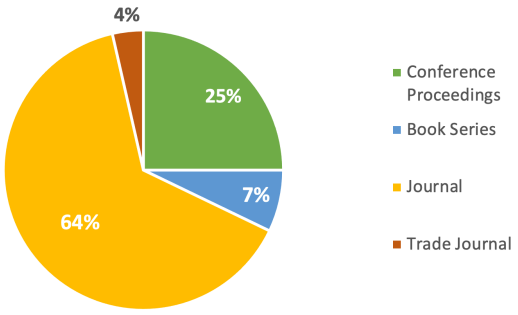

Figure 27 Source type
(Personal elaboration)

Regarding the year of publication of the articles, as mentioned earlier it was decided to exclude articles prior to 2010. In any case, most of the articles considered are of recent publication. More than 70% of the articles considered have been published in the last 3 years. The year with the highest number of articles related to the digital transformation of the agri-food industry is 2020 with a total of 9 articles. As can be seen from the trend in the bar graph, authors' interest in the topic has been steadily increasing in recent years.

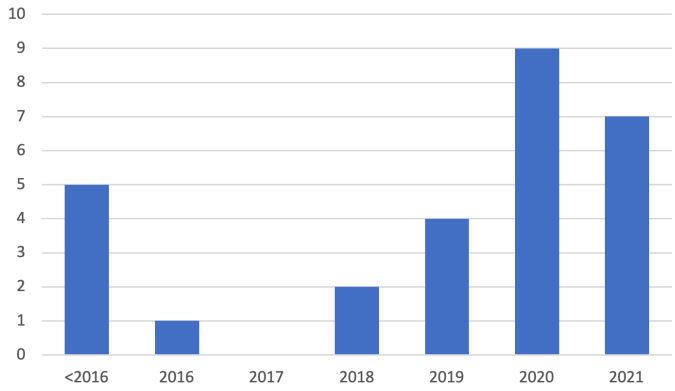

Figure 28 Year of publication
(Personal elaboration)

Considering instead the continent of publication of the articles, the vast majority of them were published in Europe (64%). Eight articles were published in Asia and only two in America.

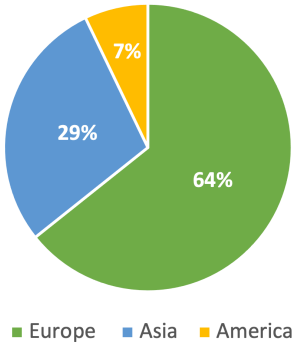

Figure 29 Continent of publication
(Personal elaboration)

It is important to clarify, however, that the continent of publication is intended as the continent of the university or institution to which the authors belong. In fact, there are authors from America who have published for European universities and vice versa. Coming now to a more content-oriented part, let's see in a pie chart what are the research methods that the authors have used to address the theme of digital transformation.

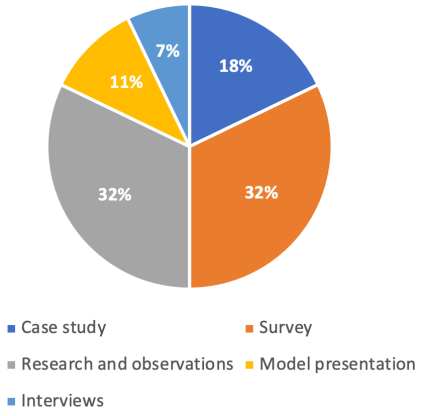

Figure 30 Research method
(Personal elaboration)

As can be seen from the graph, the research methods adopted are the most varied. The two most widely used methods are to submit a survey to a panel of

respondents and research through observation of a phenomenon. In both cases, 9 articles were considered. This is followed by the analysis of a case study from scratch (5), the presentation of a model (3) and interviews (2).

3.2 Relevant theories and models

In the first part of this chapter, we provided bibliographic and general information about the list of scientific articles selected for this thesis. We now proceed with a more content-oriented review regarding the literature considered. As seen above, the articles consulted for the writing of this dissertation make use of a variety of research methods. Each of these focuses on different aspects of digital transformation in agribusiness. Furthermore, each article makes a different contribution to the scientific community. Some of them are oriented to analyze the causes of the digitalization process, others highlight its advantages. Still others try to develop models thanks to which companies can base their digital transformation. Clearly, this thesis will not report all the contributions of each individual article. It would be difficult to do this first of all for a question of length and secondly for coherence with the logical thread held so far. Instead, the goal of the next following paragraphs is to report the most significant insights from the articles. We will report on the research of three articles which, in different ways, integrate the discourse so far developed on digital transformation. The first of the three is based on a survey, which gives us a more qualitative insight into digitization. The second article is based on a case study and provides a model for understanding the various steps of digital transformation for an SME. Finally, third and last article, starting from the areas of industry 4.0 (explained before) provides concrete examples of application of digital technologies for agri-food companies. As stated in the introduction to the literature review, therefore, no reference will be made in this chapter to the literature regarding the digital transformation “concept” in general. The definition of digital transformation has, in fact, already been given in Chapter 1. Therefore, refer to the articles already cited in chapter 1.

3.2.1 Digital transformation and customer value creation

The first scientific article we will consider is *Digital transformation and customer value in Made in Italy SMEs: A dynamic capabilities perspective*[50] by M. Matarazzo, L. Penco, G. Profumo and R. Quaglia. This study is focused on the analysis of digital transformation's impact on consumer value creation. The reference context is clearly the one of Italian SMEs. In this case the panel is compound of companies operating in the sector of food, fashion, and furniture. This study therefore analyzes the case studies of 6 different SMEs, interviewing each of them with the aim of understanding which dynamic capabilities can help the digital transformation process. In-depth interviews with these companies revealed how they all are inclined to use digital technologies in the different phases of their business (communication, market analysis, distribution, etc.). It emerged that digital tools such as applications, social media, chatbots, QR codes or others help to improve the process of value creation. These tools aid in creating new distribution channels that are more engaging and appreciated by consumers. As mentioned in the first chapter, these interviews have confirmed that the use of digital technologies does not only benefit companies per se, but on the contrary, it benefits the customer first and foremost. In fact, an important part of the concept of digital transformation is precisely that dedicated to CRM and Customer Insights systems. The journal article also makes a further important contribution. In fact, it postulates the 3 fundamental dynamic capabilities for digital transformation in SMEs. The first dynamic capability is sensing.

Sensing: Sensing is described in the article as the first driver of digital transformation. Through sensing, entrepreneurs understand the importance of adopting certain technologies, mainly social networks, which help companies develop a more emotional relationship with customers. Through these media it is easier for companies to understand the needs, desires and feelings of consumers. This idea is in agreement with the text *Customer engagement, buyer-seller*

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[50] Matarazzo M. et al, Digital transformation and customer value in Made in Italy SMEs: A dynamic capabilities perspective, Journal of Business Research, 2020

relations, and social media by C. Sashi (2012)[51]. Sashi reported how, through the use of digital technologies, companies engage in a virtual circle that begins with customer interaction and moves through customer satisfaction to finally arrive at customer engagement.

The second dynamic capability is learning.

Learning: Learning is an important dynamic capability specifically because we are speaking of SMEs. Indeed, small companies are much less likely to have initial digital skills. As a result, for SMEs, digital transformation is a learning process that needs effective capabilities to integrate technology, and real learning strategies. As seen in the second chapter of this thesis, the slow and gradual integration of digital skills into the company's DNA is very important for SMEs.

The third dynamic capability is integration and coordination.

Integration and coordination: Integrating and coordinating digital knowledge into your business model is the last and final dynamic capability. In fact, the article explains how the ability to integrate and coordinate digital technologies was key for all the companies of the panel.

For the purposes of this thesis, it is important to highlight these three dynamic capabilities because they help us understand what ingredients SMEs must have in their approach to digital. These three competencies can also be seen as a kind of path that companies need to take for effective digital integration. We will see, however, in the next paragraph another model properly intended to explain this path.

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[51] Sashi C.M., Customer engagement, buyer-seller relationships, and social media, Management Decision, 2012

3.2.2 *Smart District 4.0*

The second article that will be reported here is *Fostering digital transformation of SMEs: a four level approach*[52] by A. Garzoni, I. De Turri, G. Secundo and P. Del Vecchio. The article focuses on the case study *Smart District 4.0*, a project aimed at promoting the digitization of small and medium-sized enterprises in several sectors, including food. It is a project carried out in the Puglia region and financed by the Italian Ministry for Economic Development. The case study of Smart District 4.0 is interesting for us because it allows us to understand the various levels of engagement of SMEs in Puglia with respect to the process of digital transformation. The various levels of involvement were identified following four selection steps to which the companies were subjected. The first level of engagement was oriented towards a sample of about 1,000 companies to which a project of gradual digital transformation was proposed. These were contacted by phone or email. Despite the opportunity for growth offered, the majority of companies did not consent to procedures with subsequent levels of involvement. This shows that in many cases, SMEs are not fully aware of the opportunity that digital technology offers to improve their processes. This is why the first step has been called *Digital Awareness*. The second level of commitment was achieved through an official adhesion to the project and an active participation in initiatives proposed by Smart District 4.0. which was aimed at understanding their business and customer needs. This second level was then called *Digital Enquirement.* The third level of engagement was verified on the few companies that accepted the project to access the use of the G Suite platform and start with a first process of digitization of processes. Subscribing to G Suite licenses allows companies to use the collaborative and digital solutions (in administration, sales, purchasing, marketing, etc.) Moreover, participants in this phase also receive the benefits of training sessions and assistance with a 24/7 remote support service. This level has been called *Digital Collaboration*. Finally, last level of involvement represents the

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[52] Garzoni A. et al, Fostering digital transformation of SMEs: a four level approach, Emerald Insight, 2020

highest level of engagement (Level 4 - Digital Transformation), and is reserved for the companies most interested in Digital transformation. Their profile is characterized by a critical representativeness in terms of sectors of interest for the project and the potential innovative solutions. In addition, they are characterized by a structured innovation and technological background, a willingness to change, and to digitize business processes. This phase is finally called *Digital Transformation*.

The results allow to identify a four-level approach for understanding the digital transformation of SMEs. Thus, this four-level model includes digital awareness, digital questioning, digital collaboration, and finally digital transformation. Already Kane et al. (2019)[53], had anticipated a similar type of four-step model by proposing a path that includes the different stages of exploration, initial implementation, transformation, and aspirational digital being. As in the first article, even here we are provided with a model which can help us to give a rational and schematic interpretation about the digital transformation process. If in the first model this process was described through progressive dynamic capabilities, here the phases have instead been tested through a real project.

3.2.3 Technologies application in food sector

The third and final article we will mention is *Short review: Application Areas of Industry 4.0 Technologies in Food Processing Sector*[54] by N.Z.N Hasnan & Y.Md. Yusoff. This article has already been mentioned in the first chapter, in which the application areas of industry 4.0 technologies in the food processing sector were analyzed one by one. However, it is important to return to this article because it is particularly relevant in this context. The article in question, in fact,

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[53] Kane G.C. et al., *The Technology Fallacy*, The MIT Press, Cambridge, 2019
[54] Hasnan N., Yusoff Y., *Short review: Application Areas of Industry 4.0 Technologies in Food Processing Sector*, Department of Process and Food Engineering, Universiti Putra Malaysia, 2018

differs from the rest of the literature because it has a totally different structure. While the other articles try to explain the reality of SMEs through some models or other research methods, this article is more like a quick guide for SMEs in the food sector. Starting from the pillars of industry 4.0, this article provides food companies with a list of all the possible applications of the latest digital technologies. It is not possible to report here all the examples listed by the text, but let's see some of them anyway. Let's start for example with robotic technologies. In addition to the use of robots in the production of food, the article reports other alternative uses of the technology, such as the transport of food and its service in restaurants. Another technology listed is the one of QR code, which the article proposes as used in food traceability but also in the context of the food supply chain. Then another technology is Augmented Reality (AR). Usually, AR is only considered in marketing activities. The article, however, expands its use for staff training purposes. The real strength of this article lies in the fact that it provides concrete and real-life examples of the use of technologies, so that companies can use the same to take a cue based on their own possibilities and needs.

3.3 Concluding remarks on literature

As mentioned earlier in the introduction of this literature review, it is not possible to summarize all the issues addressed by the selected articles. In fact, many articles have been excluded because they took into consideration the concept of digital transformation in general, others because not in line with the discourse conducted so far. What this literature review has attempted to do is providing the reader with additional insights into digital transformation in the agri-food sector of SMEs. If in the previous two chapters an attempt was made to describe the phenomenon in a more technical and quantitative way through data, here we have provided an internal perspective of the companies. The in-depth interviews and case studies reported correspond to real situations experienced by companies and reflect one side of digitalization in Italy. While the third article is a story in itself,

and should be understood more as a cue for companies, the first two articles were chosen because they help explain digital transformation as a process. Several times throughout this thesis, digital transformation is explained as a process concept rather than a simple business choice. In this sense, the two articles show how digitization is the result of various steps. The first of the two presents these steps as progressive capabilities, while the second shows successive stages of development of the digital mindset. This literature review is then not intended to be an end in itself in this thesis. The articles chosen have been selected precisely because the theories and models provided will be further verified in the following chapters. In fact, in the fourth chapter of the thesis, in-depth interviews conducted specifically for the purposes of this paper will be reported. It will therefore be the opportunity to compare the model of Sensing, Learning, Integration and coordination as well as the 4-Engagement step with other companies in the same sector.

4. CHAPTER 4: ANALYSIS OF THE NORTH EAST OF ITALY

4.1 Analysis introduction

The first two chapters gave an overview of the state of digitization in the agri-food sector. Data on the situation in Europe and worldwide were reported. Finally, we have examined the difficulties encountered by Italian SMEs in integrating digital solutions into their business models. In this fourth chapter a completely new analysis will be provided, with data expressly calculated for the purpose of this thesis. As mentioned in the introduction of the document, in fact, this thesis is written in collaboration with a larger project of the Agrifood Management & Innovation Lab of the Ca' Foscari University of Venice, called "*Osservatorio il futuro del food tra digitale e sostenibilità".* The research project is part of the activities of the Observatory and aims to analyze the development of the sector, while expanding and updating the investigation compared to its first edition of 2020. The main objective of the project is to measure the diffusion of digital-presence among agri-food SMEs in Triveneto, identifying the determinants of digital maturity. In addition, the project, compared to the first version of 2020, wants to identify the actions and projects taken by companies in the field of sustainability. This second part, related to sustainability, will not be considered in the data reported in this work. In summary, therefore, the project will provide an overview of the digital presence of a representative sample of food SMEs in this geographical area.

The project activities required a work team, which was engaged on three main activities:

- A desk analysis on digital presence of a sample of over 500 companies from the main food supply chains.

- A survey of a subsample of 300 companies aimed at identifying decision-making processes and factors that determine the adoption of digital tools.

- In-depth interviews with the most digitally "mature" companies, in order to build benchmarks.

The presentation of results in this chapter will therefore follow this order. First of all the sample will be introduced. Then data about the company's online presence, collected through desk analysis, are presented. Next, most relevant results of some questions extracted from the survey will be proposed. Finally, some main points of the interviews with the companies will be discussed. Now, throughout this thesis it has been explained how the concept of digital transformation is actually very broad. In fact, the possible areas of digital innovation are many. However, in the first part of this chapter we will not provide data regarding all areas of digitization, but only those related to the companies'online presence. Data about online presence is easier to collect as it is available to everyone on the web, searching for companies one by one. This is precisely the work done at the base of the desk analysis. In line with the Observatory project, the data and graphs presented here aim to provide a measure of what has been done and what remains to do in terms of developing an online presence. These data are therefore intended as a contribution to potential future initiatives, training and effective policies for the food sector. In the second part of the chapter, through the results of the survey and in-depth interviews, the discussion will be extended even beyond the online presence issue. Some of the questions in the survey ask companies about the degree of adoption of different types of technologies. In addition, in the context of in-depth interviews we tried to really understand which technologies and uses of digital are considered as fundamental by companies in their day life. In summary, data provided in the first part of the chapter will be most of all quantitative, while the graphs derived from the survey will show the companies' responses in a qualitative way.

4.2 Analysis of the North East of Italy

Before presenting the actual data and graphs we explain in the next section how the sample was chosen and how it is composed.

4.2.1 Statistical sample

As it has been explained the focus of the thesis is now concentrated on the North East of Italy. In particular, the geographical area taken into consideration is the Triveneto, which includes the regions of Veneto, Friuli-Venezia Giulia and Trentino-Alto Adige. The reasons why this specific area has been selected are many. This territory is an area in which the agri-food sector, and not only, is particularly developed. As stated in the second chapter then, the digital capability of SMEs in this area tends to be on average higher than the rest of the country. Moreover, *Ca' Foscari University of Venice* and the *Agrifood Management & Innovation Lab* are both based in the heart of this area (Venice). For this reason, both institutions want to make themselves available to the area of which they are part of, and which they are most familiar with. Consequently, the Observatory project, and this thesis itself, focus precisely on this specific area.

The sample investigated was extracted from the AIDA-Bureau Van Dijk database. Only companies with between 10 and 250 employees were considered (SMEs according to the ISTAT classification). The extraction referred to all ATECO codes from 10.1 to 10.8, excluding the one related to beverages. Given these premises, a sample of 520 companies was derived. Some of these companies have also developed some sub-brands with which they target different sales channels. Considering the sum of the companies plus the various sub-brands, we obtain a total of 540 brands of agri-food products. Almost three quarters of the companies in the sample are based in Veneto (74.2%). Trentino-Alto Adige and Friuli-Venezia Giulia, on the other hand, have a similar number of companies. Respectively, they represent 13.5% and 12.3% of the sample. Therefore, we have

386 companies from the Veneto, 70 from Trentino-Alto Adige and 64 from Friuli-Venezia Giulia.

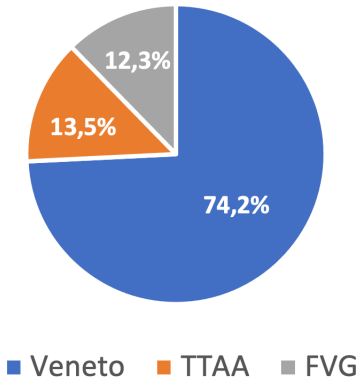

Figure 31 Region of origin
(Personal elaboration)

As mentioned, the various sectors of the agro-food industry are represented almost in their entirety. All ATECO[55] codes from 10.1 to 10.8, excluding the one related to beverages, are included in the sample. The most represented sector in the sample is that of bakery products (32%), followed by meat sector (21%), and the dairy sector (11%). All the other sectors, visible in the pie below, have a percentage lower than 10%, therefore a number that does not exceed 52 companies in the statistical sample. Here it has been made an attempt to give a

[55] ISTAT, Classificazione delle attività economiche Ateco, 2007, Available at: https://www.istat.it/it/archivio/17888

The ATECO (ATtività ECOnomiche) classification of economic activities is the classification adopted by the Italian National Institute of Statistics (ISTAT) for national statistical surveys of economic nature. It represents the Italian translation of the Nomenclature of Economic Activities (NACE) created by Eurostat, adapted by ISTAT to the specific characteristics of the Italian economic system.

For the purposes of this thesis, the Italian industry nomenclature (ATECO) will be used in the graphs shown, while the English translation will be provided in the body of the text.

quantitative representation of the agro-food sector as faithful as possible. Consequently, the larger sectors are, on average, more numerous and vice versa.

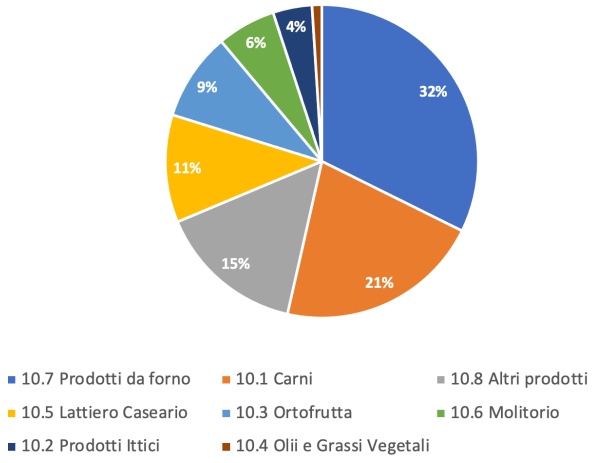

Figure 32 Numerosity by ATECO
(Personal elaboration)

The table presented below combines these two pies into a single classification that divides companies by region and industry at the same time. It can be observed that the most numerous companies in the sample are those in Veneto producing bakery products (123 companies). Again, in Veneto, the second most represented sector is that of meat production (75 companies). Also in the other two regions, the most numerous sectors are bakery products and meat (25 and 18 companies in TAA, 19 and 18 companies in FVG).

ATECO	Veneto	TAA	FVG
10.1 Carni	75	18	18
10.2 Prodotti Ittici	18	1	3
10.3 Ortofrutta	36	9	1
10.4 Olii e Grassi Vegetali	6	0	1
10.5 Lattiero Caseario	42	7	8
10.6 Molitorio	25	3	3
10.7 Prodotti da forno	123	25	19
10.8 Altri prodotti	61	7	11

Figure 33 Sample numerosity by region and ATECO
(Personal elaboration)

Let's now take a look at the prevalent sales channel in the sample. As anticipated in the previous chapters, the majority of Italian agro-food companies are producers of raw products rather than final sellers. Therefore, the sample chosen reflects this trend. The 540 brands were divided by prevailing market into B2B, B2C (and B2B/B2B if no prevailing market could be identified between the two). It's important to clarify that the choice has been made here to consider the aggregate sum of brands (540), rather than the number of companies (520), because often some companies have developed a new sub-brand specifically to target the B2C channel.

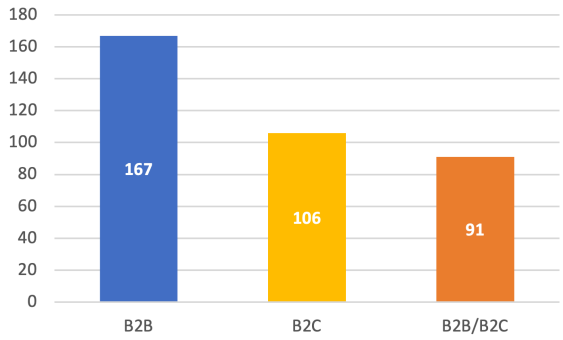

Figure 34 Sales channels
(Personal elaboration)

As mentioned above, it can be seen from the graph that the predominant channel is clearly the B2B channel. In fact, if we aggregate the B2B bar together with that of B2B/B2C, we arrive at 71% of the total. It can be noticed that the sum of the numerosity of the three bars does not reach the total 540 brands. This is because some brands have been excluded from the count. For some brands, in fact, it was not possible to determine which was the prevalent market, and it was therefore decided to exclude them from the count.

Therefore, we believe that the sample just described can be a good representation of the agri-food sector of the Italian North-East. Although some sectors are more represented than others, and there is a greater number of companies from the

Veneto region, an effort has been made to create a sample as representative as possible of the agri-food "population" of Triveneto.

4.2.2 Desk research

As mentioned in the introduction to this chapter, a desk analysis was conducted on the entire sample, with the aim of mapping the online presence of the companies. Therefore, the analysis consisted of gathering information regarding the companies' proprietary online spaces (websites, social networks, etc.), editorial and content publishing practices, frequency and mode of use of the various channels, presence of proprietary e-commerce initiatives, etc. Some statistical analysis will therefore be proposed below regarding proprietary websites, the presence of online sales channels and the use of social networks by companies.

The analyses that follow have all been calculated in terms of sub-brands, so we have the aggregate sum of the companies together with their sub-brands. Consequently, from now on, for simplicity the term company will be used indistinctly to refer to the various brands. In addition, the collection of all data was done in the last week of December 2021, so the data is reliable for the entire year 2021.

Let's first analyze the situation regarding the presence of websites for agribusinesses.

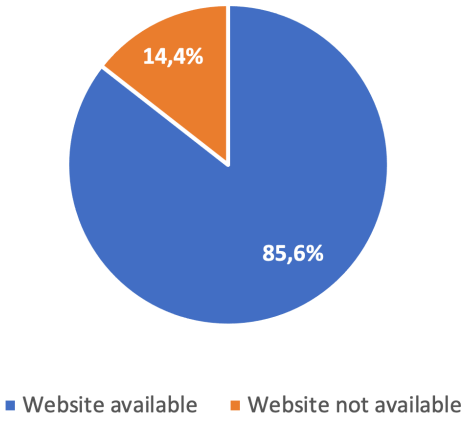

Figure 35 Website availability
(Personal elaboration)

There are 462 websites online at the end of 2021, meaning 85.6% of businesses have an active online site. This corresponds to a percentage increase of almost 2% compared to the year 2019, when there were 454 active websites. An overwhelming majority of companies have therefore developed a website. However, it must be said that although the majority of websites are functional some of them are not updated periodically, and in some cases, they are reduced to a simple contact page. It is interesting to observe now how the presence of the websites is divided in the various compartments.

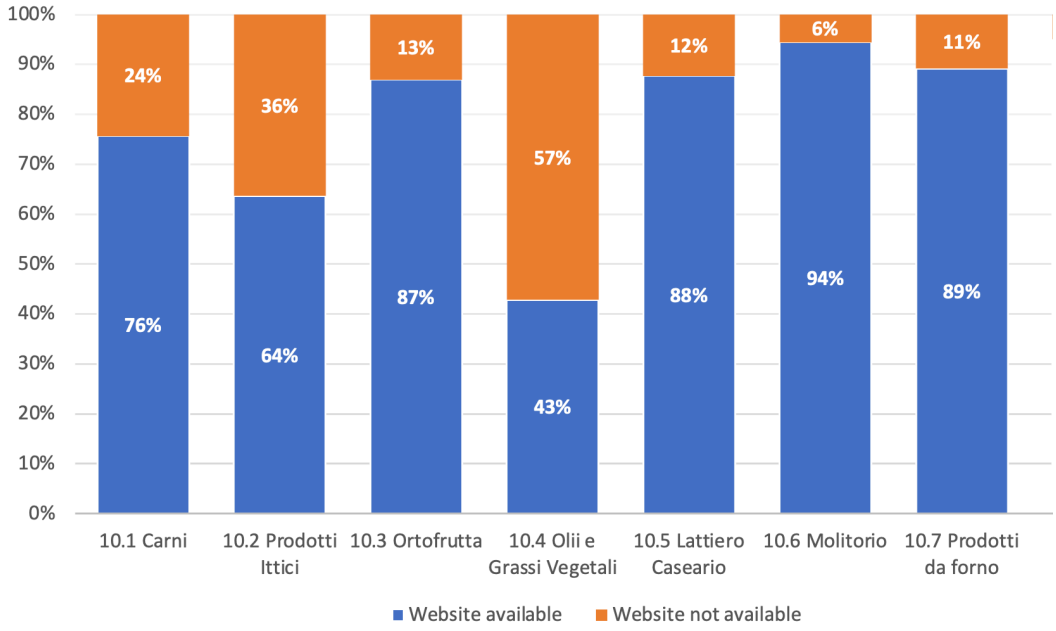

Figure 36 Website availability by ATECO
(Personal elaboration)

Looking at the graph it is possible to divide the compartments into 3 groups. The first group by greatest website presence is made up of the milling, bakery, dairy and fruit&vegetable sectors. Each of these has a website presence rate of at least 87%, so they are all above the sample average. Best of all is the milling industry with 94% of companies with a website. The second tier is the meat sector, which despite being one of the largest and most developed sectors in general has a website presence ratio almost 10% lower than the rest of the sample. Finally, the

worst performer are the oils and seafood products sectors. Both sectors are well below average. In the case of oils, there are more companies without a website than the ones that can be found surfing on the internet.

Let's now look at the situation regarding the languages available on websites. This can also be seen as a measure of the propensity of the companies in the sample to consider exports. Clearly, if a company has a website in more than one language, it is more attractive to potential customers outside Italy.

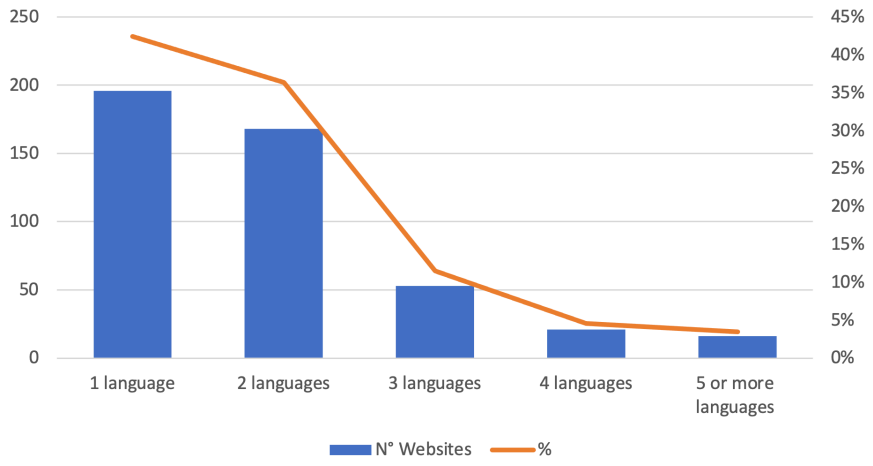

Figure 37 Language's availability in websites
(Personal elaboration)

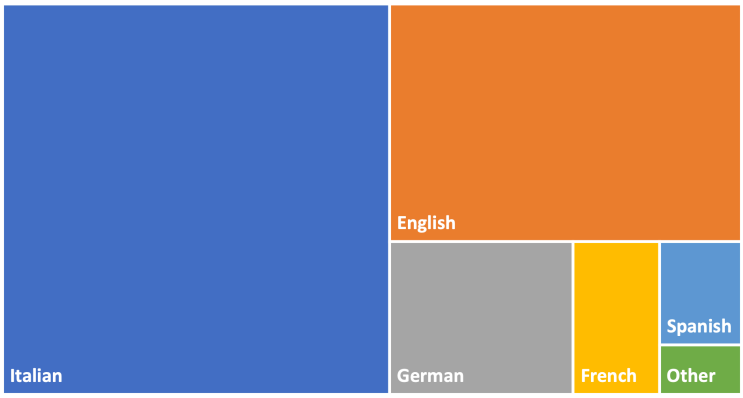

Figure 38 Ranking languages available
(Personal elaboration)

From the first graph it is clear how the majority of sites are only available in one or two languages (almost 80% of sites). In fact, 43% of websites are available in only one language, 36% in two. Almost in all cases the combination of languages is Italian + English. German is the third most commonly encountered language. In some cases German is even the first and only language of the website. This situation occurs on some sites of companies from Trentino-Alto Adige, where German is the standard language spoken.

Let us now consider the data relating to the presence of the e-shop channel within or outside the website. As mentioned above, most of the companies in the sample have a B2B business. Since these companies do not target the final consumer, the tendency is not to develop an online sales channel. In fact, only one out of 5 companies considered has opened an e-commerce channel. However, as emerged from the interviews with some selected companies, the e-commerce channel is a very interesting showcase for companies. Having an e-commerce in fact allows to expand the customer base as well as expose the main products. Not only final consumers but also potential customers of the company (retailers, wholesalers, horeca) can then benefit from the e-shop channel. In addition, having a functional e-shop is a sign of digital and managerial maturity for a company.

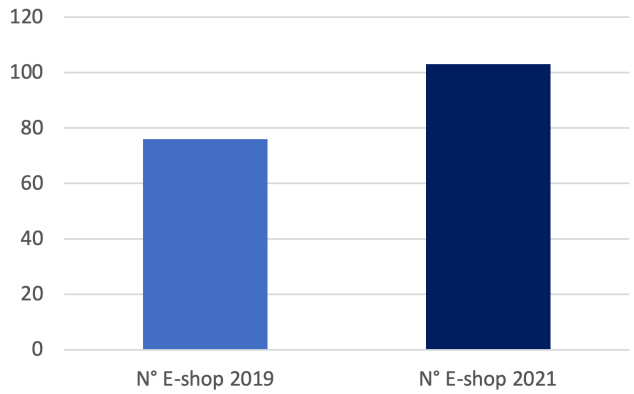

Figure 39 N° E-shop growth 2019-2020
(Personal elaboration)

It is clear from the graph above that there has been a strong increase in e-commerce in the food sector of the Triveneto region. In 2019, only 76 out of 540 companies adopted an e-shop. Within two years, 27 new ecommerce stores were opened, an increase of more than 35%. Unfortunately, we do not have trend data for previous years, as the first report was precisely for 2019. It is therefore impossible to make any real considerations about the reasons for the strong growth in the last two years. However, it is clear to everyone that one of the main drivers for the increase of e-shops is the situation related to the covid-19 pandemic. As we saw in chapter two, online food purchases increased significantly during the pandemic period. As online demand for ready-to-eat meals increased, so did demand for food in general. The companies in our sample that have opened up shop online in the past two years have been riding a trend of increased demand in that particular channel. Note now from the graph below the widespread growth across the various sectors.

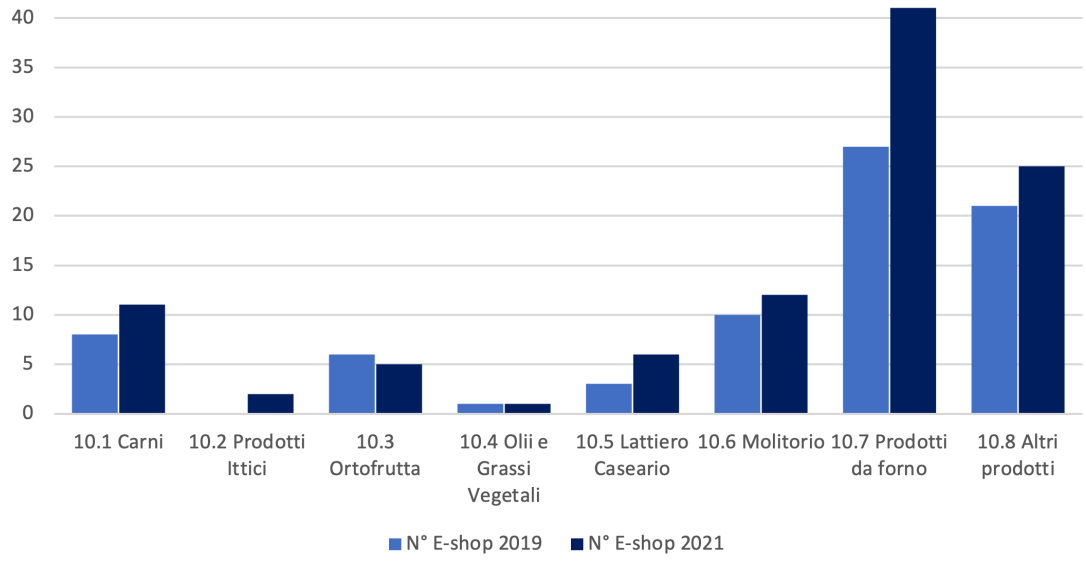

Figure 40 N° E-shop growth by ATECO
(Personal elaboration)

It's visible how the growth in the number of e-shops is generalized across the various industries. The industry that has grown the most overall is baked goods, with a 52% increase over 2019. The meat sector also saw a big +38% growth. The

dairy sector, where the number of eshops is very low, has even doubled in the space of two years. The only two sectors not showing growth are fruits & vegetables and oils.

Let's now move on to the analysis of companies' presence in the various social networks. The desk analysis revealed that the social networks most used by the companies in our sample are in order: Facebook, LinkedIn and Instagram. The data collection also included the social networks YouTube, Pinterest and TikTok, however it was not found a minimum presence of companies, so it was decided to exclude these social networks from the analysis. It is good to clarify that the latest data on social networks have been collected at the end of 2021, as the other data shown so far. However, the historical data with which these will be compared are instead from the year 2020. Consequently, if for websites and e-shop presence there was the comparison between the year 2019 and 2021, for social networks the comparison will be between 2020 and 2021.

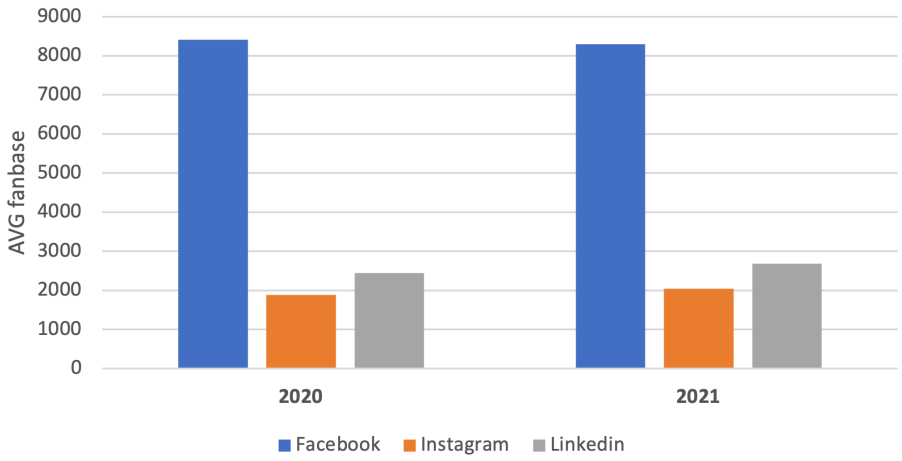

Figure 41 Average fanbase by social network
(Personal elaboration)

Starting with the most popular, Facebook, business pages present have increased by 26 since 2020. In fact, it rose from 348 pages to 374, a percentage increase of 7%. Today, almost 70% of the companies in the sample have opened their own Facebook page. The average following of Facebook pages is just over 8k likes.

LinkedIn use has also increased among companies in the sample. From 170 active pages in 2020, there are now 205 pages (+20%). The average page following grew by 10%, from 2.4k followers in 2020 to 2.6k in 2021. Finally, Instagram is the social network in which the presence of companies in the sample has increased the most. There was a 30% increase in new page openings in 2021 (62 new pages). There was also a nearly 10% increase in the fanbase (from 1.8k average followers per page to 2k). As the chart above shows, Facebook is clearly the social network where the companies in the sample garner the most following. Therefore, by focusing on this social network, we tried to analyze the use that companies make of it. Considering the last 6 months of 2021, the average monthly posts were calculated.

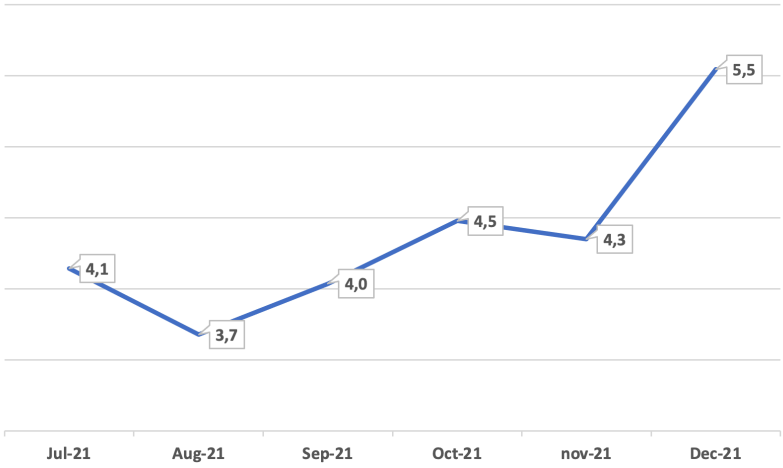

Figure 42 AVG N° Facebook post by month
(Personal elaboration)

From the graph, we can see that the average monthly post count is just over 4 (4.4 posts per month). As expected, the month where companies publish the most is December. In fact, companies try in this month, where the average consumption of food increases, to obtain a greater conversion. Therefore, promotional posts with special offers or products for the Christmas holidays are frequent. The minimum number of posts is reached in August (3,7). This could derive from the fact that some companies don't have a real publishing editorial plan. As a result, when the social media manager is on vacation (mainly in August), weekly posts are not scheduled.

In view of this data regarding the social fanbase of companies, we tried to bring the reader a further investigation. It was tested whether there are (and what are) the determinants of a larger following in social networks. For this purpose, the database was searched for variables that could be linked to the fanbase of companies in the various social networks. The only two available variables that could determine a greater or lesser following on social networks were therefore identified as “revenue” and “number of employees”. Therefore, we proceeded by first considering revenue. The companies in the sample have revenues ranging from a minimum of €139,000 to a maximum of €750 million. The average revenue in the sample is €9.3 million. It was decided to divide the companies in the sample into revenue bands.

Four revenue bands were determined, representing a similar number of companies. The selected bands are listed below:

Band 1: Revenue up to €2 million (114 companies)

Band 2: Revenue from €2 to €5 million (129 companies)

Band 3: Revenue from €5 to €20 million (179 companies)

Band 4: Revenue over €20 million (118 companies)

Once these revenue brackets were determined, we then looked at the average following in the 3 main social networks for each of the revenue ranges. Looking at the graph below, it is quite clear how the Facebook following volume scales between the various revenue brackets. The average Facebook fan base does not vary much between €2 and €20 million in turnover (4k/5k likes) but becomes almost three times as large in the "over €20 million" turnover bracket. With regard to Instagram, there seems to be no real upward trend among the four groups. Only the "over €20million" bracket stands out from the others. In any case, the average fan base on this social network does not exceed 2k followers in any of the four revenue bands. As regards LinkedIn, a typically less generalist social network, we find a peculiar situation. The average following is practically null in the first three bands, while it exceeds an average of 4k in the last band.

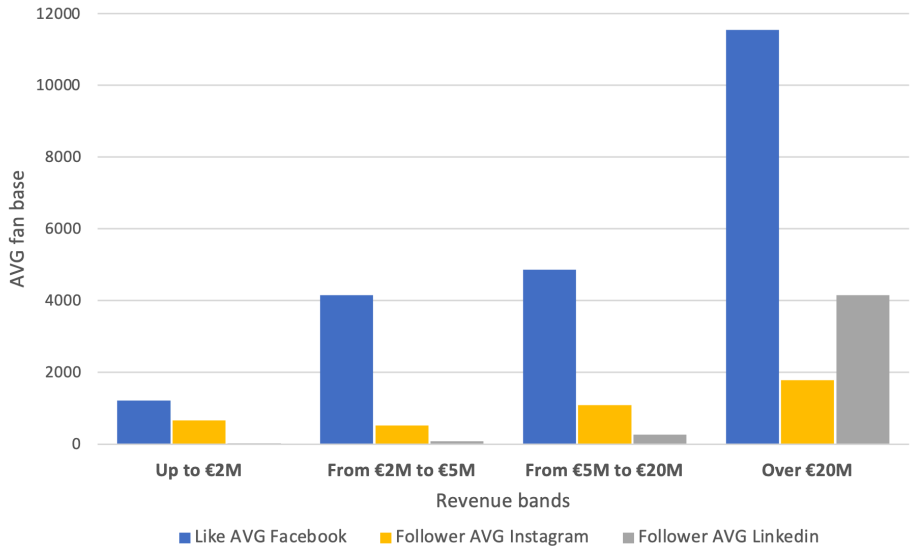

Figure 43 Average fan base by revenue
(Personal elaboration)

Looking at this graph as a whole, there seems to be, with the exception of Facebook, no real correlation between revenue and fan base in social networks. However, this is not the most appropriate graph to see if there is an actual linear correlation. We have therefore used a scatter plot.

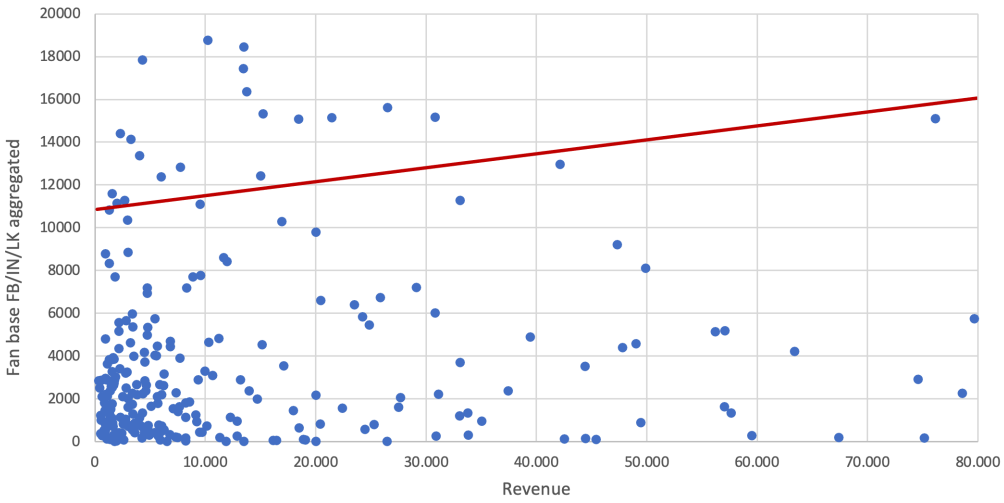

Figure 44 Revenue and aggregated fan base correlation
(Personal elaboration)

The scatter plot therefore shows the x-axis as the revenue and the y-axis as the aggregate fan base of the three social networks (Facebook likes + Instagram

followers + LinkedIn followers). The blue dots represent the 540 companies in the sample whose data were collected. The graph shows that most of the companies have a turnover of no more than €10m with an aggregate fan base of no more than 6k users. As can be observed, there are some companies with large revenues that have little or no fan base. These companies can be identified at the bottom right of the graph. Other companies, on the other hand, with low revenues have managed to develop a large following in the three social networks. These companies can be identified in the top left of the graph. In general, looking at the cloud of blue dots, no real upward trend can be identified. The red linear trend line itself is inclined upwards, but only by a few degrees. Calculating the true linear correlation between the two variables, the correlation is 0.08. It can therefore be said that there is no real linear correlation between turnover and social following (or rather the correlation is very minimal).

Having excluded the possibility of a real correlation between social network following and revenues, we then moved on to the second variable to be taken into account, which was the number of employees. In our sample, companies range from a minimum of 10 employees to a maximum of 245, with an average of 36 people employed. In order to be consistent in the method, it was again decided to divide the companies into groups of employees. Here, too, a similar number of companies was maintained between the bands.

Band 1: Up to 15 employees

Band 2: From 15 to 30 employees

Band 3: From 30 to 50 employees

Band 4: Over 50 employees

Let's take a look at the graph of the fan base in the three social networks for the different employee number ranges.

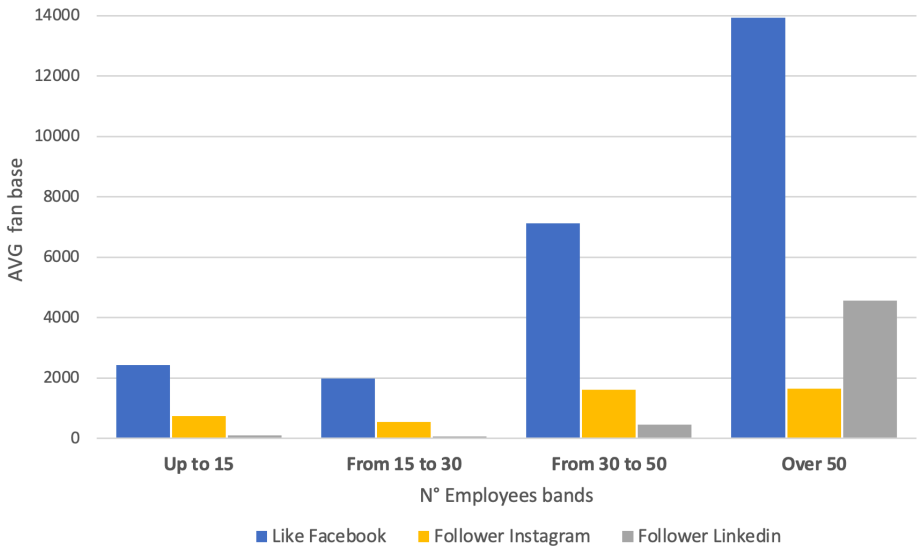

Figure 45 Average fan base by N° employees
(Personal elaboration)

Again, the average Facebook fan base seems to grow with the employee bracket. For Instagram, too, there is a kind of growth between the bands. The situation for LinkedIn is quite similar to that seen in the graph with the revenue bands. Once again, this bar graph gives only a vague idea of the possible correlation between the two variables. Let us examine the scatter plot again.

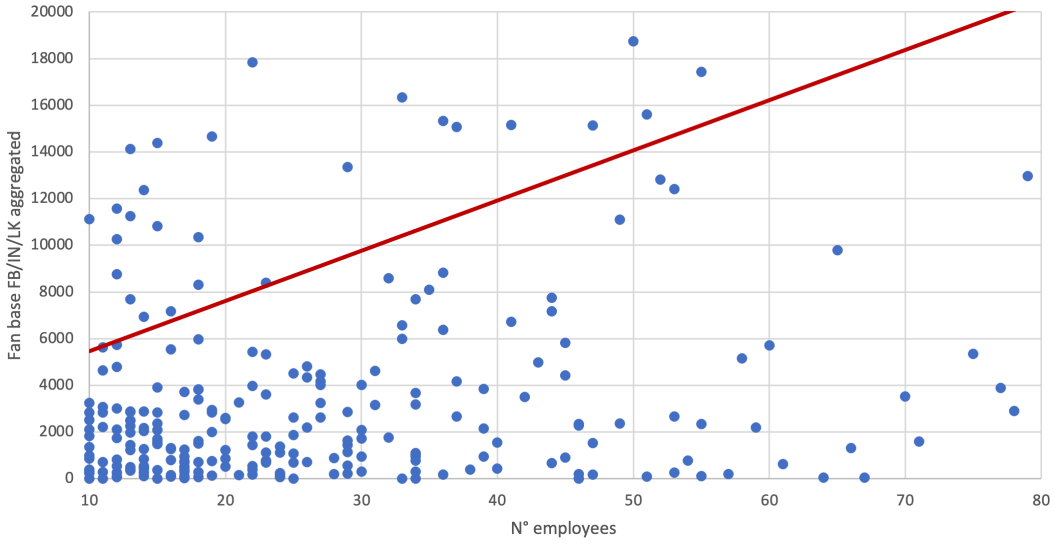

Figure 46 N° employees and aggregated fan base correlation
(Personal elaboration)

In this scatter plot, the red trend line is actually more inclined than the previous one. Calculating the linear correlation between the two variables, it is 0.22. We can therefore say here that, although moderate, there is a positive linear correlation between the two variables. Therefore, in the sample analysed, statistically speaking, as the number of employees recruited increases, the number of fans on the three social networks considered also increases, in proportion to the correlation. There may be several reasons for this trend. For example, companies with few employees may spend most of their staff on tasks directly related to production or sales, neglecting the company's online presence. On the other hand, companies that have decided to expand their staff by adding professionals in online communication management may be more successful in social networks. Clearly, this analysis has led us to identify this type of trend, but it is not possible to make any definite statements about the reasons behind it. We have indeed no qualitative data on individual companies. In the next chapter, however, we will look at the results of some questions contained in the survey. The analysis of these answers can help us to understand in a more qualitative way the propensity of companies towards certain technologies and digital in general. We will therefore try to explore further on this last graph shown, relating it to some of the survey questions.

4.2.3 Survey results

As mentioned in the introduction of this chapter, the Agrifood Management & Innovation Lab project did not only consist in the collection of desk data, but also included the online submission of a questionnaire. In fact, it consisted of a structured, predominantly closed-ended survey on a sub-sample of 300 companies within the sample. Companies were selected on the basis of their digital presence. The purpose of the questionnaire is to obtain information on companies' strategies in general and about their decisions regarding digital, innovation in general and sustainability. In the course of this paragraph, some of the aggregate responses of the participating companies will be proposed. This will help us to better understand the propensity of companies towards technology and innovation in

general. We will therefore try to understand in a qualitative way how companies are experiencing the digital transformation process. The questions that will be presented are various and cover different aspects such as investments in R&D, the degree of technology integration in the company, staff training and the consequences of the pandemic. It should be noted that, at the time of writing this document, only 51 of the 300 companies in the selected sub-sample responded to the questionnaire. Consequently, the results that will be presented from now on are calculated basing on the responses of these 51 companies. All ATECO codes that we considered earlier are still represented by the respondent companies.

The first question of the survey we are considering asked responding companies to indicate the percentage of total revenues that is reinvested in research and development.

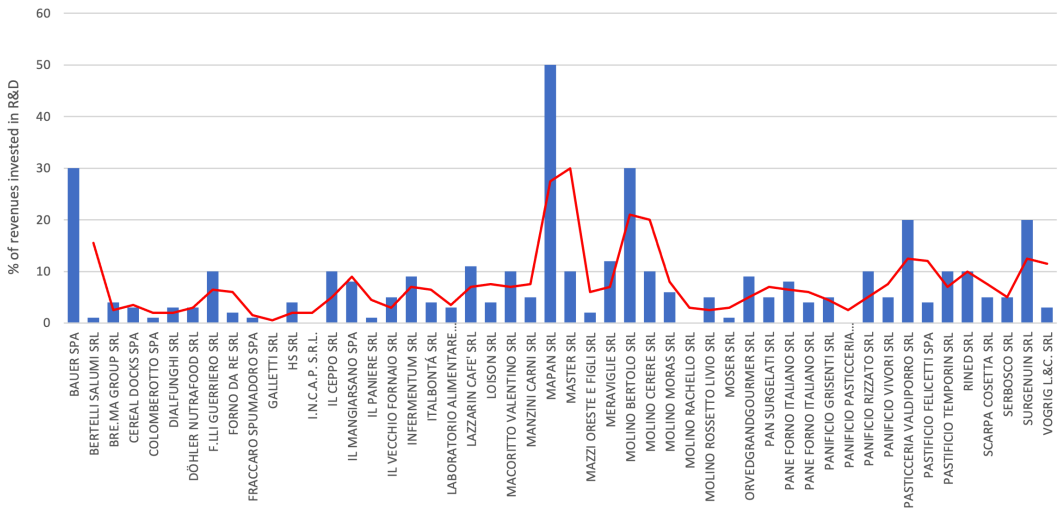

Figure 47 Portion of revenues invested in R&D

(Personal elaboration)

As can be seen from the graph, the investment range is quite wide between companies. The highest recorded value of investment in R&D is 50% of revenues. However, the average is 9%, in fact almost 90% of the responding companies have a value of R&D investment that is less than or equal to 10% of their revenue.

The next question reported here is a " Likert scale " question. It asks companies to express the degree of agreement with two phrases, which have to do with the experimentation of innovations in the company and the degree of familiarity with these innovations among employees. Here below the results.

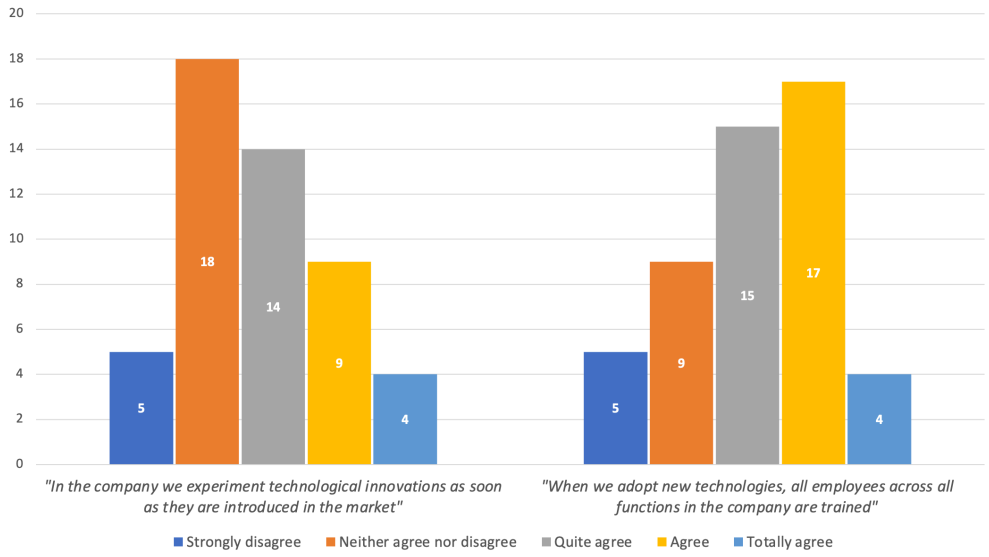

Figure 48 Agreement level with sentences regarding innovation
(Personal elaboration)

The first of the two phrases investigates the readiness of the companies interviewed to experiment a technology once it becomes available on the market. Looking at the answers, a substantial neutrality towards the rapid adoption of new technologies is perceived. Only a small minority of the companies stated that they adopt new technologies immediately. 32 companies (62% of the total) expressed neutrality ("Neither agree nor disagree") or only moderate agreement ("Quite agree"). From these results we understand that the trend among companies is to wait before integrating a new technology. This is quite understandable since, as seen in the previous chapters, adopting a technology into the business model requires the necessary specialized technical skills. Let's see instead, with the graph on the right, whether all the employees in the various functions of the company are educated when adopting a new technology. A tendency towards agreement with this sentence can be observed here. In fact, 70% of the companies surveyed

(36 companies) responded with at least moderate agreement with the phrase. Trying therefore to make a consideration involving both questions we can say that companies are generally cautious in adopting new technologies. However, when they decide to integrate a new technology there' s a real commitment to ensure that all employees are aware of and trained to interact with it.

Let's see now, with a new question extracted, the degree of integration of a set of four digital solutions in the sample: big data, traceability, e-commerce and digital marketing solutions.

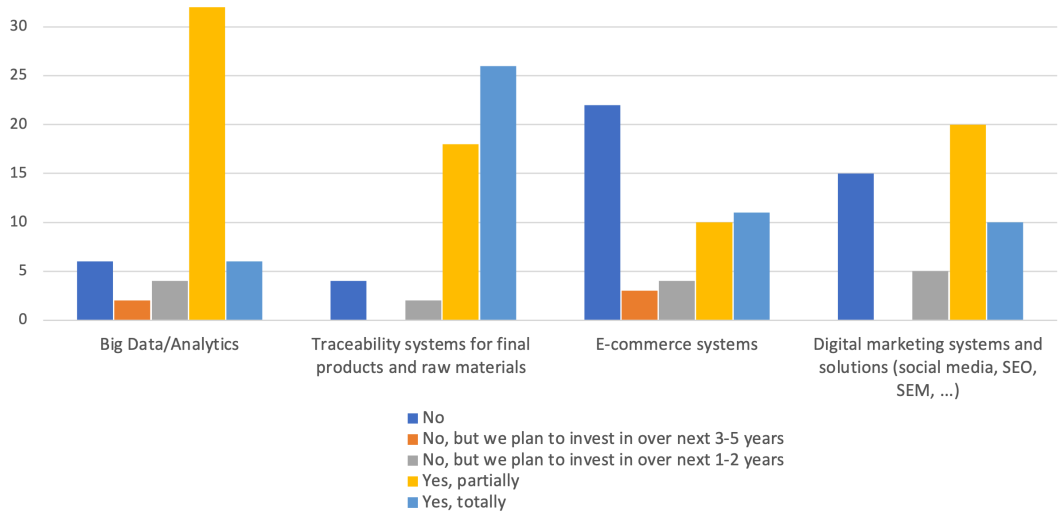

Figure 49 Integration level of different technologies

(Personal elaboration)

Going in order, let us first consider big data. As can be clearly seen, the vast majority of companies have expressed a partial integration of big data into their business strategy. This could indicate that the companies surveyed perhaps understand the importance of data collection, but only manage to analyse it in certain areas, or just partially. With regard to traceability systems, 86% of the respondents (44 companies) reported that they have integrated these systems (at least partially). This is easily explained since the European Community imposes very stringent laws in terms of traceability of food products. As far as e-commerce systems are concerned, the answers are more varied. The most selected answer,

however, is the absence of e-commerce systems. This reflects the information collected in the desk analysis, where we explained how only 1/5 of the companies in the sample have started an online sales channel. Also with regard to digital marketing solutions, the answers are quite varied. Here, companies seem to be divided into two groups: the first group (of about 30% of companies) does not make any use of this type of tool at all. A second group (of about 60% of the companies) adopts digital marketing tools at least partially. This predominance of companies which use digital marketing partially recalls the scenario of big data.

The next two graphs show the answers to two different questions in which companies were asked to think about their digital transformation process. Again, these questions are Likert scale questions. The first one is about the recruitment of qualified workers while the second one has to do with the role of the pandemic in the digital transformation process.

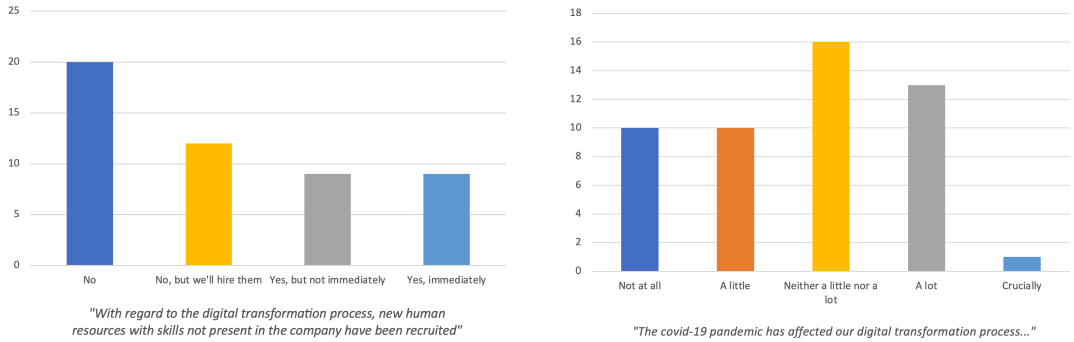

Figure 50 Hiring of qualified workers and Covid-19 impacts
(Personal elaboration)

The first graph, concerning the recruitment of new qualified human resources in the digital transformation process, does not give us much information. In fact, it seems that companies are rather divided on this aspect. Considering instead the impact of the pandemic on the digitalisation process, companies seem to report that the pandemic had an effective booster impact, but this was not so strong.

We now see a further elaboration of the data that links a graph shown in the desk analysis with the survey one. The last point covered in the desk analysis concerned the correlation between the number of employees and the following in social networks. A positive correlation was found between the two variables. Although this correlation was detected, the scatter graph alone does not give us any explanation about the reasons of the correlation itself. The only way to learn more about this correlation is therefore by comparing the scatter plot with the survey questions concerning the recruitment of qualified staff and the use of digital marketing solutions. Therefore, starting from the scatter plot, it was decided to consider only those companies that have a fan base above the sample average. In this case greater than 8k followers. Consequently, looking at the graph below, all companies in the brown highlighted rectangle were considered.

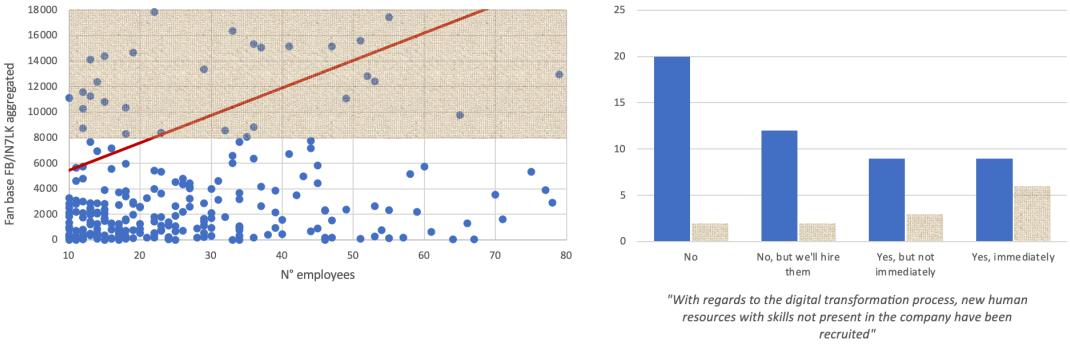

Figure 51 Joint analysis 1
(Personal elaboration)

The question regarding the recruitment of qualified resources was then re-considered. The brown bars refer only to companies with a following of more than 8k users, while the blue bars correspond to the graph seen before, i.e. all respondents together. It is easy to observe a clear difference between the two colored bars. While the (blue) aggregation of companies employed fewer qualified resources on average, the companies in the brown display the opposite trend. On average, therefore, companies that have invested more than others in digital qualified resources tend to receive a larger following on social networks.

The same approach was then used for the survey question concerning the use of digital marketing solutions.

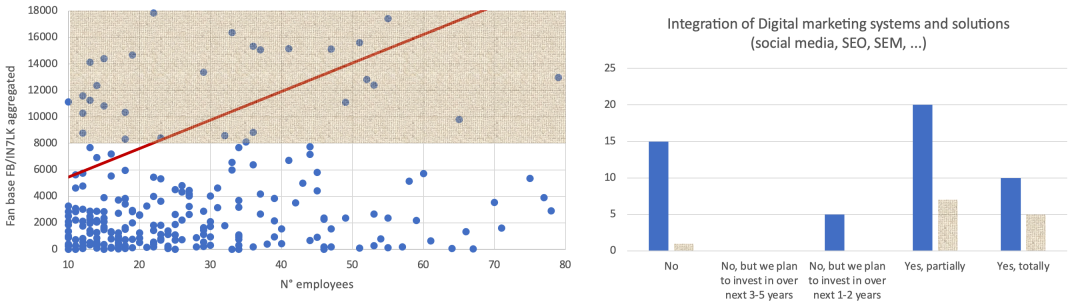

Figure 52 Joint analysis 2
(Personal elaboration)

Here, too, the brown bars show a very different trend from the one of all the aggregated companies (blue bars). Among the companies with a larger fan base in social networks, only 1 company reported that it does not use any digital marketing tools, such as SEO, SEM etc. Conversely, in the total sample 30% of companies do not use them. This reveals that companies which make greater use of digital marketing services, on average, enjoy a higher following on social networks.

4.3 Agri-food companies' interviews

As mentioned in the introduction to this chapter, the third part of the observatory project consisted of in-depth interviews with selected companies. The most pioneering companies were therefore chosen. This selection was precisely made to engage with companies that could describe an experience of real digital transformation. For this study, it was decided to select companies belonging to the same industry. It would have been illogical to select companies from different industries as we have seen in the previous paragraphs how industries differ in their digital maturity. Therefore, the choice of interviewing companies from the same industry is more consistent and allows us to find commonalities between the interviews.

The sector in which the companies interviewed operate is the meat sector (ATECO 10.1 - Carni). Before getting into the content of the interviews, let us briefly review the data collected in the desk analysis on this industry. According to the data, the meat sector appears to have a slightly lower digital maturity than the sample average. The online presence of companies through a website is 76% of the total (-3% compared to the sample average). Also with regard to the availability of the e-commerce channel, companies in this sector fall below the average. The meat companies with an e-commerce account for 9% of the total (17% the sample average).

4.3.1 Companies' presentation

The 3 companies interviewed are Colomberotto Spa, Moser Speck Srl and Centro Carni Company Spa. Let's briefly look at some general information on each of them.

Colomberotto Spa is a company based in Moriago della Battaglia (TV). Founded in 1953 it operates in the agro-industrial sector of beef production, slaughtering and processing. The main target of the company is large-scale retail. It employs 82 workers, and with a gross turnover of more than €200million it is the largest

company in the sample[56]. For the purpose of this thesis, Matteo Filippetto, the production manager, was interviewed.

Moser Speck Srl is a company based in Naturno (BZ). Founded in 1974, it has always had strong roots in the South Tyrol area. It is specialized in the production of Speck Alto Adige IGP. Also, Moser's main target market is the large-scale retail trade, although it also has its own physical shop and e-shop. It has a gross turnover of almost €40million and employs 100 workers. For the purpose of this thesis, Peter Spath, Head of Information Systems, was interviewed.

Centro Carni Company Spa is a company based in Tombolo (PD). Founded in 1979, it operates in the production of fresh and frozen meat. Its target market is the large-scale retail trade. In addition to wholesale production, it has developed 4 different brands of products, with different positioning. It is the third company by gross turnover in the sample (approximately €100 million). It employs 86 people. For the purpose of this thesis, Silvia Pilotto, Head of marketing and communication, was interviewed.

As mentioned in the introduction of this chapter, this section will highlight some of the most interesting aspects of the interviews. In particular, the common elements that emerged from the interviews will be explored. The general question this paragraph aims to answer is "what are the digital technologies and innovations that the three companies consider most crucial in their business?".

The first common aspect that emerged from all the interviews was the need to manage business activities through ERP (Enterprise Resource Planning) software. An ERP is a management software that manages to combine all business processes and functions. Data relating to purchases, sales, warehousing, accounting, etc. are collected centrally by this type of software, even if they come from various functions of the company. All three companies highlighted the simplification of administrative processes following the adoption of this type of

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[56] Colomberotto Spa, *Bilancio di sostenibilità 2020*, 2020, Available at: https://www.colomberotto.it/wordpress/wp-content/uploads/2022/01/BILANCIO-DI-SOSTENIBILITA-COLOMBEROTTO-2020-2.pdf

software. Moreover, Colomberotto Spa and Moser Srl stressed the importance of having integrated PLC devices to their production machinery. PLC are devices used in industrial automation to regulate production cycles and collect data on the machines work. The two companies are able to interact with the data collected by PLCs through their own management software (ERP). Then, all three companies explained that collecting large amounts of data, especially in production, is essentially a strategic choice. Being able to analyze production data on a daily basis allows them to develop metrics and self-assessment parameters (e.g. on consumption, time, etc.). In this way, it is possible to evaluate all the resources employed and optimize their efficiency. Thus, the most relevant technologies that emerged from the interviews, speaking in terms of Industry 4.0 pillars, have to do with 'system integration' and 'big data'. There is also a third pillar that emerged from the interview with Colomberotto Spa, which is the 'Internet of Things'. The interviewee explained they are working on the development of stables fully connected to the internet. This means that stables are equipped with a computer system that guides the human operator providing live data on consumption, temperature of the barn, humidity, etc. Systems like this therefore, not only improve the efficiency of the producer, but also improve animal welfare.

CONCLUSIONS

Coming to the end of this elaboration, it can be helpful to review the key points that have emerged throughout the chapters. Doing so, would make easier to draw some conclusions about the research. The analysis regarding the agri-food sector began with some industrial data. These kinds of data showed how the food&beverage industry is a major contributor to the Italian and European economies. The sector is not only profitable and constantly growing, but also, the number of people that it employs, is impressive. The discussion then turned to the impact of the Covid-19 pandemic on the industry. Although the pandemic has limited some channels of the food sector (such as ho-re-ca), it did not cause a significant drop in turnover for food companies. However, the shock after the pandemic has revealed some clear deficiencies in the digitalization level of a lot of enterprises. Through graphs and data, we observed that a low level of digital capability is common among small and medium-sized enterprises. The problem here is that the vast majority of Italian food companies are small to medium-sized enterprises themselves. This means that many of the new technologies outlined in the second chapter of this thesis are to some extent precluded to a large number of companies. This essay, at this point, emphasizes that the real common problem for most companies is the lack of competences. It is important to point out here that a lack of competencies does not only mean a lack of hard skills, but also scarce awareness of the advantages in assuming concrete approach to digital technology. The importance of qualified and trained employee which can assist the process of digital transformation in a company, is a point that strongly emerged also in the second part of the thesis. In the statistical sample analysed, we found that, rather than turnover, it is the larger number of employees, better if specialized, which determines a larger fan base on social networks. Again, another very interesting aspect that emerged in the analysis of the Triveneto sample is the widespread tendency among companies to launch new e-commerce in 2021. In fact, as

mentioned, most of the companies in the sample are B2B organisations, and therefore usually tend not to invest in online sales. Yet the data tell us that an increasing number of companies are investing in this channel. The reasons for this trend can be multiple. One could attribute this trend to a natural response to the pandemic situation. At the same time, we could state that companies are looking at e-commerce as a way to expand their business model. A final point that is worth mentioning here is the contribution of the 3 in-depth interviews with successful companies in the meat sector. In fact, in the first two chapters of the thesis, a whole range of digital solutions and technologies was presented. However, we did not know what the companies think about them. Which ones they find more useful, and which ones less so. Instead, by interviewing the companies, we got feedback on which kinds of technologies actually bring value to the company. In this case, the most relevant technologies, according to the interviewed, are the ones related to system integration and big data collection. These aspects just reported represent a few of the hints and insights that emerged from the analysis of the sample and the companies' responses to the survey. The hoped behind the thesis is that this work may be useful to those wishing to carry out further analysis of the agri-food sector. However, looking now at the limitations of this work, it is clear that one cannot rely totally and unconditionally on this data. There are in fact some issues with the sample, that can vitiate the research. For example, if the full sample is very large and representative of the agri-food north east industry, the companies which responded to the survey are only a small part of the total. Moreover, the number of respondents per single ATECO code does not proportionally reflect the number of companies in that ATECO across the full sample. Therefore, it is always quire risky to compare the data from the desk analysis with the ones from the survey. Another limitation is then the lack of historicity in the data collection. That’s due to the fact that we are only at the first re-edition of the Observatory project. Consequently, when comparing a data such as the following on a social network or the presence of a website, it is possible to compare it only with one value, i.e. the correspondent of 2020. It would be more interesting instead to analyze a trend, across several data points, over a longer time period.

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