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INDUSTRY 4.0 IN THE REALITY OF THE "CHAMPIONS".

AN ITALIAN WAY TO THE FOURTH INDUSTRIAL REVOLUTION?

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INTRODUCTION

The evolution of new digital technologies is transforming the industrial system in a profound and irreversible way. Its impact is disruptive in all major sectors of the economy and is now widespread on a global scale. This enables the application of innovations in industry and manufacturing that are revolutionizing the production methods. This transformation represents a structural evolution in production systems due to a new way of operating. We are talking about the Fourth Industrial Revolution, better known as Industry 4.0.

The significant economic crisis of recent years has increasingly highlighted the weakness of economies linked to financial aspects and which are less interested in implementing policies aimed for developing the real economy. The crisis affected most of the advanced countries, such as Italy which has seen its growth and development prospects decline over time. The Italian production system has always been characterized by a great fragmentation and a high degree of entrepreneurship. The size structure is dominated by the strong prevalence of Small and Medium Enterprises (SMEs) which have been affected by the economic and financial distress. Our country is the second industrial power in Europe but today it presents itself as an industrial landscape characterized by a deteriorated profile. Despite these aspects, in recent years there has been a gradual recovery of the country. This recovery has seen a part of SMEs to be the main actors: a group of companies for which the crisis has represented an opportunity and that have accumulated, day after day, enormous margins of advantage over their competitors, including global ones. We are talking about the so-called “Champions" which are realities whose business models prove efficient even in the presence of adverse factors. These are not a few large companies, such as Brembo, just to name one of the best-known and most successful case, but a large group of small companies. They are companies that have achieved excellent economic and financial performance: Compound Annual Growth Rate (CAGR) of more than 7% in the period 2010-2016; average gross operating margin (EBITDA) of more than 10% in the last three years; debt to total assets ratio (Debt ratio) of less than 80%; positive net result in 2016. We are talking about companies with at least 20 employees; they have a turnover between 20 and 120 million euros; they are not subsidiaries of multinationals or foreign groups but are privately owned. These companies and institutions of reference will have to face challenges in the coming years in order to be able to make this extraordinary entrepreneurial heritage a real engine of recovery for the whole country.

So, are Italian companies ready to face the challenges of Industry 4.0 and exploit its full potential? Is there an Italian way towards the fourth industrial revolution? These are the key questions that inspired the following paper.

The aim of this paper is to understand how the *Champions* are interfacing with the world of digitization and how technological evolution is affecting productivity and competitiveness in the market. The evolution of these digital technologies, in fact, is putting businesses in front of an expected paradigm shift whose main results are a greater efficiency of production processes and a greater competitiveness of the system. This will give the opportunity to those who are able to follow and adapt to the digital disruption to grow in the long run, allowing them not only to be resilient to the cyclical effects of the economy but, above all, to play a leading role in the global market that will come.

The thesis, therefore, analyzes which are the processes of adoption of digital technologies that fall under the "Industry 4.0" label by Italian companies and what are the implications related to production and innovation activities. The aim is to investigate how the Champions are facing the challenges of the new technological scenario and the opportunities offered by these technologies in terms of production and relations with the market.

The work is organized as follows. The first chapter focuses on the theme of 4.0 trying to understand what is meant by Industry 4.0 and how this is reflected on production processes. This revolution brings significant changes on the execution of operations and on their planning in real time together with a dynamic self-optimizing. This is possible thanks to the use of various technological innovations that will enable the affirmation of the Industry 4.0.

The second chapter highlights the current industrial situation in our country, the direction in which it is moving on the theme "Industry 4.0" and analyzes the impact that it has on Italian companies. We will discuss some relevant aspects of the crisis and the consequent loss of competitiveness that has profoundly affected Italian SMEs, trying to understand how the digitization of the industry can represent an opportunity for many countries to overcome the economic distress. But, to do so, they must be prepared and ready to face the continuous market changes. In fact, Italy presented an action plan that aim to invest in innovation. It is the National Industry 4.0 Plan, the Government's new industrial policy strategy that consists of a wide range of policies aimed at creating a premium environment for productive investments, trying to modernise production processes. This industrial policy strategy is an essential tool through which small and medium-sized enterprises can gain competitiveness on international markets. Then, we will try to understand the plan policies' impact on Italian companies, taking into

account some recent research conducted by the Ministry of Economic Development and the report of 2017 of the Digital Manufacturing Laboratory of the University of Padua.

The third chapter focuses on the Italian manufacturing model, characterized by a myriad of SMEs, representing the backbone of our economy. This kind of economy is based on manufacturing and the rediscovery of craftsmanship which sees in the Made in Italy its added value. SMEs and the phenomenon of Made in Italy are two important characteristics that make our country unique in its kind being observed from other countries with admiration and curiosity. It is the mark of a "know-how" that distinguishes us in the eyes of other countries, the most vital part of the Italian economy based on small and medium enterprises and industrial districts, capable of gaining large leadership positions in global markets. Finally, the chapter focuses on that part of the country that, even if has remained out of the spotlight, represents one of the most solid protagonists of the Italian recovery: the *Champions*. They are new companies, as defined by Filiberto Zovico, which have understood the changes in the market growing against the trend, reaching excellent levels of profitability and a financial and equity strength that has allowed them to compete with global companies. Particular attention is paid to the study of the 500 "Champions" identified by the *ItalyPost Study Center* after a careful research.

The last chapter presents the results of a survey on the "Champions and digital manufacturing" conducted in part by me and coordinated by Professor Marco Bettiol and Professor Eleonora Di Maria. The aim of the survey is to find out the level of adoption of digital technologies that fall under the Industry 4.0 label and the implications that these have in the various business processes and on the business value chain of "Champions".

CHAPTER 1

THE NEW INDUSTRY
"THE FOURTH INDUSTRIAL REVOLUTION"

SUMMARY: 1. Introduction – 1.1What is Industry 4.0? – 1.2 The future of production – 1.3 Enabling Technologies Industry 4.0 – 1.3.1 Additive Manufacturing – 1.3.2 System integration – 1.3.3 Internet of Things (IoT) – 1.3.4 Cloud Computing – 1.3.5 Cyber-security – 1.3.6 Big Data and Analytics – 1.3.7 Simulation – 1.3.8 Augmented Reality – 1.3.9 Robots – 1.4 Conclusions

1. INTRODUCTION

In recent years the concept of Industry 4.0 has been developed, defined by Roland Berger Strategy Consultants as the set of technologies that will accompany the so-called fourth industrial revolution, based on digitization and interconnection of all production units within an economic system[1]. The paradigm Industry 4.0 will have strong impacts on the economic system, acting on relations with internal and external stakeholders of the companies, on new technologies, on new requirements of cybersecurity and on the organization of business processes. Through the following chapter we try to introduce the theme of 4.0, trying to understand what is meant by Industry 4.0, how this is reflected on production processes, bringing significant changes in the execution of operations and their planning in real time, together with a dynamic self-optimizing. That is possible thanks to the use of various technological innovations, as many as nine technologies that will enable the affirmation of the Industry 4.0 and that we will discover in this chapter.

1.1 WHAT IS INDUSTRY 4.0?

Industrial revolutions that characterized the end of the nineteenth and the entire twentieth century, have allowed man no longer depends on its strengths, making mass production possible and providing millions of people with digital skills.

These changes were the prelude to the advent of a further revolution. For some time now, we have been hearing about Industry 4.0 and this will happen more and more in the future. The term *Industry 4.0* was used for the first time in Germany in 2011, during the Hanover Fair[2]. On this occasion a working group announced a project for the development of the German manufacturing sector, the *Zukunftsprojekt Industrie 4.0*, which was supposed to bring the country's industry back to a leading role in the world. Subsequently, the German model inspired numerous European initiatives and the term Industry 4.0 also spread internationally.

Industry 4.0 is also known as the fourth industrial revolution, it refers to an organizational mode of production of goods and services that leverages the integration of plants with

[1] A. Cibocchi, *INDUSTRY 4.0 & IOT*, in "Yourceo", 2017.
Source available on: https://www.yourceo.it/ceo/industry-4-0-iot/

[2] Source: http://startupitalia.eu/57350-20160531-industria-4-0-spiegazione

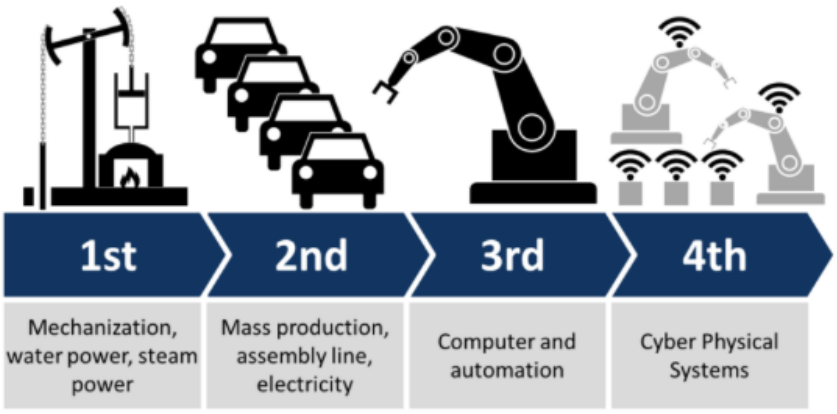
digital technologies. Technology transformations that have been influencing industries and the economy since the past ten years.

Industry 4.0 or Intelligent Manufacturing[3] represents a new paradigm and consists in the convergence of advanced ICT and manufacturing technologies.

The data therefore assumes a primary role, since it is the basis of any operation. Goes from being a simple information to becoming a tool that creates value. It is through the data, in fact, that the computing power of the machines is determined and the economy of today and of the future moves.

It provides a solid foundation for effective and optimized decision making through faster and more accurate decision-making systems[4].

In fact, unlike previous industrial revolutions, it is not based on a single enabling technology as was the mechanical frame and steam in the first industrial revolution, electricity in the second one, computer science in the third one, but on the implementation of a set of enabling technologies that are aggregated through the Internet in a systemic way in new production paradigms at the base of innovations of a very different nature, of process, organizational, product and business model.



The 4 Industrial Revolutions (by Christoph Roser at AllAboutLean.com)

[3] Ray Y.Zhong, XunXu, *Intelligent Manufacturing in the Context of Industry 4.0: A Review*, Research Intelligent Manufacturing—Review, October 2017.

[4] H. Kang, J. Lee, S. Choi, H. Kim, J. Park, J. Son, B. Kim e S. Noh, *Smart manufacturing: past research, present findings, and future directions*, International Journal of Precision Engineering and Manufacturing, 2016.

The basic concept is that of collaboration, or better of cooperation, which can take place between people, machines or between machines and people. We are talking about Cyber Physical Systems[5] or the Internet of Things, which consists of the virtualization of processes and factory operations. It means the inclusion in manufacturing processes, hitherto carried out by human beings, of intelligent and internet-connected machines[6].
The ordering element of the new industry turns out to be the continuous interconnection of every single individual, every single enterprise, every research structure in planetary relational networks.

Therefore, the development of digitalization has allowed the continuous interconnection, both between productive systems and between individuals, which has changed the same daily life of populations that are very distant from each other in terms of history and traditions.
This connection not only generates the possibility of responding to the demand derived from individual needs but is also an important tool to address major global challenges, such as water scarcity, sustainability of life and social inequality, which today are the new public goods at the global level. Nevertheless, the social change that has taken place in this phase of global interconnection allows us to develop the dynamic tension that pushes us to use all available technologies and to stimulate research to respond to the new private and public demand[7].
From a technical point of view, Industry 4.0 can be described as the increasing digitization and automation of the manufacturing environment and the digitization of the value chain to allow communication between objects and the context around them, and with industrial partners[8].
According to a recent Magruk's research (2016) the development of the fourth industrial revolution involves three phenomena: one is the universal digitization, so the constant communication between individuals, devices and machines; then the implementation of technological innovations that influence the efficiency and effectiveness of the socio-

[5] Cyber-Physical Systems (CPS), which include sensors, data processing units, and actuators, are at the heart of the IoT. They represent the fusion of the virtual and real world and allow the real-time transfer of data. By J. Lee, B. Bagheri e H.-A. Kao, *A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems*, Manufacturing Letters, 2015.
[6] G. Fiandese, *Fabbrica 4.0: la quarta rivoluzione industriale, "Informatica e Documentazione"*, PubbliScienze, 2015, pp. 4-6.
[7] P. Bianchi, *4.0 La nuova rivoluzione industriale*, Ed. Il Mulino, 2018, p. 58.
[8] H. Lasi, P. Fettke, H.-G. Kemper, T. Feld e M. Hoffmann, *Industrie 4.0*, 2014.

economic system; and the other one is the development of the machine, which improves the possibility of autonomous behavior using artificial intelligence[9].
The integration of production, educational and scientific systems becomes the way to manage contemporary complexity, and a determining factor for the localization of the head of global production cycles.

1.2 THE FUTURE OF PRODUCTION

The industry 4.0 combines the real and virtual worlds and is based, as mentioned above, on Cyber Physical Systems (CPS) and Cyber Physical Production Systems. Moreover, the Fourth Revolution is the transformation of industry based on centralized production to decentralized production and the users are transformed from partial participants to total participants of the production. consumer, who no longer limits himself to be a simple active consumer, but it will be considered a prosumer, "*a customer who helps a company design and produce its products*" (Cambridge Dictionary)[10], a customer more than active in the process involving the stages of creation, production, distribution and consumption of the product. We refer to the concept of manufacturing on-demand (MOD)[11].
Helmsch (2017) in one of his articles states that the implementation of technologies related to Industry 4.0 involves faster production and flexibility, with greater efficiency and reduced complexity[12].

Let us now try to understand better what the transformations in the organization of production have been since the first industrial revolution up to what we call the fourth industrial revolution, helping us with a scheme by Patrizio Bianchi (2018)[13].

[9] A. Magruk, *Uncertainty in the sphere of the industry 4.0 – potential ares to research*, Business, Management and education, 2016, pp. 275-291.

[10] Source: https://dictionary.cambridge.org/dictionary/english/prosumer
[11] A manufacturing process wherein goods are produced when or as they are required. In traditional manufacturing, an assembly line works on standard shifts to produce large quantities of products, which are then kept in storage facilities until they are ready for shipping. With manufacturing on demand, the system is a bit different; scalable and adjustable assembly and manufacturing processes work to complete customized packages based on real-time or current data from a client.
Source: https://www.techopedia.com/definition/10725/manufacturing-on-demand-mod
[12] R. Helmsch, *In pursuit of 4.0*, SMT magazine, 2017.
[13] P. Bianchi, *4.0 La nuova rivoluzione industriale*, pag. 59.

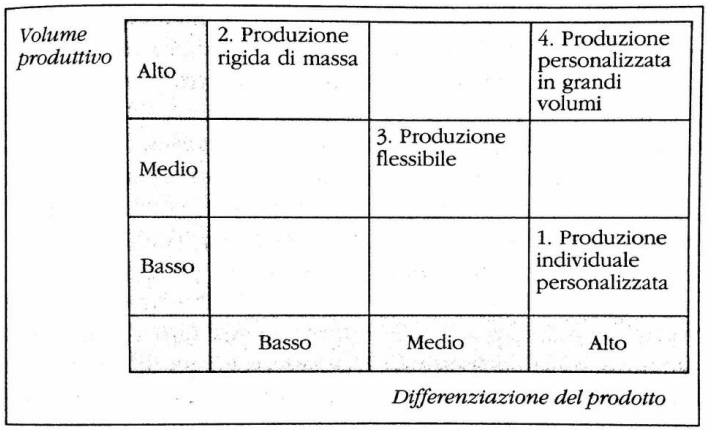


Fig. 2. Product and process transformations starting from two variables: production volumes and the degree of product differentiation (by P. Bianchi, 2018).

On the vertical axis we have *production volume*, that means the quantity of goods produced, while on the horizontal axis the *product differentiation*, that means the variety of goods produced in the same production structure.

Bianchi (2018) begins its schematization starting from the artisan production, defined as individual personalized production (1), which has small volumes but a great ability to differentiate the final product listening to the needs of the consumer. The trustworthy tailor is taken as an example of this mode of production, who takes the measurements and creates a suit according to the tastes and availability of the customer. With the second industrial revolution, however, we can refer to a way of producing in large volumes only one type of standardized product, the rigid mass production (2), characterized by a high volume of production and low differentiation. Bianchi takes the example of a textile company that makes standard clothes to buy in department stores, in an exclusively price competition. This was the dominant form for large industrial enterprise, i.e. Fordism.
As exemplified by the famous quote of the American entrepreneur Henry Ford, who in his biography, said "*Any customer can have a car (Ford T) painted any color that he wants so long as it is black*"[14] (H. Ford, 1922).
Between these two forms of production (1) and (2), a further form has been inserted over time, which Bianchi defines as Flexible Production. Through this way of production, it is possible to achieve significant production volumes (mass production), differentiating the homogeneous product, expanding the range of products on offer (flexible production).

[14] H. Ford, *My Life and Work*, 1922.

This is the organizational way in which the great crisis of the 1970s was dealt with and which has dominated the industrial scenarios over the last forty years.
The objective of the restructuring of the production organization, defined as Industry 4.0, could be defined as a customized production in large volumes (4), i.e. maintaining a continuous flow of production but composed of a continuous series of differentiated products, to respond to individual needs.
Therefore, the fourth industrial revolution has the objective of introducing continuous differentiations in production, up to a customization of the final product, which is, however, made in large volumes.

The impact on production lies in the in terms of old economic logic: the process affects productivity, on the business models of the as well as on the modalities of organization of production, and therefore on training and qualification of the entire workforce, from the manager to the production worker. Therefore, it has an impact on competitiveness and about the ability to stay in the markets[15].
The digital manufacturing allows for an environment able to be exploit both the cost benefits deriving from mass production and the communication channels deriving from mass customization.

What happens from a *cost efficiency* point of view?

Now we consider the different types of production previously identified and place them in relation to economies of scale and economies of scope (see Fig. 3). Economies of scale are reductions in the unit cost of a good produced and sold as it moves from a smaller to a larger production unit. We have economies of scale when average production costs decrease as the size of the company increases. If the marginal cost is lower than the average cost, we have the possibility of achieving economies of scale[16]. Whereas economies of scope are economies of joint production. The production of two or more products is cheaper than the separate production of each of them[17].

[15] G. Cervelli, S. Pira, L. Trivelli, G. Fantoni, *INDUSTRIA 4.0 senza slogan*, Ed. Towel, 2017, p.5.
[16] Source: https://www.tesionline.it/appunto/Definizione-di-economia-di-scala/210/47
[17] Ibidem, source: https://www.tesionline.it/appunto/Economie-di-scopo-/210/56

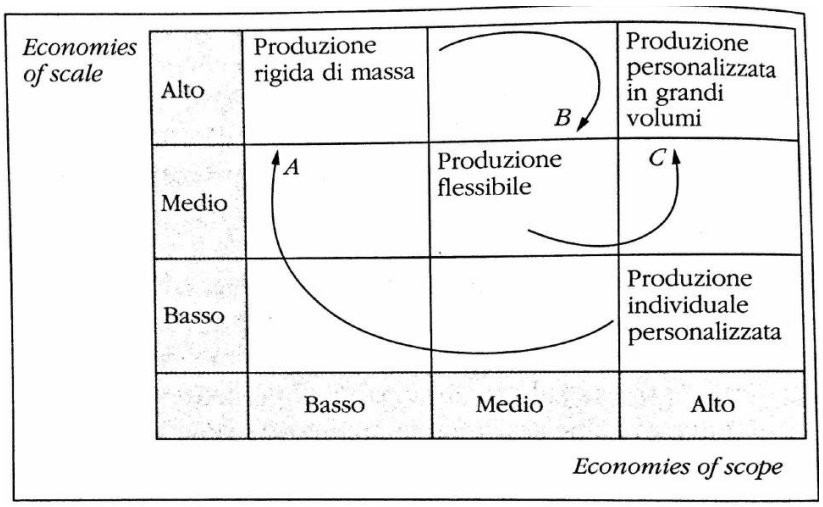


Fig. 3. Relation between economies of scale and economies of scope (P. Bianchi, 2018)

As mentioned before, the artisan production presents a high differentiation of the product but low production volumes. However, it is an example of how it is possible to benefit both from the use of the same skills and the same machines to produce differentiated goods. In this case, if we wanted to increase production volumes, we would have to insert new individuals with the same skills in order to carry out the entire tasks required. We could then have products customized for a customer, but with high costs. Rigid mass production, on the other hand, is efficiency based on specialization in a single product, achieved by segmenting the production cycle into phases, one after the other, in order to maximize skills and tools on individual production activities. In this case, unlike the previous case, if you want to increase production volumes you have to insert new individuals in the different stages of production and form them. This would reduce the execution time with the risk, however, that the old individuals would lose the other skills required. We would thus have products at lower prices but standardized. From a competition linked to quality, to customization, we move to a competition based on price, for the same product. Obviously, these are forms of production aimed at different markets.

This passage is highlighted in Bianchi's graph (2018) by the arrow A (fig. 3).
The reorganization of production processes in the last part of the twentieth century, due to the oil crisis that had reduced the spending capacity of families, has tried to increase the economies of scope without losing much in economies of scale (arrow B). In recent years there has been a further extension of the market, with the entry on the world market of new competitors (i.e. China), which has led to a new organization of production, which must now be adapted to a different market, of global size and highly competitive. This

transition is highlighted by the arrow C of the graph, where it is evident how we try to obtain all the advantages associated with both economies of scale and economies of scope, i.e. achieving the maximum benefits of joint production.

The Industry 4.0 formula represents this profound industrial transformation, where are required large volumes suitable for a global market and differentiation in order to respond more and more to the new needs of individuals[18].

1.3 ENABLING TECHNOLOGIES INDUTRY 4.0

The industry 4.0 has been transposed in a different way between the various countries, both in terms of timing and in terms of the choice of investments to be made. It is possible, however, to recognize a common element which started the revolution, the set of enabling technologies. A study conducted by Boston Consulting Group shows that the fourth industrial revolution is based on the adoption of those technologies, such as Additive manufacturing; Augmented reality; Simulation; System Integration (Horizontal and Vertical integration); Industrial Internet (IoT); Cloud; Cyber security; Big Data Analytics; Autonomous Robots; through which, companies have the possibility of radically innovating their business model.

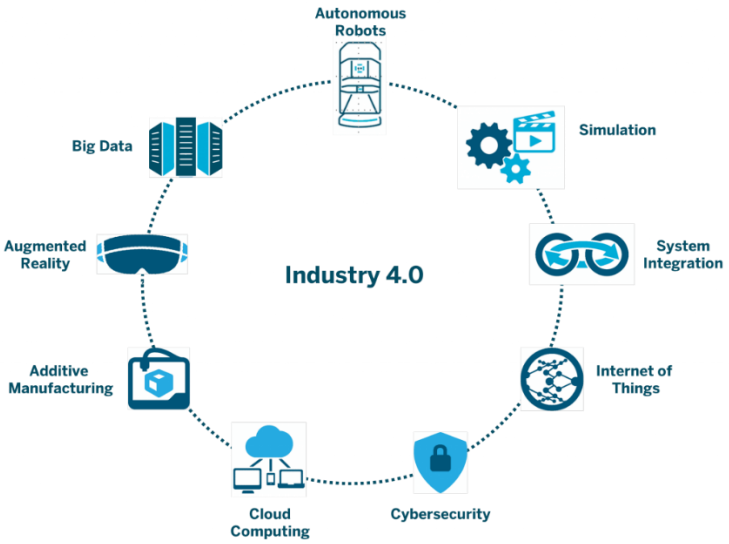


Fig. 4. Enabling technologies for Industry 4.0 (Source: focusindustria40.com)

[18] P. Bianchi, *4.0 La nuova rivoluzione industriale*, pag. 64.

1.3.1 Additive Manufacturing

Additive Manufacturing or also known as 3D printing, consists of various processes for the creation of solid three-dimensional products, of any shape and customizable, starting from a digital model[19]. It consists of five basic steps:

- Development of a three-dimensional model of the product;
- Conversion to a standard format used in additive manufacturing;
- Sending the file to 3D printer where it is manipulated to be ready for processing;
- The component is manufactured by layer by the machine;
- Cleaning and finishing the model.

Additive manufacturing is a method of mass production that can offer new opportunities for mass customization. Industry 4.0 and Additive manufacturing allow the co-design of the product with the contribution of several companies, each with a specialization in a small phase of the production cycle that is realized in a subsequent way with 3D printing.

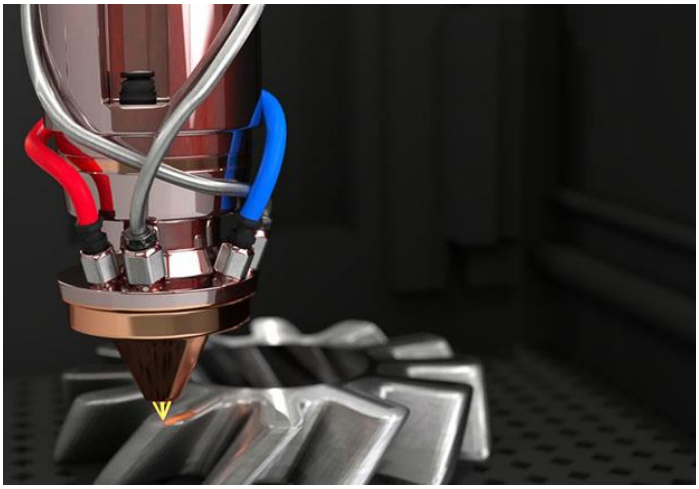


Fig.5. Additive Manufacturing in DMG MORI with INTECH (Source: DMG MORI)

[19] S. S. Babu, R. Dehoff, L. Love, S. Pannala, W. Peter, T. R. Watkins, *Additive manufacturing of materials: Opportunities and challenges*, article in MRS Bullettin, December 2015.

The advantages associated with the application of Additive manufacturing technologies can be traced back to four categories that refer to elements on which a company can act to create an advantage over its competitors[20]: Flexibility; Time; Cost; Quality.

- *Flexibility*: a greater customization of products and services results in greater dependence on individual customer needs that are difficult to predict.

- *Time*: benefits related to the ability to intervene on business processes, reducing the time of execution. The 3D printer allows the prototype to be created directly from the 3D model, eliminating the need to create tools and moulds. Obviously, this generates a competitive advantage, no longer just related to the possibility of creating different products, but also allowing to reduce the overall time-to-market of the product, thus offering a better service to the customer.

- *Cost*: Additive technologies make possible to pursue cost reduction, reduction of incoming raw materials, reduction of waste and non-conformities. Some companies make the production and assembly process more efficient by making it possible to produce different components in a single printing process.

- *Quality*: it is possible to develop products with additional functions, with superior performance, more complex geometries and shapes, improved aesthetic.

1.3.2 System integration

The use of interconnected technologies capable of analyzing and communicating information and data, and therefore of interacting with each other, creates a new world of system functionality for horizontal and vertical integration[21].

- Horizontal integration as this will lead to an exchange of data between the enterprise and the geographically remote sites across the value chain.

[20] https://www.agendadigitale.eu/infrastrutture/stampa-3d-in-azienda-i-quattro-benefici-reali-e-dimostrati-con-casi-applicativi/
[21] K.Chukalov, *Horizontal and vertical integration, as a requirement for cyber-physical systems in the context of industry 4.0,* International scientific journal "industry 4.0", 2017

- Vertical integration as it involves all key partners in the value chain, from suppliers to companies and consumers. The vertical and horizontal integration on the chain of value represents the basis of the production cyber system.

1.3.3 Internet of Things (IoT)

Internet of Things encompasses a group of technologies that enable communication between objects, systems, environments and the people who are equipped with them, creating a virtualized version of business processes and operations to monitor and optimize them.

According to the IERC[22] definition, IoT represents "*A dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual things have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network*"[23] (O. Vermesan *et al.* 2011).

Some examples of electronic devices installed to enable these forms of communication are Wireless-Sensor Networks (WSNs), i.e. intelligent sensors used to monitor and control systems; Radio-Frequency Identification (RFID), which are microchips that transmit wirelessly information about the product to which they are associated, to a receiving device. Or our most common devices such as barcodes, mobile devices, actuators and GPS systems[24]. The things around us become a system of objects inserted into electronics, sensors, software and connections to the global network of computers.

The applications of Internet of Things are manifold and span the entire industry. One of the goals of the IoT is to help the manufacturing industry address major challenges such as increasing market volatility and complexity, and the need to reduce the time taken to introduce innovations.

There are, in fact, high expectations as to the possibilities of generating new added value. The IoT is changing the competitive landscape of industrial production. Its development has consequences for the digital factory and effects such as flexibility, product

[22] IERC, European Research Cluster on the Internet of things. The aim of European Research Cluster on the Internet of Things is to address the large potential for IoT-based capabilities in Europe and to coordinate the convergence of ongoing activities.

[23] O. Vermesan, P. Friess, P. Guillemin, S. Gusmeroli, et al., *Internet of Things Strategic Research Agenda*, Chapter 2 in O. Vermesan and P. Friess (Eds.), Internet of Things—Global Technological and Societal Trends, River Publishers, Aalborg, Denmark, 2011.

[24] L. Xu, W. He e S. Li, *Internet of Things in Industries: A Survey*, IEEE Transactions on industrial informatics, 2014.

customization, real-time dialogue between market, design, suppliers and production, with significant consequences on plant characteristics[25]. This means that the IoT system will lead to a large-scale deployment of intelligent products and objects, with unlimited applications.

1.3.4 Cloud Computing

The cloud is a common, flexible and open-by-design IT infrastructure that consists of delivering IT services over the Internet via a scalable resource system. It is a system aimed at sharing data, information and applications through the Internet, in order to follow the transformation of business models with the necessary capacity. The flexibility is one of cloud's strengths, along with broad geographic coverage and savings in purchasing infrastructure. The three cloud service models are Platform-as-a-Service (PaaS), Infrastructure-as-a-Service and Software-as-a-Service.
The benefits of cloud computing are not only strictly economic. Luca Zanetta (2018) of Uniontrasporti summarize them as follows[26]:

- *Flexibility*: adapting contract conditions to suit greater or lesser needs, without having to worry about reconfiguring architectures;
- *Reducing initial fixed costs* of software and hardware (purchase, configuration, installation, maintenance and decommissioning of hardware and software);
- *Cost shift* from Capex (Capital Expenditure) to Opex (Operating Expense): I pay as much as I consume;
- *Accessibility* even with mobile devices: the applications become independent from the device hardware, as well as the computing capacity, which is no longer local.

[25] M. Zanardini, *La rivoluzione digitale nella manifattura*, impresa & città, 2014, n.4.

[26] Source: https://www.bo.camcom.gov.it/

- *Data security policies* and their integrity homogeneous and aimed at protecting the system.

Although the benefits of cloud computing are considerable, there are some concerns related mainly to the scarcity of resources and staff trained on the subject, and the issue of security.

1.3.5 Cyber-security

Cyber security includes the part of information security, i. e. threats to privacy, cyber security, which depends exclusively on information technology. It represents the set of technologies that have the purpose of protecting data from unauthorized access, ensuring the necessary security[27].

As already mentioned, industrial systems are increasingly equipped with technologies that collect in real time detailed data on their operation, then communicate them to other computer systems, which analyze and store them. These data are used by companies for the management and control of industrial processes, but can also be used by other actors, such as suppliers or end users. The increase in the number of connected devices may make other parts of the global system more insecure and therefore require a risk analysis. The issue of cyber-security therefore becomes fundamental. This is because through the 4.0 industry there is a significant growth in connectivity and, therefore, there is an increasing need to protect industrial systems and production lines from cyber-attacks.

1.3.6 Big Data and Analytics

As mentioned above, the data represent one of the main cornerstones of the fourth industrial revolution. Nowadays, any type of object connected to the network and any service produces data. The expression Big Data refers to the ability to manage large volumes of data generated by any type of connection and device. It not only refers to the actual amount of data, but also refers to its analysis. This significant amount of data, in order to be usable, must be processed through the creation of data analytics, able to produce adequate and relevant information for making decisions.

[27] Source: https://www.agendadigitale.eu/tag/cyber-security/

Big data refers to a massive volume of both *structured* and *unstructured* data so large that it's difficult to process using traditional database and software techniques. The first one refers to information with high degree of organization and easy to digest. They consist mainly of text files that include very well-organized information. Structured data is stored inside of a data warehouse where it can be pulled for analysis and it is made up largely of basic customer data. Structured data is largely managed with legacy analytics solutions given its already-organized nature[28]. While unstructured data are the opposite. It continues to grow in influence in the enterprise as organizations try to leverage new and emerging data sources, which are made up largely of streaming data coming from social media platforms, mobile applications, location services, and Internet of Things technologies. Businesses have much more trouble managing it than structured data. As a result, companies are being challenged in a way they weren't before and are having to get creative in order to pull relevant data for analytics.

In 2001 research report and related lectures, META Group's, now Gartner.inc[29], analyst Doug Laney defines big data through three dimensions, the so called 3Vs model: Volume, Velocity and Variety[30].

- *Data Volume* refers to the need to determine the relevant data within a huge amount of data.

- *Data Velocity* means that with a fast data flow, it is necessary for organizations to be able to process data quite quickly.

- *Data Variety*, organizations need to compare with the wide variety of existing data.

[28] Available on: https://solutionsreview.com/data-management/key-differences-between-structured-and-unstructured-data/

[29] World leader in strategic consulting, research and IT analysis with over 60,000 customers worldwide.

[30] D. Laney, *Application Delivery Strategies*, 6 February 2001, File 949.

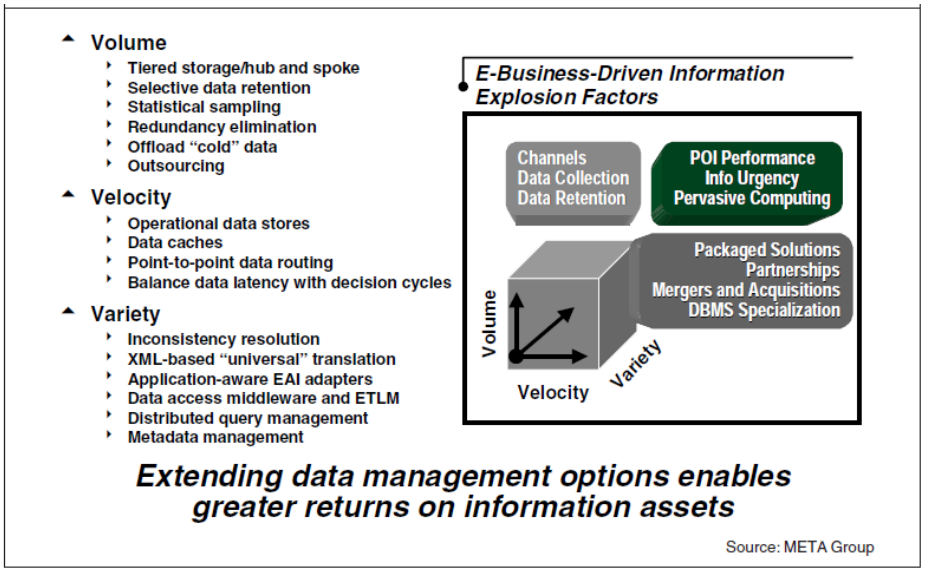


Fig. 6. Data Management Solutions (D. Laney, 2001)

The extraction of information from large amounts of data is performed through *data mining*. Data mining uses appropriate algorithms and techniques such as grid computing, in-database processing and in-memory analytics that detect associations, patterns or sequences making the information available and immediately usable in the context of decision making.

1.3.7 Simulation

The adoption of these technologies, IoT, cloud and big data analytics, contribute to the creation of a virtual representation on the different production lines in order to optimize industrial processes. These simulations are based on the use of real-time data, so that they reflect material reality in a virtual model, which will help operators to test and optimize the setting of production process machinery in the virtual world before setting it in the physical world. This reduces learning-by-doing costs and machine set-up time to make a product's production process more efficient.

The objective is therefore to use digital models that can simulate the behaviour with respect to certain objectively measurable dimensions. It is possible to say that the new generation simulation systems, which integrate advanced analytics, artificial intelligence and big data, allow an innovative approach to the development, implementation and maintenance of a product.

1.3.8 Augmented Reality

According to Agid'[31] statement, Augmented reality refers to the enrichment of human sensory perception through information processed and transmitted to a user's device.
In augmented reality we continue to live physical reality, and other elements that enrich it, which can be images, information or instructions that the user can use them for their own purposes, they can be added with increasing levels of sophistication through a device, unlike virtual reality where the user is totally immersed in a virtual environment. Augmented Reality may seem like the next step to smart mobility and smart working (fig.7). In fact, Augmented Reality (AR) is a form of visual content management 2.0 that allows companies and organizations to add new levels of information, in real time and at a high rate of interaction using mobile devices of any kind, wearable technologies included[32].

Fig.7. Augmented Reality device (Source: Yamagata Europe)

[31] The Agenzia per l'Italia Digitale (Agid) is the technical agency of the Presidency of the Council with the task of ensuring the achievement of the objectives of the Italian Digital Agenda.
Coordinates administrations in the implementation of the Three-Year Plan for Public Administration Information Technology. The basic objective is to contribute to the dissemination of the use of information and communication technologies, thereby fostering innovation and economic growth.
The Agid collaborates with the commissarial structure of the Digital Team to the Presidency of the Council, for the Digital Agenda. (Source: https://www.agendadigitale.eu/tag/agid/)
[32] Source: https://www.digital4.biz/executive/realta-aumentata-cose-come-funziona-e-ambiti-applicativi-in-italia/

The adoption of this technology makes it possible to facilitate, for example, the selection of products and spare parts, or more generally any decision relating to the production process, thus improving working procedures. For example, about logistics, augmented reality tools help to locate products in the warehouse but also to verify in real time the compliance of orders, while for maintenance are adopted for example *Optical viewers* that help operators to identify faulty or defective components having schematics of the plant, operating data.

1.3.9 Robots

Another enabling technology is autonomous robots. Automation and in this case autonomous robots represent crucial elements of industrial change. In the field of factory automation adaptive robots create new efficiencies and change how companies produce goods and organize the shop floor (G. Mies, P. Zentay, 2017)[33].

We are talking about machines, such as robots in box, that can carry out repetitive tasks independently, tasks requiring complex programming for setup and implementation, while lacking the agility to easily adjust operations, but also machines that can work alongside the individual, the so-called collaborative robots, better known as co-robot or cobot. A cobot can be simply defined as "*Collaborative industrial robots are complex machines which work hand in hand with human beings. In a shared work process, they support and relieve the human operator*" (IFA, 2015)[34]. To make clear the concept, IFA do the example of a robot lifts and positions a heavy workpiece whilst a human worker welds light iron hooks to it. As result, the operator and the various elements of the robot come into direct contact with each other[35].

Humans can work directly with collaborative, trained and controlled robots quickly and easily. In other words, we can say that collaborative robots enable new forms of human machine interaction.

[33] G. Mies, P. Zentay, *Industrial robots meet industry 4.0*, December 2017.
[34] Internationale Funkausstellung Berlin is one of the oldest technology fairs in Germany.
[35] Source: https://www.dguv.de/ifa/fachinfos/kollaborierende-roboter/index-2.jsp

"*Autonomous robots can recognize and learn from their surroundings and make decisions independently*" (Deloitte, 2017)[36]. Robots represent the key instrument in production strategies of an automation characterized by flexibility[37].

Overview	
Value drivers	• Increased efficiency • Reduced error and return rates • Improved safety in high-risk environments • Collaboration with humans • Faster delivery or product movement rates • Ability to operate in environments inaccessible to humans
Scope	More efficient operations within all segments of the supply chain
Technology substitutes	• Advanced software • Simple machines or tools • Human workforce

Fig. 8. Autonomous robots key factors (by Deloitte, 2017)

The adoption of these technologies has several benefits According to Deloitte[38], the adoption of robots achieves more consistent levels of quality and productivity, as they are able to perform tasks that humans cannot do. These technologies can perform functions such as testing, collecting, packing, ordering, building, inspect or transport materials more rapidly and efficiently.

Its adoption allows, in the industrial sector, a greater production efficiency through a reduction of errors, times and costs and an improvement in productivity and safety of workers as well as processes.

However, we can find some disadvantages, which are inherent the high cost of implementation, for example the prices are high because it is necessary to develop software that ensure the operation and safety of the robot; while as regards collaborative

[36] Source: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/manufacturing/us-supply-chain-of-the-autonomous-robots.pdf

[37] Executive Summary World Robotics 2017; Industrial Robots, 2017.

[38] Source: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/manufacturing/us-supply-chain-of-the-autonomous-robots.pdf

robots, they cannot apply their full capacity to speed up the process, as being in contact with man, because it is necessary for it to stop to avoid collisions.

The global use of robots is being expanded and it will expand even further, in fact, according to a study by the Boston Consulting Group, global spending on robotics will reach $ 87 billion in 2025[39], to include various functions such as production, logistics, and office management for distributing documents.

Fig.9. Robots at work as a team in the factory (Source: sites.ieee.org)

1.4 CONCLUSIONS

Through this chapter we have tried to give a definition of Industry 4.0, trying to better understand the emergence of this phenomenon in the industrial and manufacturing context, putting into relationships key elements such as production, and how this is developing, costs, comparing economies of scale and scope, enabling technologies and what could be the benefits in terms of increased productivity, customization of products, services, labor management, collaboration between machines and people within the value chain.

[39] E. Gregoire, *Global Spending on Robots Projected to Hit $87 Billion by 2025*, June 21, 2017. Source: BCG, available on: https://globenewswire.com/news-release/2017/06/21/1026967/0/en/Global-Spending-on-Robots-Projected-to-Hit-87-Billion-by-2025.html

The next chapter intends to deepen the theme Industry 4.0 in relation to our country, going to understand how Italy is moving about the theme 4.0 and what is its strategy to make the fourth industrial revolution

CHAPTER 2

ITALY 4.0. THE REVOLUTION ROAD

SUMMARY: 2.1 Introduction – 2.2 Industrial Evolution in Italy – 2.3 National Industry 4.0 Plan "Industria 4.0" – 2.3.1 Hyper and Super Depreciation – 2.3.2 Nuova Sabatini – 2.3.3 Tax credit for Research and Development – 2.3.4 Patent Box – 2.3.5 Innovative Startup and SMEs – 2.3.6 Guarantee Fund for SMEs – 2.3.7ACE – 2.3.8 IRES, IRI and Cash Accounting – 2.3.9 Productivity wages – 2.3.10 Competence Center – 2.4.National Industry 4.0 Plan's impact on Italian SMEs

2.1 INTRODUCTION

As stated in the previous chapter, Industry 4.0 marks the change of the way of operating, behaving and interacting by the main actors of this reality, people, machines and software, within the industrial processes. The crisis of recent years has increasingly highlighted the weakness of economies linked to financial aspects and which are less interested in implementing policies aimed for developing the real economy. From this point of view, therefore, the digitization of the industry can represent an opportunity for many countries to overcome the crisis. To do so, however, they must be prepared and ready to face the continuous market changes. In fact, to date, there are several countries that are, or are being, active on the theme Industry 4.0, presenting action plans that aim to invest in innovation. Among these is Italy, the last country to present an action plan, the National Industry 4.0 Plan in 2016, which we will mention later, preceded by Japan (Vale Chain Initiative, June 2015) and France (Industrie du Futur, May 2015), unlike Germany, which was the first to present an action strategy with the "High-Tech Strategy" in 2006, followed later by the United States with the "Advanced Manufacturing Partnership" in 2011[40]. With the following chapter we will talk about Italy trying to understand what the current situation in our country is, and in what direction it is moving on the theme Industry 4.0, going to analyze the impact that it has on Italian companies.

2.2 INDUSTRIAL EVOLUTION IN ITALY

Italy is one of the largest industrial countries. One of the main engines of our country is precisely the industry, and especially the manufacturing industry. If there's one thing in this country's DNA, it's manufacturing (S. Micelli, 2011). After years of total darkness, characterized by a significant economic crisis that has affected most of the advanced countries, including Italy, which has seen its growth and development prospects decline over time, the weight of manufacturing had almost halved in Italy, both in relation to value added from 29.6% in 1976 to 16.6% in 2010, and in terms of employment: from 28. 1% in 1977 to 17.5%, in recent years there has been a gradual, but still slow, recovery of the country. In fact, according to

[40] L. Franzoni, M. Zanardini, *Industria 4.0 in Italia e nel mondo. I Governi rilanciano il manifatturiero,* Sistemi&Imprese, Giugno 2017.

Istat[41] data, in September 2018 the index increased by 1.3% on an annual basis. The average for the first nine months of the year is estimated to have grown by 1.7% compared with the previous year[42].

Between the first months of 2016 and the last months of 2017, the turnover of the Italian industry increased from 94.9 to 106. 1, considering the value of 2010 equal to 100, almost 12% more in about a year and a half. After a stagnation of three years following the previous big recession. The Italian manufacturing industry can be said to have definitively as the outgoing of the heavy recession of recent years, being in fact the second manufacturing country in Europe, after Germany and before France.

The factors that led Italy to this slight recovery are explained by A. Botticini, A. Pasetto and Z. Rotondi in their research *"The impact on the Italian firms of the fourth industrial revolution and the strategic role of banks"* in 2016. They identify four drivers: the first is represented by the stabilization of production and domestic trade, with Italy in seventh place, according to the latest data from Confindustria[43]. The second driver is the slowdown in international trade, which has stopped growing at a rate higher than the world GDP; the third factor is the variation in the incidence of the industrial sector on the GDP of the more industrialized countries; there is a reduction in the share linked to industry and an increase in the wealth produced by the tertiary sector instead. The last driver is the decrease in the prices of raw materials, such as oil, where supply exceeds demand both because of the entry of new operators and because of the lack of agreements between the countries of Opec[44].

According to a recent analysis by Prometeia, the expansion of manufacturing turnover should be consolidated between 2018 and 2019, with growth rates of about 2% (C. Rossi, 2017)[45].

The fall, first, and then the persistent weakness, of the domestic market, together with the worsening of financing conditions and the high level of uncertainty, have led to a reduced capacity to invest and expand on foreign markets. Although, according to some Istat data, in 2016 Italian companies showed a renewed ability to penetrate some key markets, thanks to a significant containment of prices and costs that has led to a gradual recovery of competitiveness.

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[41] The National Institute of Statistics, an Italian public research entity. Its activities include: population censuses, industry censuses, services and agriculture surveys, family sample surveys, numerous economic surveys.

[42] Istat data, source: https://www.istat.it/it/archivio/223451

[43] Source: https://www.giornaledellepmi.it/confindustria-il-manifatturiero-traina-la-ripresa-litalia-mantiene-il-settimo-posto-tra-i-paesi-piu-industrializzati-il-secondo-in-europa/

[44] A. Botticini, A. Pasetto, Z. Rotondi, *Sviluppo e prospettive dell'industria 4.0 in Italia e ruolo strategico del credito*, 2016, p.53.

Note: OPEC, the Organization of Petroleum Exporting Countries, was founded in 1960; it includes twelve countries that have been associated for negotiations with oil companies.

[45] C. Rossi, *The point on Italian manufacturing and the Revolution 4.0,* Prometeia, November 2017.

In this recovery phase, Italian exports grew faster than the world average and, in 2016, more than Germany and France, especially in volume (Fig. 10).

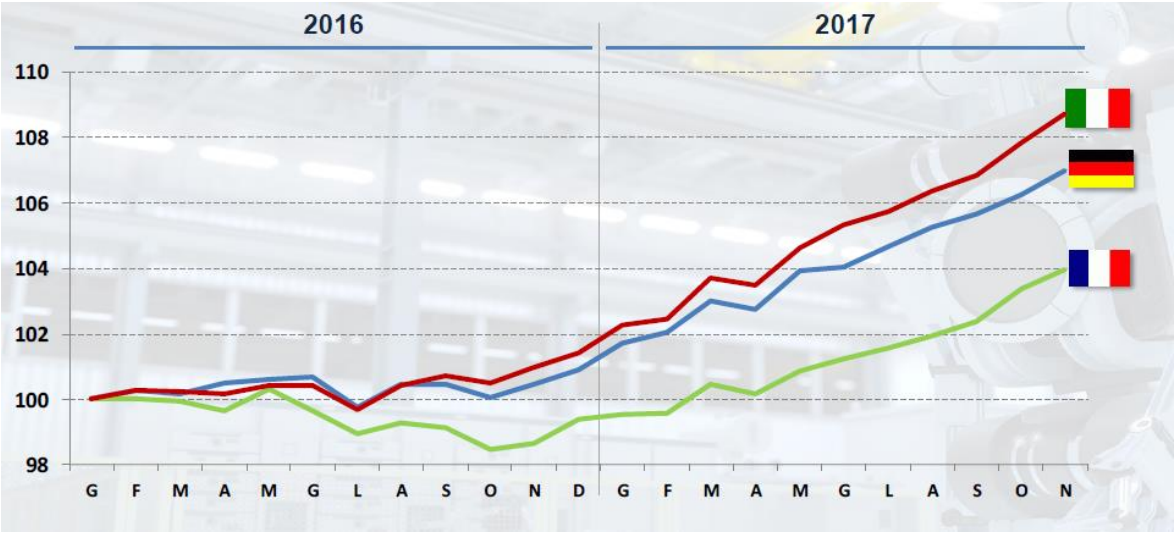


Fig. 10. Exports of goods (Source: MISE analysis based on Eurostata's data, 2017)

From the point of view of internationalization, Italy remains a country that is overall not very internationalized compared to the other major European economies. As a percentage of GDP, foreign direct investment (FDI) in Italy is less than half of the levels in France, Germany, the United Kingdom and Spain. However, as it is possible to see from the following table, which shows the stock of foreign direct investment outflows and inflows of the main countries, the gap has narrowed over time, as a result of active internationalization[46].

PAESI E AREE	All'estero				Nell'economia			
	1990	2000	2010	2015	1990	2000	2010	2015
Uem	11,8	27,3	54,0	62,9	11,3	25,1	41,9	47,1
Italia	5,1	14,9	23,1	25,9	5,1	10,7	15,4	18,6
Germania	17,5	24,8	39,9	55,0	12,8	24,2	28,0	34,0
Francia	9,4	26,7	44,2	54,7	8,2	13,4	23,8	32,2
Spagna	2,9	21,7	45,6	39,8	12,3	26,3	43,9	45,0
Regno Unito	21,0	59,4	65,5	54,1	18,7	29,8	44,0	51,3
Stati Uniti	12,2	26,0	31,9	33,4	9,0	26,9	22,7	31,2
Giappone	6,5	5,9	15,1	30,1	0,3	1,1	3,9	4,2
Cina	1,1	2,3	5,3	9,1	5,2	16,0	9,8	10,9
India	0,0	0,4	5,8	6,3	0,5	3,6	12,3	12,7

Fonte: Unctad

Fig.11. Stock of outbound and inbound FDI for the main countries - Years 1990-2015 [47]

[46] Istat data; *Rapporto sulla competitività dei settori produttivi*, 2017, p.29. Available on: https://www.istat.it/storage/settori-produttivi/2017/Rapporto-competitivita-2017.pdf

[47] Note: stocks are in percentage on the GDP and variations in percentage of the absolute values

The internationalization process is passed by the being a strategic solution in order that new markets enter and to grow in profit terms, to be a survival tool in the market, more and more competitive, in which they make the single enterprises. The internationalization is a multidimensional phenomenon, which takes place through different shapes: commercial exchanges, transfers of activity abroad, acquisitions, fusion and other shapes of complex activities. Such a process represents, nevertheless, a push to the qualitative upgrading of the Italian industry, but exporters are needed important measures of industrial politics looked at an increase of the competitiveness of the Italian entrepreneurial system and the share of enterprises. It is assisted then to a slow and gradual recovery of the Italian industry, even if it turns out to be a growth anchors too weak loans at the enterprises, with an increase of the cost of the work for unity produced, that from 2007 until 2016 has risen significantly in 15,2 %, creating further problems from the point of view of the competitiveness of cost of the Italian enterprises compared to the German ones, French ones and Spanish ones. From the fig. 12, we can notice, in fact, how a very low global manufacturing competitiveness index equal to 46.5 presents our country, compared to countries such as United States (99.5), Germany (93. 9) and the France (55.5), and it will tend to go down on the time in accordance with Deloitte forecasts[48].

Rank	Country	Index score (100=High) (10 = Low)
1	China	100.0
2	United States	99.5
3	Germany	93.9
4	Japan	80.4
5	South Korea	76.7
6	United Kingdom	75.8
7	Taiwan	72.9
8	Mexico	69.5
9	Canada	68.7
10	Singapore	68.4
11	India	67.2
12	Switzerland	63.6
13	Sweden	62.1
14	Thailand	60.4
15	Poland	59.1
16	Turkey	59.0
17	Malaysia	59.0
18	Vietnam	56.5
19	Indonesia	55.8
20	Netherlands	55.7
21	Australia	55.5
22	France	55.5
23	Czech Republic	55.3
24	Finland	52.5
25	Spain	50.6
26	Belgium	48.3
27	South Africa	48.1
28	Italy	46.5
29	Brazil	46.2
30	United Arab Emirates	45.4

Rank	2016 vs. 2020	Country	Index score (100=High) (10=Low)
1	(▲+1)	United States	100.0
2	(▼-1)	China	93.5
3	(⟷)	Germany	90.8
4	(⟷)	Japan	78.0
5	(▲+6)	India	77.5
6	(▼-1)	South Korea	77.0
7	(▲+1)	Mexico	75.9
8	(▼-2)	United Kingdom	73.8
9	(▼-2)	Taiwan	72.1
10	(▼-1)	Canada	68.1
11	(▼-1)	Singapore	67.6
12	(▲+6)	Vietnam	65.5
13	(▲+4)	Malaysia	62.1
14	(⟷)	Thailand	62.0
15	(▲+4)	Indonesia	61.9
16	(▼-1)	Poland	61.9
17	(▼-1)	Turkey	60.8
18	(▼-5)	Sweden	59.7
19	(▼-7)	Switzerland	59.1
20	(▲+3)	Czech Republic	57.4
21	(▼-1)	Netherlands	56.5
22	(▼-1)	Australia	53.4
23	(▲+6)	Brazil	52.9
24	(⟷)	Finland	49.7
25	(▲+2)	South Africa	49.3
26	(▼-4)	France	49.1
27	(▼-2)	Spain	48.4
28	(▲+5)	Romania	45.9
29	(▼-3)	Belgium	45.8
30	(▼-2)	Italy	45.0

Fig.12. 2016 Global Manufacturing Competitiveness Index rankings by country
(Source: Deloitte Touche Tohmatsu Limited and US Council on Competitiveness, 2016 Global Manufacturing Competitiveness Index).

[48] *Global Manufacturing Competitiveness Index*, Deloitte, 2016, p.4.

The central theme in our country is therefore growth, which, as mentioned above, has an important differential with other industrialized economies. The loss of productivity and competitiveness of our public and private system is therefore one of the main reasons, but basically there is the lack of competitive digital transformation. Digital investments in European countries now represent about 6.4% of GDP, while in Italy they reach only 4.7%. The Italian digital gap can therefore be estimated at around 25 billion euros per year of missed investments[49].

In the last 15 years investments in technologies have had a strong impact on productivity, contributing 45% of the average GDP growth in the USA, 30% in Europe and only 20% in Italy. Little investment has therefore been made in digital innovation, in fact Italian digital investments out of the total gross fixed investments have decreased from 15% to 10%, and our economic system has been transformed even less (Confindustria, 2017)[50]. Therefore, it is necessary to adopt specific strategies so that the Italian industry is more efficient and readier to face this new phase of globalization and digitalization, reaching a high level of competitiveness. This means that Italian companies, remain competitive with foreign companies in terms of product quality.

Now the question that arises is "how to improve the efficiency of Italian companies?".

Investment in technological innovation plays a crucial role in improving business capacity. That's why the 2016 National Industry 4.0 Plan comes in, to tackle the transformation induced by the Industry Revolution 4.0.

2.3 NATIONAL INDUSTRY 4.0 PLAN "INDUSTRIA 4.0"

Italy, although considerably behind other countries such as Germany, the United States and partly France, is moving on the subject of Industry 4.0, driven by this profound technological change which, as mentioned in the previous chapter, involves the production processes of manufacturing industries and human relations and machines, resulting from the spread of the Internet and the interconnection between the real and digital dimension.

At institutional level, a first contribution was done by the survey launched in February 2016 by Chamber of Deputies, *Commission for Productive Activities, Trade and Tourism*, with the aim

[49] E. Catania, *La trasformazione competitiva digitale: le leve di politica industriale per la crescita,* Aprile 2016, p. 3.

[50]The *General Confederation of Italian Industry*, also known as Confindustria, is the main representative organization of Italian manufacturing and service companies, grouping together more than 150,000 companies on a voluntary basis, including banks and since 1993 also public companies for a total of 5,439,370 employees.

of defining which model to apply the digitization of national industrial chains[51], and then, in September 2016, prepare a National Industry 4.0 Plan, which in 2018 becomes "Impresa" 4.0, presented by the Italian Government led by the then Prime Minister Matteo Renzi and the Minister for Economy and Development Carlo Calenda; for this reason is also known as "Piano Calenda". The Italian Government wants to create a favorable environment for businesses, for this reason the Industry Plan 4.0 represents a great opportunity for all companies that want to seize the opportunities related to the fourth industrial revolution […] to fully respond to emerging needs (C. Calenda, 2016). It is the Government's new industrial policy strategy for promoting digitisation and competitive reinforcement of the fabric Italian production. It consists of a wide range of policies aimed at creating a premium environment for productive investments. Modernising production processes is, in fact, an essential tool through which small and medium-sized enterprises can gain competitiveness on international markets.
The government's commitment is such that some of the most important points of the "National Industry 4.0 Plan" will be incorporated into the measures of the budget law for 2017. In fact, the Government, through the action and promotional initiatives of the Ministry of Economic Development, supports the National Plan Industry 4.0 by allocating 13 billion euros between now and 2024[52], to support the fourth industrial revolution that will lead Italian companies to digitize production processes.

The National Industry 4.0 Plan defines a real agreement of trust between the Italian Government and the world of businesses that want to grow and innovate, that want to become competitive, offering support in investments, in the digitization of production processes, in the enhancement of workers'; productivity in the development of new products and processes and in the training of appropriate skills. A further objective of this program is to contribute to the construction of a vision of the most authentic scenario of Industry 4.0 and of the dynamics connected to it, those hypothesized in a medium-term perspective. A vision that, while not underestimating the indisputable role of technological innovation, puts the role of the person, of the worker, in the new production processes back at the center of the reflection and with it affirms a renewed awareness of the historical and political function of that branch of the legal system brought

[51] Documento finale, Commissione X della Camera dei Deputati, *Indagine conoscitiva su «Industria 4.0»: quale modello applicare al tessuto industriale italiano. Strumenti per favorire la digitalizzazione delle filiere industriali nazionali*, Roma, 30 giugno 2016.
[52] Source: Il Sole 24 Ore, 2016; available on: https://www.ilsole24ore.com/art/notizie/2016-09-21/industria-40-piano-13-miliardi-221943.shtml?uuid=ADWGEpOB

under the expression of "labor law", not only as a distributive right of protection and resources but also as a right of production[53].

The challenge of the Government is addressed to Italian entrepreneurs who, however supported by the allocation of important resources in the coming years, will have to engage themselves in a path of growth and innovation, adopting the most appropriate tools addressed to them[54]. In this context, innovative start-ups and SMEs are increasingly proving to be a strategic lever for the economic development of the country and today represent an integral axis of the Business Plan 4.0 (C. Calenda, 2017). The Plan provides for several integrated and complementary measures to facilitate investment in innovation and competitiveness, measures that any company can implement automatically without having to resort to long and complicated calls for tenders or counters and, above all, without any limit inherent to the size, the production sector or the geographical area to which it belongs. The measures under the 4.0 program are distinguished based on three aspects: innovation; competitiveness; competences.

In terms of innovation there are Hyper and Super Depreciation; Nuova Sabatini; R&D tax credit, Patent Box; Innovative Startup and SMEs.

About competitiveness are established measures regarding the Guarantee Fund for SMEs; ACE (Allowance for Corporate Equity), IRES (Corporate Income Tax), IRI (Enterprise Income Tax) and Cash Accounting; Productivity wages. After made the industry 4.0, it's time to do the workers. Therefore, in addition the government will also fund training and research programs introducing the so-called Competence center.

2.3.1 Hyper and Super Depreciation

Hyper and Super Depreciation are measures of the National Industry 4.0 Plan with the aim of encouraging Italian companies to invest to grow. They are used to encourage and support companies that invest in new capital goods, both tangible and intangible (i.e. IT systems, system integration), which are functional to the transformation of production processes. It is open to all persons with business income, sole proprietorships subject to IRI with their tax headquarters in Italy, permanent establishments of companies' resident abroad, regardless of their legal form, size or economic sector in which they operate.

Hyper depreciation provides for an overestimation of 250% of investments in new tangible assets, devices and technologies enabling transformation into 4.0 key purchased or leased. Allows to increase by 150% the deductible cost of all capital goods purchased to turn the

[53] M. Tiraboschi, F. Seghezzi, *Il Piano nazionale Industria 4.0: una lettura lavoristica,* 2016, p.10.
[54] Source: https://www.sviluppoeconomico.gov.it/index.php/it/industria40

company into a technological and digital 4.0 key. This is specifically about investments in intelligent and interconnected machines.

The hyper increase is due only to the extent that the asset complies with the guidelines drawn up by the Ministry of Economic Development (MISE). In case of uncertainties about the admissibility of the benefit of a specific machine you can request a technical opinion from MISE, in case these uncertainties are, however, of a tax nature, you can submit ordinary question to the Revenue Agency[55].

Super Depreciation, on the other hand, consists of an overestimation of 140% of investments in new capital goods purchased or leased. In other words, this measure provides for a 40% increase in the tax cost of tangible assets originally purchased from 15 October 2015 to 31 December 2016, which is now extended. The higher cost, recognized only for income taxes and not for IRAP purposes, can in fact be deducted extra-accounting from income by making decreasing changes in the tax return.[56].

These measures are automatically accessed during the preparation of the financial statements and through self-certification. The right accrues when the order and payment of at least 20% advances shall be made by the beneficiary by 31 December 2017 and the goods shall be delivered by 30 June 2018.

For investments in Hyper depreciation higher than 500,000 euros for each asset, a technical report by an expert or engineer registered in the respective professional registers is required, certifying that the asset possesses the necessary characteristics provided for by the Ministry of Economic Development.

To make the concept clearer, let's take into consideration the example given by the Ministry of Economic Development[57]. Let's take the case of an investment of 1 million euros made by an IRES subject for the purchase of an asset that benefits from the super or hyper depreciation, as it has all the necessary characteristics, compared to the hypothesis of ordinary depreciation.

[55] Source: https://www.sviluppoeconomico.gov.it/index.php/it/198-notizie/2036312-super-e-iper-ammortamento-per-favorire-lo-sviluppo-dell-industria-4-0

[56] Ibidem, Source: https://www.sviluppoeconomico.gov.it/index.php/it/198-notizie/2036312-super-e-iper-ammortamento-per-favorire-lo-sviluppo-dell-industria-4-0

[57] Source: https://www.sviluppoeconomico.gov.it/index.php/it/198-notizie/2036312-super-e-iper-ammortamento-per-favorire-lo-sviluppo-dell-industria-4-0

	Ammortamento ordinario	Super ammortamento (maggiorazione 40%)	Iper ammortamento (maggiorazione 150%)
Importo deducibile ai fini IRES	1.000.000	1.400.000	2.500.000
Risparmio d'imposta (24% dell'importo deducibile ai fini IRES)	240.000	336.000	600.000
Costo netto dell'investimento (1.000.000 - risparmio d'imposta)	760.000	664.000	400.000
Maggior risparmio sul costo netto dell'investimento		9,60% (760.000 - 664.000)/1.000.000	36,00% (760.000 - 400.000)/1.000.000

Fig.13. Super and Hyper depreciation compared based on tax savings (Source: Ministry of Economic Development, 2017)

As can be seen from the table (Fig. 13), the amount deductible for IRES purposes is 1,000,000 euros in the case of ordinary depreciation, but with the benefits provided by the National Industry 4.0 Plan, you would have an increase of 40% in the case of Super depreciation or 150% in the case of Hyper depreciation, thus achieving greater savings on the net cost of investment. If with the ordinary amortization it would be possible to obtain a saving of 240 thousand Euros, with the super amortization it would be of 336.000 euros and 600.000 euros thanks to the hyper amortization.

2.3.2 Nuova Sabatini

Nuova Sabatini consists of an innovation credit measure. It provides an interest rate subsidy to support companies seeking bank financing for investments in capital goods, machinery, plant, factory equipment for productive use and digital technologies. One of the advantages of the Nuova Sabatini measure is a contribution that partially covers the interest paid by the company on bank loans between 20,000 and 2,000,000 euros, granted by banks affiliated with the MISE. This contribution is calculated based on a conventional five-year amortization plan with an interest rate of 2.75% per annum and is increased by 30% for investments in Industry 4.0 technologies. A further advantage is maximum of 80% priority access to the Central Guarantee Fund.

The beneficiaries of this measure are SMEs that are present on the national territory, regardless of the economic sector in which they operate and, in particular, that upon application, are regularly constituted and registered in the Register of Enterprises or in the Register of Fishing Enterprises; they are in the free exercise of their rights; they do not appear to be in voluntary liquidation or subject to bankruptcy procedures; aid considered illegal or incompatible by the European Commission is not included among those who have received and subsequently not reimbursed or deposited in a blocked account; they are not in a state of difficulty; they are based in a Member State provided that they open an operating office in Italy within the deadline set for the completion of the investment[58]. All sectors of production are eligible, except for financial and insurance activities; export-related activities and for interventions subject to the use of domestic over imported products.

Before any contribution can be made, the parties concerned must initiate a specific procedure. They must first submit the application for credit to a financial intermediary by 31 December 2018, and the application for access to the contribution according to the requests of the Ministry. Subsequently, the financial intermediary, after verifying that there is no breach in the request, transmits to the Ministry the request for reservation of resources, which, within 5 working days will notify the financial intermediary of the availability, partial or total state resources. The grant is payable on completion of the investment self-certified by the company and is made in annual instalments according to the disbursement plan set out in the concession provision[59].

2.3.3 Tax credit for research and development

The tax credit for research and development aims to stimulate private spending on R&D to ensure the future competitiveness of enterprises. A 50% tax credit is granted on incremental R&D expenses incurred in the period 2017-2020, up to an annual maximum of 20 million per beneficiary and calculated on a fixed basis based on the average R&D expenses in the years 2012/2014. The tax credit can be used, even in the event of losses, to cover a wide range of taxes and contributions. All expenses related to fundamental research, industrial research and experimental development, costs for highly qualified and technical personnel, research contracts with universities, research institutions, companies, start-ups and innovative SMEs, depreciation rates for laboratory instruments and equipment, technical skills and industrial

[58] Source: https://www.sviluppoeconomico.gov.it/index.php/it/incentivi/impresa/beni-strumentali-nuova-sabatini
[59] Italian Ministry of Economic Development, *Guida alla trasmissione delle richieste di erogazione delle quote di contributo*, 2018. Available on: https://www.sviluppoeconomico.gov.it/images/stories/documenti/Beni_Strumentali_Guida_trasmissione_richieste_erogazione_NS_07082018.pdf

property rights are eligible. The beneficiaries are all those who hold business income regardless of the legal nature, size and economic sector in which they operate; Italian companies or companies residing abroad, with a permanent establishment in Italy, which carry out research and development activities, either on their own or on commission. This facility is accessed automatically when drawing up the budget, indicating the expenses incurred in the tax return, with the requirement of certified accounting documentation[60].

2.3.4 Patent Box

Patent Box is used to give value to intangible assets, patents, registered trademarks, industrial designs and models, know-how, software protected by copyright, to make the Italian market more attractive for domestic and foreign long-term investments, encouraging the placement in Italy of intangible assets held abroad. The facility consists in reducing the IRES and IRAP rates on income from intangible assets by up to 50% from 2017. The benefit is given on condition that the taxpayer conducts R&D activities related to the development and maintenance of intangible assets. The beneficiaries are the holders of business income derived from the use of copyrighted software, industrial patents, supplementary protection certificates, designs and models and processes, formulas and information relating to experience acquired in the industrial, commercial or scientific field, as well as from the use of two or more intangible assets, complementary to each other for the realization of a product or a process. The option must be exercised in the tax return for the first tax period for which it is intended to opt for the same, is valid for five tax periods, starting from that in which it is communicated to the Revenue Agency, can be renewed and is irrevocable[61].

If the intangible asset is used directly by the subject it is necessary, that this activates a ruling agreement. It consists of a prior agreement with the Revenue Agency in order to define the rules for determining the eligible income. On the other hand, if the asset is used indirectly, the ruling agreement is optional, and the effectiveness starts from the exercise of the option (Decree of 28 November 2017, Art. 12)[62].

[60] Source: https://www.sviluppoeconomico.gov.it/index.php/it/incentivi/impresa/credito-d-imposta-r-s
[61] Source: https://www.sviluppoeconomico.gov.it/index.php/it/incentivi/impresa/patent-box
[62] Ministry of Economic Development, Decree of 28 November 2017, Art. 12

2.3.5 Innovative Startup and SMEs

This measure has the function of accelerating innovation, supporting innovative enterprises in all phases of their life cycle, promoting both the development of the national ecosystem of innovative entrepreneurship and that of a new entrepreneurial culture based on collaboration, innovation and internationalization.
This measure concerns *innovative start-ups*, newly established unlisted companies with an annual production value of less than EUR 5 million whose corporate purpose is linked to innovation and which meet at least one of the following requirements:

- annual R&D costs are at least 15%of turnover;
- 2/3 graduates, or 1/3 doctors, PhD students or researchers;
- holders of patents or software;

and *innovative SMEs* in the form of corporations, which are provided with certified accounts and which present:

- annual R&D costs are 3% of turnover;
- 1/3 graduates, or 1/5 doctors, PhD students or researchers;
- ownership of a patent or software.

As reported in the executive summary of Italy's Startup Act[63], innovative start-up benefits apply for 5 years from their establishment, and are represented by:

1. Incorporation and following statutory modifications by mean of a standard model with digital signature;
2. Cuts to red tape and fees: innovative start-ups and certified incubators are not subject to the annual fee due to the Chambers of Commerce for secretarial fees and stamp duty usually due for the obligations to be carried out at the Register of Companies;
3. Flexible corporate management: the possibility also for the S.r.l. to issue equity incentive plans, tax-advantaged;

[63] Italian Ministry of Economic Development, *The Italian legislation in support of innovative startups: executive summary*, 2017, pp. 14-21.

4. Extension of terms for covering losses: in the case of a capital reduction of more than one third, the period within which the loss must be reduced to less than one third shall be postponed to the second following financial year;
5. Exemption from regulations on dummy companies: innovative startups are not subjected to regulations concerning non-operational companies and companies registering systematic losses;
6. Exemption from the duty to affix the compliance visa for compensation of VAT credit up to EUR 50,000 (art. 4, comma 11-novies of the Investment Compact)[64];
7. Tailor-made labour law: innovative start-ups are subject, except for some specific variants, to the discipline of fixed-term contracts provided for by Decree-Law 81/2015 (the so-called Jobs Act);
8. Flexible remuneration system;
9. Remuneration through stock options and work for equity schemes: the income deriving from these instruments does not contribute to the formation of taxable income;
10. Tax incentives for corporate and private equity in start-ups: deduction of IRPEF (for investments up to €1 million) or deduction of IRES taxable income (up to €1. 8 million) equal to 30%;
11. Equity crowdfunding for the raising of new venture capital;
12. Fast-track, simplified and free of charge access for innovative start-ups and certified incubators to the SMEs Guarantee Fund, which covers up to 80% of the credit granted by the bank to innovative start-ups and certified incubators, up to a maximum of €2.5 million;
13. Fail-fast: in the event of failure, innovative start-ups can count on faster and less cumbersome procedures than ordinary start-ups to complete their activities;
14. Italian Trade Agency (ITA): ad hoc services to support innovative startups in international markets. The Agency aids in legal, corporate and fiscal activities;
15. If successful start-ups, they can easily convert into innovative SMEs.

When start-ups become innovative SMEs, they continue to enjoy the main benefits. In fact, as for innovative start-ups, also innovative SMEs have the main advantages such as: Flexible corporate management; extension of terms for covering losses; exemption form regulations on dummy companies; remuneration through equity participation instruments; tax incentives for

[64] art. 4, comma 11-novies of the Investment Compact

investments in risk capital innovative SMEs, possibility to raise capital through equity crowdfunding campaigns; simplified intervention, free of charge and directed to the Guarantee Fund for SMEs[65]. It is important to underline how innovative start-ups and SMEs, in order to benefit from these benefits, must submit a registration by means of online self-certification of possession of the requirements of start-ups or innovative SMEs, to the respective special sections of the Commercial Register.

2.3.6 Guarantee Fund for SMEs

The Guarantee Fund for SMEs is one of the measures based on the competitiveness aspect, which aims to expand the credit possibilities of a company and professionals who have difficulties in accessing bank credit because they do not have enough guarantees. This measure is therefore aimed at SMEs, including start-ups, and professionals who are registered with professional associations or who are members of professional associations registered with the Ministry of Economic Development. Beneficiaries operating in all sectors apart from the financial sector and considered to be economically and financially sound are eligible. The Guarantee Fund essentially consists of a public guarantee, up to a maximum of 80% of the loan, for both short and medium/long-term operations. The Fund guarantees each company or professional a maximum of 2. 5 million euros, a ceiling that can be used through one or more transactions, until the ceiling is reached. There is a limit which is inherent to the guaranteed amount and not to the financing.
Depending on the nature of the entity that turns to the Central Guarantee Fund, there are different methods of intervention:

- *Direct guarantee:* a guarantee provided by the Fund directly to the lenders. In this case, the company in need of financing can ask the bank to guarantee the operation with the public guarantee.

- *Counter-guarantee:* guarantee given by the Fund in favour of the Credit consortia and other Guarantee Funds. In this case, the company contacts a Credit consortia or other guarantee fund that will send the counter-guarantee application to the Fund.

[65] Italian Ministry of Economic Development, *the Italian legislation in support of innovative SMEs: executive summary*, 2017, pp. 12-16.

- *Co-guarantee:* a guarantee provided by the Fund directly in favour of the financing entities and jointly with the Credit consortia, other Guarantee Funds or Guarantee Funds established within the European Union or co-financed by it.

Interested parties in the Direct Guarantee, in order to access this facility, must submit a request for financing to a bank or financial intermediary and request that it be backed by the public guarantee. The financial intermediary transmits the request to the entity managing the intervention, Banca del Mezzogiorno - Mediocredito Centrale SPA[66].
The activation of this guarantee is at zero risk for the bank or financial intermediary which, in the event of insolvency of the company, is compensated by the Fund and, in the event of any exhaustion of funds of the latter, directly by the State[67]. The procedure is fast and streamlined.

2.3.7 ACE

ACE or Allowance for Corporate Equity is a measure aimed at strengthening the capital in the company, encouraging the strengthening of the capital of Italian companies, through financing with equity capital, in order to obtain more appropriate financial structures between sources and uses and between risk capital and debt, and therefore more competitive. The persons concerned are business income holders, including sole proprietorships subject to IRI, with their tax offices in Italy, including permanent establishments of businesses resident abroad, irrespective of their legal form, size or economic sector in which they operate: limited liability companies, partnerships and sole proprietorships in ordinary accounts[68]. These entities will automatically benefit, when drawing up their financial statements, from a deduction from total business income of an amount equal to 2.3% in 2017 and 2.7% from 2018 onwards, of the new equity capital, calculated on the capital increases compared to that existing at the end of the current financial year as at 31 December 2010, thus creating tax neutrality between recourse to risk capital or debt financing.

[66] Mediocredito Centrale S. p. A., is a bank with sole shareholder Invitalia S. p. A. The Bank operates in the exercise of credit and in the management of public subsidies and services in line with its statutory mission
[67] See *Disposizioni operative del Fondo di Garanzia*. Available on: http://www.fondidigaranzia.it/wp-content/uploads/2018/10/D.O.-inefficacia-resto-al-sud.pdf
[68]Source: IlSole24Ore, available on: https://www.ilsole24ore.com/pdf2010/SoleOnLine5/_Oggetti_Correlati/Documenti/Norme%20e%20Tributi/2012/03/guida-ace/Articolo-Guida-Pratica-Aziende.pdf

2.3.8 IRES, IRI and Cash Accounting

Another measure taken by the Italian Government in order to increase the competitiveness of companies is to reduce the tax burden for companies that invest in the future growth of the same company, leaving them profits in the company. Specifically, this measure consists in reducing the Corporate Income Tax (IRES) from 27. 5% to 24%, and the Enterprise Income Tax (IRI) to a rate of 24%, in order to encourage the capitalization of companies, taxing more lightly the profits not withdrawn, equating it to the taxation of corporations (IRES to 24%). The 24% rate applies to the part of the business income that remains in the company while the amounts withdrawn for personal use continue to pay IRPEF, which provides rates up to 43%. The option is valid for 5 years and is renewable and takes place automatically when the budget is drawn up.[69]. This measure, in addition to encourage SMEs for increasing their assets, also aims to make taxation neutral in the choice of the form of business, if individual, partnerships, corporations, and has the advantage of distinguishing the company from the natural persons of the entrepreneur and partner.

The subjects concerned are subjects in simplified accounting; companies subject to IRES, companies with share capital, non-commercial entities, cooperatives; subject to IRI, individual entrepreneurs and partnerships in ordinary accounting. However, cooperatives and S.r.l. can also use it, with revenues not exceeding 5 million euros and with a narrow corporate base.

2.3.9 Productivity wages

Productivity wages, also known as productivity bonuses, are additional compensation to the employee's basic salary. These bonuses are therefore added to the employee's salary if a particular productivity result of the company is achieved. Productivity wages provide for a reduced taxation with a substitute rate of 10%, can calculate on a maximum amount of 4,000 euros. You can replace the award with socially useful goods and services, such as corporate welfare services vouchers, family scholarships, meal vouchers, complementary social security, health care, educational services or employee equity participation[70]. Their aim is to foster productivity growth by shifting bargaining to the enterprise level, introducing positive exchanges between productivity and efficiency gains and wage increases for workers. hey also represent measures aimed at promoting the subsidiary integration of corporate welfare with forms of public welfare and favouring organizational forms focused on the involvement of

[69] Source: http://www.governo.it/sites/governo.it/files/IRI_contabilita_cassa_industria4.pdf
[70] A. Losito, *Detassazione premi produttività 2019: cos'è, come funziona e importi*, October 2018.

employees in corporate processes. The measure is aimed at employees in the private sector, who have an income from employment not exceeding 80,000 euros, and companies with increases in productivity, profitability, efficiency, quality and production.

In order to benefit from these advantages, it is necessary to include the measures in an agreement, through a contract with the representations present in the company or with the local trade unions. The negotiation of the bonus and the welfare plan at the company level obviously make the interventions more in line with the reality of the company and the needs of the workers. If companies are not unionized, it is possible to opt for territorial agreements. These also allow SMEs to adhere to schemes and models of agreement for the performance bonus, and thus activate the welfare option for its disbursement on the basis of the choices expressed by workers. In the latter case, the parties involved must then ensure that the payment of the welfare bonus can be a lever of productivity connected with organizational change and make the measures of the plan stable over time[71].

2.3.10 Competence center

The Competence Center come into force only two years after they were conceived, studied and launched through "Piano Calenda" in 2016. According to what is mentioned in the Decree implementing 214/2017, in force since 24 January 2018, Competece center is "*a pole of innovation constituted, according to the model of public-private partnership, as defined in letter b), by at least one research organization and one or more enterprises. The number of public partners may not exceed 50% of the total number of partners*". In other words, they are highly specialized centers of competence that will operate mainly in three areas: orientation, training and applied research.

- *Orientation* for SMEs, through the preparation of a series of tools aimed at supporting companies in assessing their level of digital and technological maturity;

- *Training*, with the aim of promoting and disseminating skills in Industry 4.0 through classroom training activities, on the production line, and on real applications, using for example use cases.

[71] Source: http://www.equipeonline.it/usare-il-salario-di-produttivita

- *Applied research*, implementation of innovation projects, industrial research and experimental development, proposed by companies, and provision of technology transfer services in Industry 4.0.

The competence centers include public and private entities that have applied for the selection notice by 30 April 2018 and that meet the requirements listed in Article 4 of Ministerial Decree 214/2017[72]:

- *Universities*, 70% of staff and facilities must belong to the departments selected on the basis of the standardized departmental performance indicator (ISPD) and admitted to the submission of departmental development projects; they must also have participated in and obtained a positive vote in the last research quality assessment (VQR) exercise of the National Evaluation Agency (ANVUR);

- *research organizations* must have the same requirement for assessing the quality of university research;

- *research organizations* must have a permanent establishment in Italy, be listed in the National Research Register, have separate accounts for financing, costs and revenues of economic activities linked to the competence center and, if private organizations, must ensure that companies able to exert a decisive influence on the organization for example as shareholders or members, cannot enjoy any preferential access to the results generated. They must then have the same subject requirements as companies;

- *companies* must be registered in the Companies Register, they must be in the full exercise of their rights, they must be healthy and not in difficulty, they must not have received and reimbursed aid deemed incompatible by the European Commission, they must be in order with any repayment of sums due in relation to measures to revoke concessions granted by the Ministry of Economic Development.

[72] See Decree 12 September 2017, n. 214, art. 4

The call for proposals evaluates the competence centres on the basis of their technical characteristics, economic and financial soundness and the quality of the programme of activities (Decree 214/2017, art. 7). The "Manufacturing 4", a center coordinated by the Polytechnic of Turin, whose focus is on aerospace, automotive and additive-manufacturing; "Made in Italy 4", led by the Polytechnic of Milan, which focuses on technologies for the 4.0 factory; "BI-Rex", led by the University of Bologna but also supported by the universities of Modena, Reggio Emilia, Parma and Ferrara; "Artes 4", a center led by the Scuola Superiore Sant'Anna of Pisa which brings together the Scuola Normale Superiore, the University of Pisa, the University of Florence, the University of Siena, and other universities; "Smact", headed by the University of Padua but supported by a network of universities in the area (Verona, Venice, Iuav, Trento, Bolzano, Udine, Trieste and others) with a focus on food, clothing, furniture and automation; "Industry 4.0" a center led by the University Federico II of Naples, and which is supported by eight universities in Campania and Puglia, and by the Regions of Campania and Puglia. "Start 4.0" led by the National Research Council, along with ABB. Leonardo, Ansaldo and others; and "Cyber 4.0", led by the University La Sapienza of Rome, which focuses on cyber security[73].

2.4 NATIONAL INDUSTRY 4.0 PLAN'S IMPACT ON ITALIAN SMEs

We are in the presence of a new industrial reality, characterized by a new way of producing more and more customer-oriented and flexible, which can bring great benefits to an industrial fabric like the Italian one that for design, creativity and reliability has no equal in the world. For this reason, our country has begun to take its first steps towards technological innovation, trying to trigger the fourth industrial revolution through the National Industry 4.0 Plan, preparing strategic measures favorable to Italian companies, which if properly exploited, can really represent the key to strengthening our competitive model.

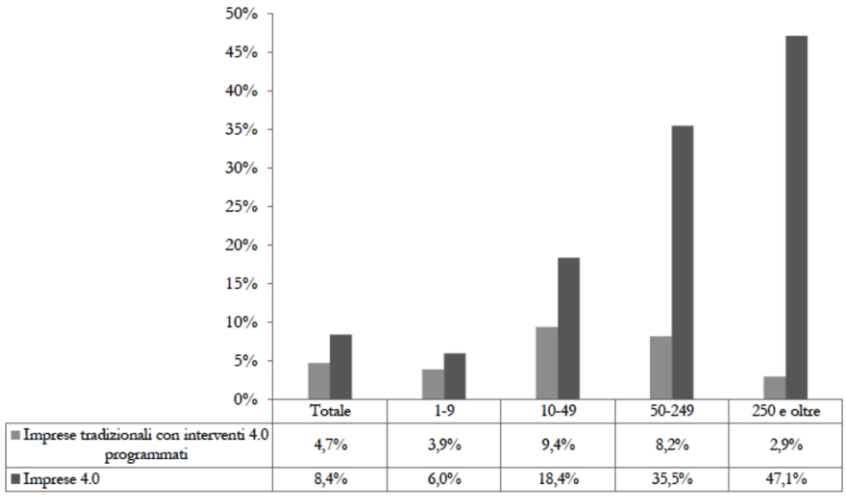
The Industry 4.0 pillar exists, even if we have chosen an "Italian way to Industry 4.0", different from that of other countries.[74] A model based on a strategy 4.0 different from that of the United States, Germany and France, in that it focuses on flexible production, niche and for small batches, customer-oriented, which is associated with the quality and entrepreneurship that still

[73] F. Meta, *Industria 4.0, scatta l'ora dei competence center: in testa i Politecnici di Torino e Milano*, 2018. Available on: https://www.corrierecomunicazioni.it/industria-4-0/industria-4-0-scatta-lora-dei-competence-center-in-testa-i-politecnici-di-torino-e-milano/

[74] R. Masiero, Ngn, Italia Login e Industria 4.0: i ponti verso l'Italia digitale, in Agenda Digitale, 2016. Available on: https://www.corrierecomunicazioni.it/pa-digitale/ngn-italia-login-e-industria-40-i-ponti-verso-l-italia-digitale/

recognizes us worldwide. Manufacturing companies can therefore have the possibility to adopt new flexible production systems, able to quickly reconfigure products and adapt manufacturing operations to ensure quality, timing and customization to the needs of the product to be made. The increasing use of cyber-physical systems will lead to ever higher levels of industrial automation and customer service. What is important to ask now is what is the impact that the Piano Calenda is having on Italian companies and how are they responding? What is the level of adoption of industry technologies 4.0 in Italian SMEs?

According to the first report of the Ministry of Economic Development, in response to the effectiveness of the measures of the National Industry 4.0 Plan, the adoption of technologies labeled as Industry 4.0 is far from being able to start the productive transformations of the fourth industrial revolution. About 13% of Italian companies are moving slowly towards 4.0, while the majority of national companies, about 87% of the total, have not implemented any transformation into a 4.0 key (Fig. 14)[75].



	Totale	1-9	10-49	50-249	250 e oltre
Imprese tradizionali con interventi 4.0 programmati	4,7%	3,9%	9,4%	8,2%	2,9%
Imprese 4.0	8,4%	6,0%	18,4%	35,5%	47,1%

Fig. 14. Spread of technologies 4.0, detail by size class. Percentage values (Source: MISE, 2017)

What comes as a general picture is that our companies have begun to move slowly towards their own transformation into a 4.0 key. The problem varies with the size of the company, affecting nine out of ten companies that employ up to 10 people, but only 50% of those that employ more than 250, and with the geographical position; in fact, the spread of technologies 4.0 is greater in the Centre-North (9.2%) than in the South (6.1%)[76]. Moreover, the involvement in technologies 4.0 is characterized by a rather marked distinction depending on whether

[75] Ministry of Economic Development, La diffusione delle imprese 4.0 e le politiche, First Report, 2017, p.3.
[76] Ministry of Economic Development, La diffusione delle imprese 4.0 e le politiche, First Report, 2017, p.4.

production-related technologies (interconnected robots, additive manufacturing, simulations, augmented reality and intelligent materials) or technologies representing the intensive exploitation of information and data (horizontal or vertical integration of information, cloud, big data, analytics, etc.) are considered. This is what can be deduced from the survey launched in 2016 by the Laboratory of Digital Manufacturing (LMD) at the Department of Economic Sciences of the University of Padua. Interviewing a sample of 1.020 companies, starting from a universe of 7.293, specialized in the sectors of made in Italy, furniture, textiles, clothing, goldsmiths, eyewear, sports goods, automobiles, electrical and lighting equipment, rubber-plastic, and located in the regions of Northern Italy (Veneto, Friuli Venezia Giulia, Trentino Alto Adige, Emilia Romagna, Piedmont and Lombardy) with a turnover of at least 1 million Euros (or less in sectors with a high district presence), a strong sectoral variety emerges, as a sign of the selection of technologies more in line with the specific product and process of the adopting companies with respect to the sector to which they belong. (Fig.15).

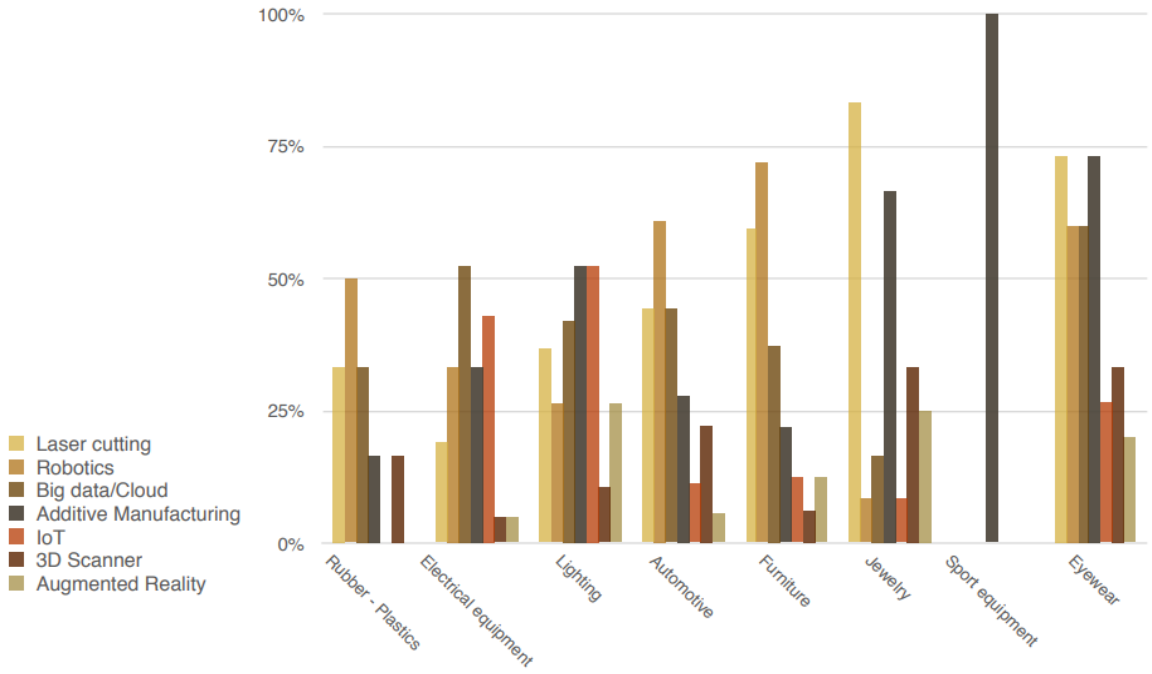


Fig.15. Endowment 4.0 for industrial sector (Source: Second Report LMD, 2017)

Digital transformation has a positive impact on company performance and it is not necessary to invest in many technologies, but rather to select one or two that are consistent with one's own industrial product or process environment (E. Di Maria, 2018). These statements are based on the answers of the companies interviewed through the survey of the Laboratory of Digital

Manufacturing. In fact, about 38% of companies have implemented only one technology, 36.2% two technologies, the rest have instead adopted three or more technologies (Fig. 16).

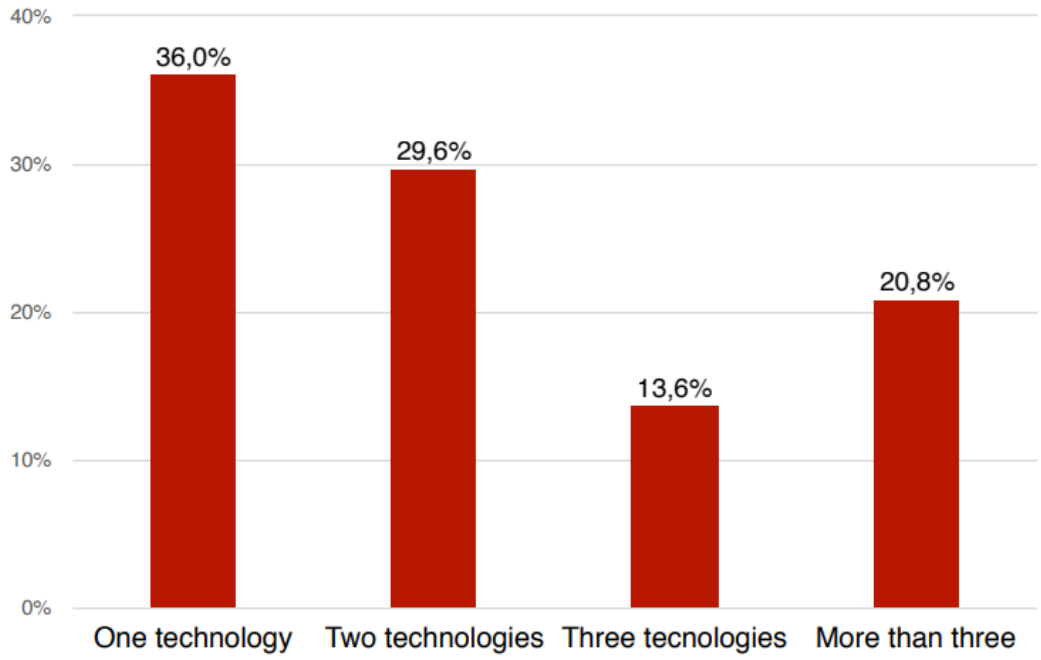
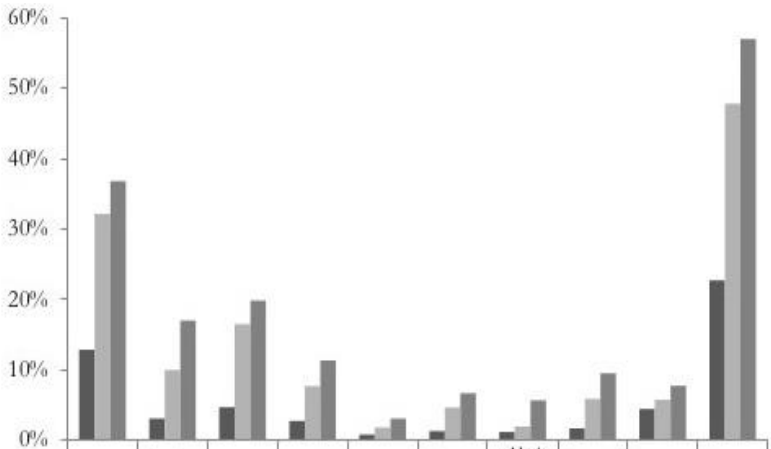


Fig.16. Number of technologies adopted (Source: Second Report LMD, 2017)

The tax incentives provided for in the National Plan are a good way for Italian companies to innovate. Figure 13 shows that about 57% of companies adopting technologies 4.0 claim to have used at least one public support measure. Companies have mostly used Super or Hyper depreciation (36.8% in the case of companies 4.0 and 12.8% among traditional companies), the tax credit for R&D expenses (17.0% vs 3.1%), the Nuova Sabatini (19.8% vs 4.7%) and guarantee funds (11.3% vs 2.8%)[77].

[77] Ministry of Economic Development, *La diffusione delle imprese 4.0 e le politiche*, First Report, 2017, p.20



	Iper e Super-ammortamento	Credito d'imposta R&S, Patent box	Nuova Sabatini	Fondi di garanzia	Start-up e PMI innovative	Export e internazionalizzazione	Altri incentivi nazionali per R&S&I	Incentivi regionali per R&S&I	Altri incentivi	Almeno un incentivo
Imprese tradizionali	12,8%	3,1%	4,7%	2,8%	0,8%	1,3%	1,2%	1,7%	4,4%	22,7%
Imprese tradizionali con interventi 4.0 programmati	32,1%	10,0%	16,5%	7,7%	1,8%	4,7%	1,9%	5,9%	5,7%	47,8%
Imprese 4.0	36,8%	17,0%	19,8%	11,3%	3,1%	6,7%	5,7%	9,5%	7,7%	56,9%

Fig.17. Use of public incentives between companies using 4.0 and not using technologies 4.0 (MISE, 2017)

Moreover, according to the MISE, in the next three years, more than 30% of companies that intend to make an investment in 4.0 key will use facilities such as Hyper or Super-depreciation. However, these benefits are not the main reason for investment; in fact, as emerged from the research of the Digital Manufacturing Laboratory, investments by SMEs reflect an innovative orientation of companies, which have invested on average in years prior to the 4.0 Industrial Plan, from 2008 to 2014, so before Piano Calenda came alive (Fig. 18).

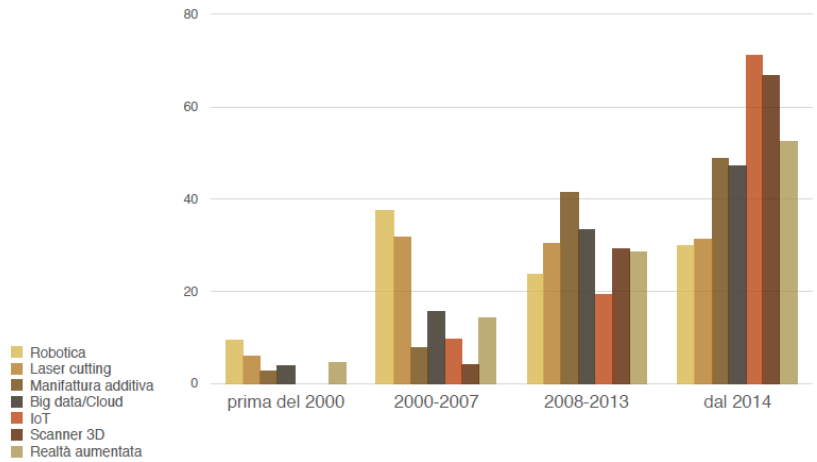


Fig.18. Industry 4.0 per year of adoption (Source: Second Report LMD, 2017)

The results achieved by the LMD show how the motivations that lead companies to adopt technologies 4.0 are mainly related to the market and to the improvement of customer service, and how these investments lead to an increase in efficiency and productivity. Adopting companies, in fact, have achieved performance benefits, in terms of EBIDTA/sales or turnover growth, higher than non-adopting companies.

What are the reasons for not adopting them instead?

The overwhelming majority of respondents confirm that the reasons are mainly strategic-cultural rather than economic-financial. In fact, about 66% of companies say that industry technologies 4.0 are not relevant to their business[78]. Nothing could be more wrong; the real potential that these technologies can offer to rethink one's relationship with the market and strengthen one's competitiveness, even at an international level, is not being grasped (M. Bettiol, 2017). In summary, there are two distinct groups of companies that show a very different approach to technology, in which the former is proactive and have anticipated the potential of the fourth industrial revolution. It emerges that there has been a slight recovery of our country and Italian industry, even if the road is still long. There are slight positive signs, which should be a further stimulus for those who have not yet embarked on the path of digital transformation but trying to increase their awareness. As Professor Sesto Viticoli[79] explains, the “Piano Calenda” has yet to be developed in its second phase and, in any case, there seems to be a lack of a more comprehensive vision that must start with the choice of which position to occupy on the international stage. This means setting objectives and establishing a strategy for achieving them. In addition, according to Andrea Rangone, head of the Digital Observatory innovation of the Polytechnic of Milan, today in Italy there are just a little less than 160 incubators and accelerators. Many in number, but few can pass on to new businesses a wealth of skills and relationships. We will see if the efforts made and the strategic plans implemented up to now can be carried out in the direction of a transformation of the manufacture into a digital key, and if they can continue to have a significant impact on Italian SMEs, aimed at full adoption, enhancing and updating the system of skills and "Italian know-how". If such signs were found, it is also thanks to a part of the country that, although it has remained out of the

[78] Università degli Studi di Padova, *Secondo rapporto Industria 4.0 nelle PMI italiane*, Laboratorio Manifattura Digitale, 2017.
[79] S. Viticoli, *Verso un manifatturiero italiano 4.0: Ricerca, tecnologia e non solo*, ed. GoWare & Edizioni Guerini e Associati, 2016.

spotlight, is one of the protagonists of the Italian recovery. We are talking about the italian new enterprises, as Filiberto Zovico[80] defines them, that will be discussed in the next chapter.

[80] Filiberto Zovico, Founder of ItalyPost, the portal for in-depth analysis of the world of businesses and territories that also promotes numerous festivals, such as the Enterprise City of Bergamo and Vicenza, the Galileo Innovation Festival in Padua, Trieste Next dedicated to scientific research, the Green Economy Festival in Trento, Open Factory and We Food. Since 2016 ItalyPost has been carrying out research and meetings on champions companies. In previous years Post Editori, of which Filiberto Zovico is the sole director, launched the magazine NordestEuropa and the portal VeneziePost. He published in 2018 for the publishing "*Nuove imprese. Chi sono I champions che competono con le global companies*"?.

CHAPTER 3

ITALY, A MANUFACTURING COUNTRY: THE BIRTH OF "NEW ENTERPRISES"

SUMMARY: 3.1 Structure of Italian manufacturing firms – 3.2 The value added of Made in Italy – 3.2.1 The rediscovery of artisan work – 3.2.2 Italian regulation – 3.3 "Champions": the winning firms – 3.3.1 The distinctive characters – 3.3.2 ItalyPost: 500 "Champions"

3.1 STRUCTURE OF ITALIAN MANUFACTURING FIRMS

For a long time, there have been questions about the root causes of the low growth of our economic system and the loss of productivity of our industrial enterprises. Our country is one of the most industrialized countries in Europe, in fact it is identified as the second industrial power in Europe, but today it presents itself as an industrial landscape characterized by a strongly deteriorated profile, despite the modest steps taken towards a gradual recovery. Industry is the sector that has experienced the sharpest drop in production, both in the construction and manufacturing sectors; the latter continues to hold a central position in Italy, representing one of the main drivers of our country's economy. Italy has been the country of manufacture for at least five hundred years[1], a quality manufacturing, even though its contribution to the economy has undergone profound changes. In recent years, the country's manufacturing fabric has seen its value-added fall by 17% with a loss of 660,000 jobs, weakening the country's growth engine[2] and, in addition, manufacturing employment has declined steadily throughout the advanced area. Despite these aspects, however, manufacturing is still today the central node of exchanges between the different sectors; a manufacturing enriched by the great aesthetic and technical-scientific tradition that has allowed our companies to compete at an international level, not by virtue of production, but thanks to the "know-how"; that is expressed in the care of the product, activating an irreplaceable demand for production inputs from other sectors and generating most of the innovative capacity of the production system. A structural evolution in production systems due to a new way of operating, as a consequence of the technological revolution of ICT, the progressive reduction of trade barriers and transport costs[3], the globalization of markets and production chains, the growth of intelligent and active consumers, who gradually replace mass consumers, condemned in principle by "old"; manufacturing companies to a condition of non-intelligent passivity (E. Rullani, 2014). One of the main effects of the long period of recession and stagnation that has affected the Italian economy is represented by the sharp decline in the number of SMEs. The Italian production system, in fact, has always been characterized by a great fragmentation and a high degree of entrepreneurship. The size structure is dominated by the strong prevalence of small and micro enterprises, which are essential for job creation and economic growth and

[1] F. Zovico, *Nuove Imprese: Chi sono i champions che competono con le global companies*, ed. Egea, 2018, p. 9.
[2] A. Bianchi, *Industry 4.0: limiti ed opportunità per la manifattura italiana*, La Newsletter di Nuovi Lavori
[3] R.C Feenstra, *Integration of Trade and Disintegration of Production in the Global Economy*, Journal of Economic Perspectives, 1998, vol. 12, 4, Fall, pp. 31-50.

ensure social stability. Let us be clearer about what these companies are. SMEs come in many forms and sizes, however, in today's complex business environment, they can develop close financial, operational or governance relationships with other companies. These relationships often make it difficult to distinguish an SME from a larger company. A distinction must be made in order to have a realistic picture of the economic situation of a company and to exclude those that are not real SMEs. An autonomous enterprise is deemed to be an enterprise if it is completely independent or if it has one or more minority shareholdings (each of which is less than 25%) with other enterprises; an associated enterprise if the shareholding with other enterprises reaches at least 25%, and does not exceed 50%, is deemed to be a relationship between associated enterprises; a related enterprise if the shareholding with other enterprises is greater than 50%. The definition of SMEs is a practical tool designed to help SMEs identify themselves so that they can fully benefit from the support of the European Union and its Member States.

Small and Medium Enterprises are companies whose size is within certain fixed employment and financial limits. With the Commission Recommendation (96/280/EC) of 3 April 1996 concerning the definition of small and medium-sized enterprises, subsequently updated with the Commission Recommendation of 6 May 2003 concerning the definition of micro, as well as small and medium-sized enterprises, the European Commission wished to stress the need to define SMEs in a precise and unitary manner, since the different criteria used and the multiplicity of definitions used could have become a source of inconsistency. For this reason, the program aimed to increase coordination between EU initiatives in favour of SMEs and those undertaken at national level. Thus, the Commission recommended the adoption of the following criteria for the identification of this category of enterprises: number of employees or annual work units (unità lavorative-anno, ULA), turnover and balance sheet total[4]. The criterion of the number of employees plays a major role, as it is one of the most significant, but in order to better understand the company, from the point of view of results and positioning compared to competitors, the financial criterion plays an equally important role. This criterion involves the analysis of both turnover and balance sheet total, which reflects the overall wealth of the company; the need to consider both values stems from the differences in turnover between the different sectors. It is important to point out that the changes made through the Commission Recommendation of 2003, with the inclusion of micro-enterprises, have allowed a large number of companies to become part of this category, which is the subject of facilitations and attention

[4] Source: EUR-Lex, Access to European Union Law. Available on: https://eur-lex.europa.eu/legal-content/IT/TXT/?uri=LEGISSUM%3An26001

from both EU and national bodies, as already pointed out. However, the definition of the parameters of an SME varies according to the country in which it resides; for example, for Italy the number of employees within which a company can be considered such is 250, although most Italian SMEs have a much smaller number of employees, and this is not always an obstacle. The definition of SMEs distinguishes among four different categories of enterprises (fig. 19). Large enterprises are defined as those which have annual work units greater than or equal to 250, or which have a turnover greater than 50 million euro and a balance sheet asset greater than 43 million euro. Medium-sized enterprises are those with less than 250 work units per year (AWU) and a turnover of less than or equal to EUR 50 million, or an annual balance sheet total of less than or equal to EUR 43 million. Small enterprises are those with annual work units of less than 50, with an annual turnover or annual balance sheet total of less than or equal to EUR 10 million. The fourth category is that of Micro-enterprises. These are defined as enterprises with less than 10 work units, which have an annual turnover or balance sheet total of up to EUR 2 million.

CATEGORIA	DIPENDENTI		FATTURATO		ATTIVO
Grande impresa	≥ 250	oppure	> € 50 mln	e	>43 € mln
Media impresa	< 250	e	≤ 50 mln	oppure	≤ 43 mln
Piccola impresa	< 50	e	≤ 10 mln	oppure	≤ 10 mln
Microimpresa	< 10	e	≤ 2 mln	oppure	≤ 2 mln

Fig. 19. Four different categories of enterprise (Source: Cerved, 2017)

Micro, small and medium-sized enterprises (SMEs) constitute the engine of the European economy and, to a significant extent, also that of the Italian economy: the production units of these classes account for 99,4% of the total, account for more than two thirds of total employment and produce 51,9% of total value-added [5] (fig.20).

[5] Istat data, *Il sistema delle imprese effetti della crisi e potenzialità di crescita*, Annual Report 2014, p.44.

PAESI	Imprese attive					Addetti				
	0-9 addetti	10-49 addetti	50-249 addetti	250 addetti e oltre	Totale	0-9 addetti	10-49 addetti	50-249 addetti	250 addetti e oltre	Totale
Germania (a)	81,8	15,2	2,5	0,5	100,0	19,2	23,3	20,5	37,0	100,0
Francia	94,2	4,8	0,8	0,2	100,0	29,7	18,7	15,0	36,6	100,0
Italia	94,8	4,6	0,5	0,1	100,0	46,0	21,2	12,6	20,2	100,0
Spagna	94,1	5,1	0,7	0,1	100,0	38,5	19,9	13,9	27,7	100,0
Regno Unito	89,5	8,7	1,5	0,3	100,0	18,0	19,4	16,2	46,4	100,0

Fig. 20. Companies and employees in main EU countries, year 2011 (Source: Istat 2014)

Moreover, in our country there are historical contrasts between a few large companies that are leaders in their sector and a large number of small and medium-sized companies. In fact, according to the latest ISTAT data, about 86% of Italian companies are micro-enterprises, formed by less than five employees. We are mainly talking about family businesses. Family businesses play a special role in the Italian economy. According to an estimate made using a restrictive definition taken from the EU's Family Business Group, 85% of industry and service enterprises are found and cover 54% of employment. In the sense of medium-sized industrial enterprises, with 21% of the Italian manufacturing product, the 47% of which is exported, most of which is outside Europe, they represent the spearhead of Made in Italy. They are also a fundamental resource for the renewal of the entrepreneurial fabric which, through the start-ups of new activities financed by families estimated at around one and a half billion euros, provides a presumed employment contribution of around 400 thousand employees[6]. The number of SMEs is growing mainly thanks to the growth recorded by micro-enterprises, there are over 5 thousand new businesses (+9,7%), a robust increase that brings the total number of small and medium-sized enterprises to 145 thousand (+3,6% on 2015)[7]. A strong growth, especially in Central and Southern Italy, where microenterprises make up about 90% of the production system, as you can see in Figure 21. This is an important fact that underlines the fact that companies are too small. Micro-enterprises cannot become small, and small ones cannot become medium-sized. The dimensional leap that would lead companies in the South to hire new employees and increase revenues is a real chimera, at least until new resources are unlocked for investment. In the north, on the other hand, Veneto, Lombardy and Emilia-Romagna, regions where about one third of the Italian population and businesses live and work and which account for 40% of the national GDP, account for about 39% of Italian

[6] G. Ferri, A. Mariani, *L'impresa di famiglia nell'economia italiana*, Fondazione Telos, 2013.
[7] Cerved data, Report SMEs 2017. Available on: https://know.cerved.com/imprese-mercati/rapporto-cerved-pmi-2017/

manufacturing (58% only if the largest companies are considered). In the three regions there are more people employed in manufacturing (1,88 million) than in the rest of the country (1,87 million). In companies with more than nine employees, the share reaches 53%.

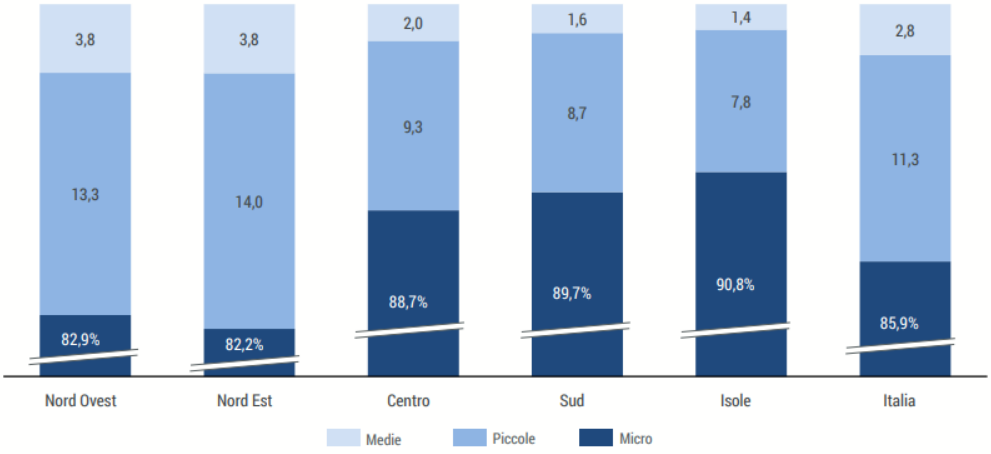


Fig.21. SMEs percentage in Italy (Source: Cerved Report, 2016)

As Marco Nespolo, CEO of Cerved Group S.p.A.[8], states in a 2017 report, SMEs have returned to growth both in terms of number and in terms of revenues, value added and improved gross margins, with profitability approaching pre-crisis levels. A recovery that has a very solid financial and earnings base. However, since growth is still too far behind that of the other main European countries, it is necessary to increase the productivity of Italian companies and accelerate the pace of growth. Italian manufacturing mainly produces for the final consumer, but there are some companies that produce for other producers. Therefore, the quality of the product is certainly important but, in the case of B2B, the price is fundamental, so productivity is vital. Out of 100 cars that run in Italy, only 1 is produced in our country, but out of 100 cars that run in the world many have Italian components, so if we do not invest in productivity, the stakes that we risk losing is very high (D. Iacovone, 2018). In this regard, Nespolo sees in Industry 4.0 an important potential: exploiting the technological transformation of production processes would imply the possibility of automating many tasks and, at the same time, would open new opportunities for the creation of jobs with high added value. In fact, according to Cerved data of 2017, “Industria 4.0”, the Government's plan to relaunch the competitiveness of

[8] Cerved Group S. p. A. is a group operating as a commercial information agency. It assesses the solvency and creditworthiness of companies, monitors and manages credit risk during all phases and defines marketing strategies.

the Italian economy, through technological innovation, has already produced significant results both in terms of investments (+9% on an annual basis) and increase in R&D spending (expected increases between 10% and 15%). Excellent incentives for a new manufacture, the so-called *digital manufacturing*, always focused on the efficiency and quality of the Italian product, the "Made in Italy", the brand that conveys to the world the image of Italy as the home of luxury, sophistication and quality.

3.2 THE VALUE ADDED OF MADE IN ITALY

SMEs and the phenomenon of Made in Italy are two important characteristics that make our country unique in its kind, being observed from other countries with admiration and curiosity. As previously stated, the Italian production system has always been characterized by a great fragmentation and a high degree of entrepreneurship, and is characterized by a large number of small, medium and micro enterprises, which have managed to translate the crafts into real industrial production, exporting Italian products globally. Therefore, the Made in Italy is able to evoke all over the world the idea of an Italian product, a well-kept and quality product, but it is rather difficult to define it, because of its many facets.

Whenever we talk about Made in Italy, we can easily think of big brands such as Armani, Gucci or Bottega Veneta, for the fashion industry, or Ferrari for the automotive industry. In reality, the Made in Italy is a much more complex and extensive phenomenon, since it embraces different industrial sectors and different activities of our system[9], what industrial goods and agri-food products can be. It is possible, therefore, to argue that the Made in Italy is the set of products and services for which Italy has a high degree of specialization, which is associated, as evidenced by a survey conducted by KPMG Advisory, values such as beauty, passion, creativity, luxury, culture and quality. The various successes, in terms of production and marketing, boasted by Italy at an international level, are not limited to a single sector. The gradual growth of many specialized companies and industrial districts have made Italy a guide also for products concerning furniture, automation and especially the food industry. With this formula, in fact, we refer mainly to four major areas of manufacturing; in Italian the so-called "4 A" of Made in Italy: Clothing; Furniture; Automation; Food.

[9] M. Fortis, *Il made in Italy*, ed. Il Mulino, 1998, pag. 15.

Italy is therefore specialized in the production and offer of quality products and services, with particular attention to detail, creativity of design and shapes, innovative products and, thanks to the beautiful scenery is also specialized in tourism and therefore in offering services and cultural experiences unique to tourists who, as Marco Bettiol says, represent an increasingly qualifying aspect of the offer especially when they are contextualized within complex experiences. The consumer proves to be interested in the quality of a product if he can associate it with a precise context of use and original meanings.[10].

According to the survey conducted by the Symbola Foundation, Unioncamere and the Edison Foundation of Marco Fortis, *Italy 2017-Geographies of the new Made in Italy report*, we discover that for the high foreign and Italian classes (i.e. the wealthy class of the population), the sectors that represent the excellence of Italian production are the fashion, tourism and wine sectors (fig. 22).

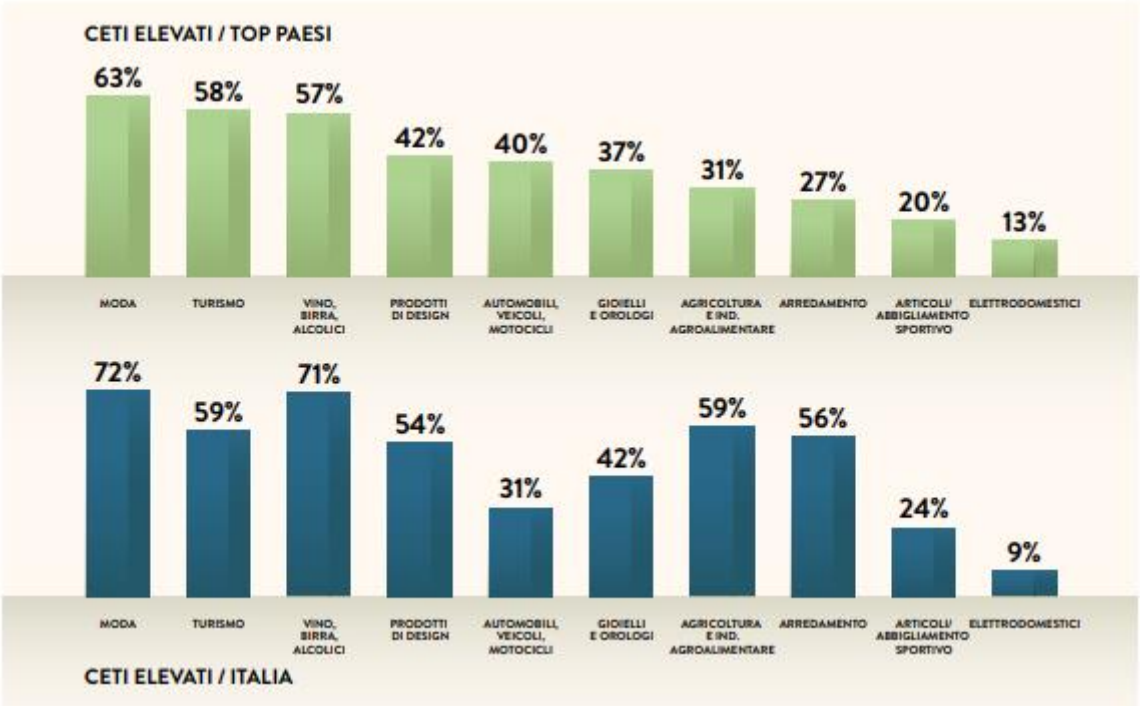


Fig.22. The main italian attractive sector (Source: Symbola.net)

As can be seen in figure 22, fashion is the first sector to be recognized for its excellence by both foreigners and Italians, as it expresses creativity and inventiveness. Tourism, with an immense heritage of history, art and culture, and with a complex wealth of coastlines, mountains, lakes, represents a fundamental sector for the economy of our country, first because it has a strong

[10] M. Bettiol, *Raccontare il Made in Italy. Un nuovo legame tra cultura e manifattura,* ed. Marsilio, 2015.

weight both in terms of GDP and employment and, moreover, represents a sector where Italy enjoys a strong and lasting competitive advantage over time. Tourist attraction is one of the main resources of our country for foreigners, offering unique experiences of great intensity and quality, thanks to the extremely widespread heritage. The wine-growing sector represents the highest expression of the Made in Italy, which tells a tradition recognized and appreciated throughout the world, for the raw material used and for its processing. The agri-food sector, on the other hand, is more valued and appreciated by the Italian population, even though foreigners recognize the taste and pleasure for Italian food[11].

Another factor of Made in Italy, recognized as a success by foreigners, according to the I. T. A. L. I. A. report, is design. It represents a true trademark of Made in Italy, in which our country maintains a leadership role. According to the most recent Istat data, in 2015 the demand for furniture and design Made in Italy has increased significantly, in fact it appears that Italy has a significant role in the international scene of furniture and design. There are 29.000 active companies, more than 23.000 German, but less than 34.000 French. In terms of the incidence of design turnover on the total economy (fig. 23), Italy is second among the major European economies after Great Britain (8.8 billion), with 4. 4 billion euros in design turnover (just under 0,3% of national GDP), ahead of Germany (3,6), France (1,9) and Spain (1,0)[12].

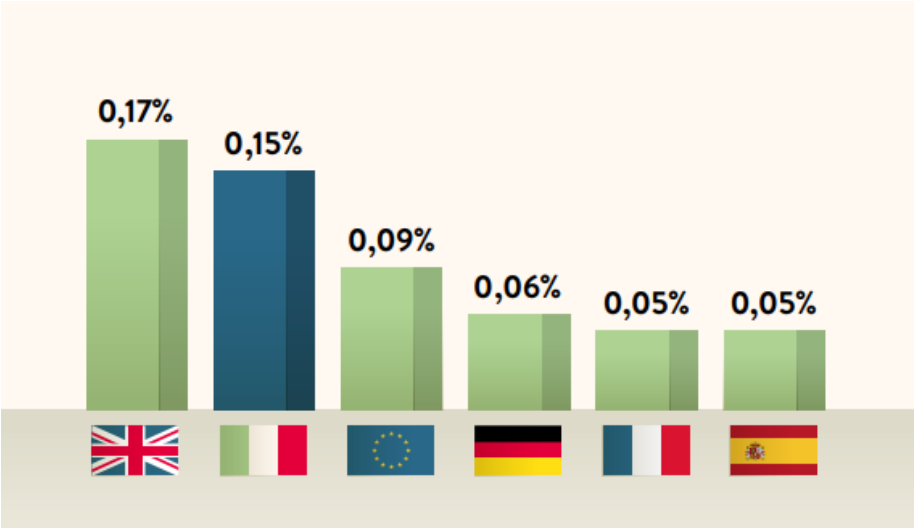


Fig.23. Impact of design turnover on the total economy in the main European countries

(Source: Symbola.net)

[11] I.T.A.L.I.A Report, *Geografie del nuovo made in italy, 2017*, p.13. Available on: http://www.symbola.net/assets/files/Rapporto_ITALIA_2017_web_1499354314.pdf
[12] Ibidem, p.35.

Another interesting factor arising from the analysis is the manufacturing trade surplus. Italy is among the five multi-specialized countries, with 90.5 billion euros in 2016, after China, Germany, South Korea and Japan (fig. 24). Performance supported by thousands of medium-large, medium and small companies that make us compete in global markets thanks to our ability to be flexible and active in different fields.

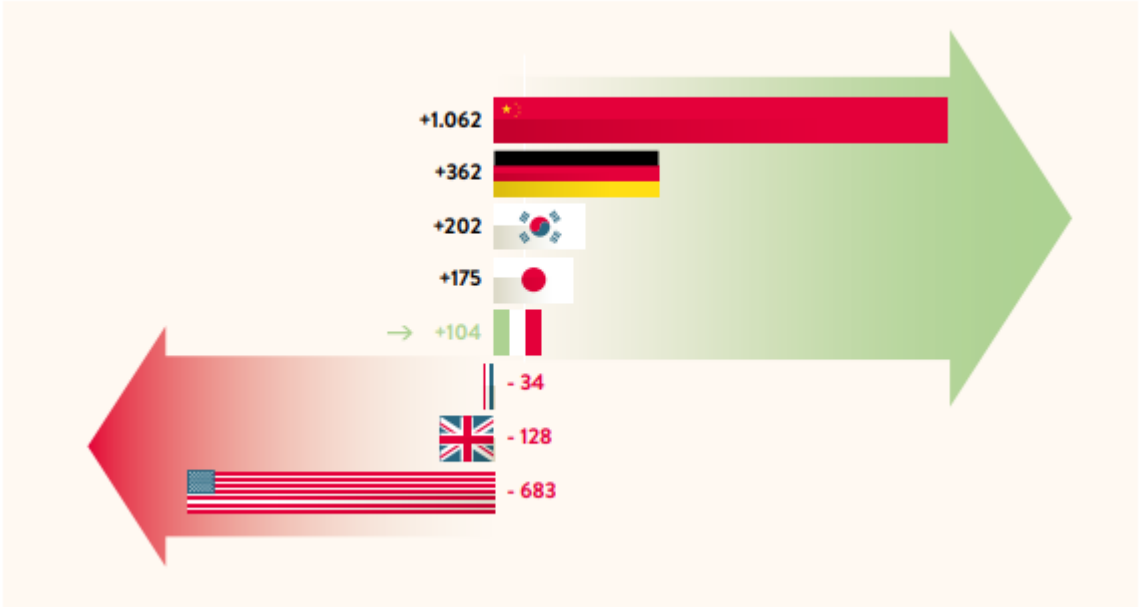


Fig.24. Manufacturing balance of some G20 countries (Source: Symbola.net)

The winning factors of Made in Italy are, therefore, confirmed to be creativity, innovation, design, diversification and the propensity to create tailor-made products for customers, even in hi-tech sectors, such as mechanics or means of transport. A remarkable result achieved thanks to a decisive choice on quality. Products which, although heterogeneous, have common denominators. For example, there is the art of transforming raw materials through old traditions; knowing how to organize production. In fact, the source of the success of Made in Italy is represented by specialized district areas that have an ancient tradition, the clusters. These, as Michael Porter defined them in 1998, are a group of geographically close and interconnected companies, united by complementarity and shared resources to institutions specializing in each field. The district model has exalted local artisan production traditions, design and the development of innovation. In the districts efficient systems of relationships between the companies are born, which exchange the same job, the technologies, the services, the know-how, allowing the overcoming of limits tied to the restricted dimension of the companies.

However, in addition to the art of processing raw materials, there is also the art of manufacturing machines for processing raw materials, as well as for wrapping and packaging finished products. This is thanks to the leadership achieved over time in the various sectors (fashion, design, food), which has allowed Italy to achieve high levels of specialization in the machines used for these productions. The Made in Italy, therefore, is not a label, as for example is the Made in China, but a signature and distinctive brand that recalls the idea of unique and special product. It is no coincidence that, according to various researches, it is the third best-known brand in the world after Coca-Cola and Visa[13]. It is the mark of a know-how that distinguishes us in the eyes of other countries, the most vital part of the Italian economy, based on small and medium enterprises and industrial districts, capable of gaining large leadership positions in global markets.

3.2.1 The rediscovery of artisan work

Craftsmanship is one of the distinctive traits of Italian culture and economy. Manual skill, ingenuity and creativity have always been an element of recognition of our country in the world, a factor, as previously stated, that distinguishes us in the eyes of other countries. The competitiveness of our industrial system is still linked, today, to artisan skills that have been able to renew their role in large and small businesses, which make Italian manufacturing flexible, dynamic and interesting in the eyes of those consumers who seek history and culture in the products they buy[14].

In the minds of the public, the term craftsmanship evokes something old, not very innovative, and destined to disappear because of globalization. In reality, today, craftsmanship is rediscovered under a new perspective, a manual *saper fare*; synonymous with excellence, manual and technical ability, deep knowledge of the characteristics of materials and high quality, but it needs greater integration and, above all, to be told, trying to overcome the preconceptions that do not see it associated with a real industrial activity, so as to enhance the craftsmanship within the industrial processes on an international scale. The know-how of craftsmen, especially in Italy, is the way to innovation that allows our country to be competitive at an international level. As better described in figure 25, Italy has never stopped exporting its artisan know-how, not even during the years characterized by the deep economic crisis, on the contrary, you can see how the Made in Italy is a growing trend. This is because the financial

[13] Source available on: https://www.italyjournal.it/2017/10/30/made-italy-brand-terzo-al-mondo/
[14] S. Miceli, *Futuro artigiano. L'innovazione nelle mani degli italiani,* ed. Marsilio, 2011.

crisis has stimulated several critical thoughts that have led to a rethinking of the theme of work, a re-evaluation of activities and, above all, of ways of working, which today have become economically and socially sustainable thanks to new technologies[15].

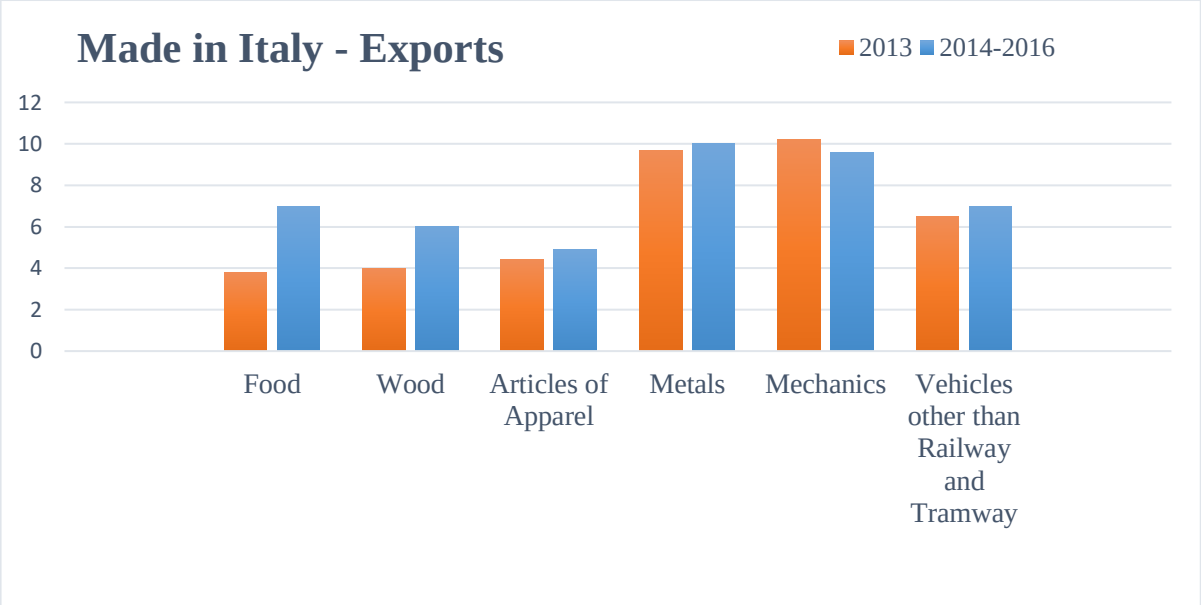


Fig.25. Growth rates of exports of Made in Italy for 2013 and 2014 - 2016. Percentage values (Source: Confcommercio)

Customers react with curiosity rather than embarrassment. They enjoy the time saving and the assurance that the product is a truly tailored, Made in Italy garment from the fabric to processing. This adds value to the product quality (Bonfanti, 2018).

The prestige of the Made in Italy brand, never seen, is recording record data for exports. This positive situation is confirmed by recent studies by Confartigianato on Istat data, according to which at the end of 2017 there was an increase in exports of +7,4% in value and +3,1% in volume. The export trend is a summary of the growth in sales to EU countries (+6,7%) and the increase in sales to non-EU countries (+8,2%)[16].

The export of goods reaches an all-time high of 448. 1 billion euros which, balanced by imports for 400.6 billion, determines a foreign trade surplus of 47.5 billion. In relation to GDP, made in Italy reaches an all-time high of 26,1%, while imports rise to 23,3%, the highest value since 2012, with a positive trade balance of 2,8% (fig. 26).

[15] S. Miceli, *Fare è innovare. Il nuovo lavoro artigiano*, ed. il Mulino, 2016.
[16] Source available on: https://www.confartigianato.it/2018/03/studi-nel-2017-74-made-in-italy-sale-a-448-miliardi-pari-al-261-del-pil-trainano-cina-222-e-ritorno-alla-crescita-della-russia-193/

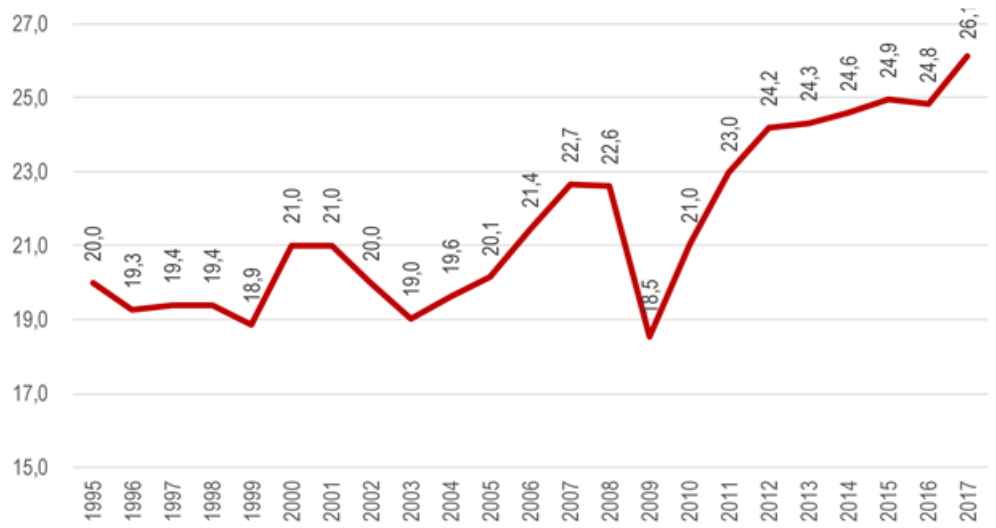


Fig.26. Trend export Made in Italy 1995-2017 – export of goods % GDP

(Source: Elaborazione Ufficio Studi Confartigianato su dati Istat)

In addition, as shown in graph 27, with respect to the main outlet markets, exports to China (+22,2%), Russia (+19,3%), Poland (+12,0%), the Czech Republic (+10,7%) and Spain (+10,2%) grew at an above-average rate and exports to the United States (+9,8%), India (+9,3%), Japan (+9,0%), Switzerland (+8,7%), Romania (+8,5%) and the Netherlands (+7,7%) increased at an above-average rate.

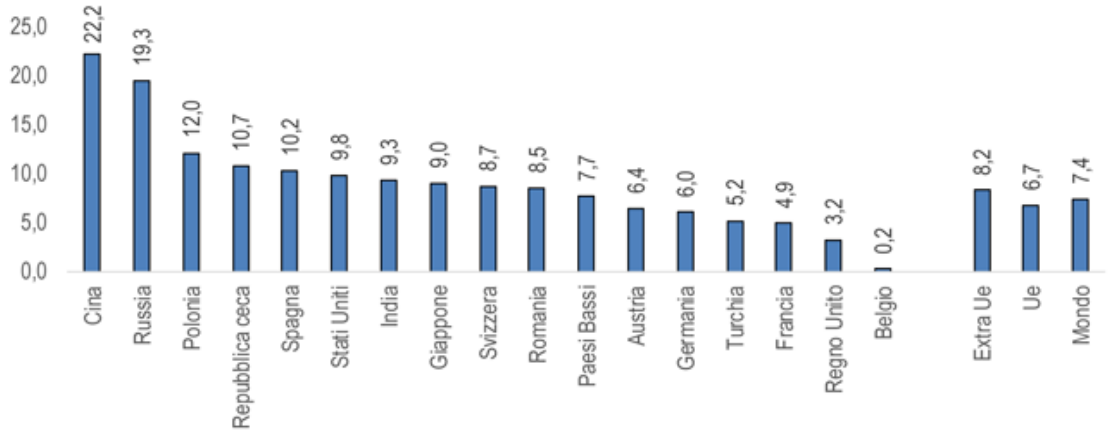


Fig.27. Trend export Made in Italy for main markets 2017 – var. % exports compared to 2016

(Source: Elaborazione Ufficio Studi Confartigianato su dati Istat)

If the export of Made in Italy products grows, it means that there is an increase in the demand for Italian products. This is the perfect situation for our economy: on the one hand, the value of the Made in Italy brand, on the other hand, the increase in demand for our products in very important European and non-European countries, such as China and the United States of America. Two large and rich countries, which have found in Made in Italy a safe haven to rely on. New consumers demand quality, experience and history of the goods they buy. And it is precisely from these data that we must start again.

The constant and gradual growth of exports of Italian products is mainly due to the Web, which has an important role in telling and promoting Italian craftsmanship. Access to international markets for the distribution of niche products is now more economically sustainable, thanks to e-commerce portals, which have made the promotion of craftsmanship a strength, and new technologies for digital production, which fall under the labeling of Industry 4.0, such as 3D printers, laser cutting, innovative robotics, now available at increasingly low cost. The evolution of these technologies, which are increasingly innovative, has allowed artisan work to take on a new role, finding increasing importance also within industrial production models. In the United States we talk about *Makers*, in Italy about *artigiani digitali*. The new craftsmen combine their passion for making with their determination to invent, creating new links between the social and the sharing of knowledge, through the use of the net. As Chris Anderson points out in his book *Makers: The New Industrial Revolution* (2006), The passion for building is the engine of social transformation and sustainable innovation. New markets and new needs call for a re-evaluation of craftsmanship in order to be more competitive in global markets. There is a need to invest in research, to innovate, to consider crafts not as a legacy of the past, but as a resource, which turns into an accelerator of innovation, and there is a need to tell the story of Italian products. The development model of artisan work must be built around a fusion between the virtual world and the real world that can determine the future of craftsmanship, as Stefano Miceli defines it, one of the few cards that our country can play to find an original place on the international scene[17]. It is necessary, therefore, that there is an integration between the “old" and the “new", between manual know-how and technological innovation, in managing and coordinating efficiently the traditional physical structure of the company with a technological and innovative structure, so as to create new opportunities that can extend the core business, generate ever-changing funding, strengthen skills and knowledge and respond to changing consumer behavior.

[17] S. Miceli, *Futuro artigiano. L’innovazione nelle mani degli italiani,* ed. Marsilio, 2011.

3.2.2 Italian Regulation

One of the questions that arises spontaneously is when we can say that a good, a handmade product is 100% Made in Italy? With the continuous change of the markets, the Made in Italy has increasingly needed definitions and legal protections, rules necessary to condemn counterfeiting and unfair competition, and to protect consumers. Since the year 2000, the wording “Made in Italy" has started to be protected, first, by associations such as the Institute for the Protection of Italian Producers (ITPI), which is the certifying company for products which are entirely Made in Italy, and then regulated by the Italian government. In general, it is possible to insert the origin mark “Made in Italy" if the product has been entirely made in Italy or if it has undergone its last substantial transformation in Italy. When we refer to the Made in Italy trademark, it is necessary to make a distinction between the trademark provided for by Law 350/2009 and that introduced by Decree 135/2009, art. 16, paragraph 1, which deals with the so-called *100% Made in Italy*. Law 350/2003 (Finance Act 2004, art. 4, paragraph 49) specified that the Made in Italy “stamping on products and goods not originating from Italy in accordance with European legislation on origin" is a false indication. Subsequently updated, this provision, paragraph 49-bis, considers misleading indication of the use of the mark, by the owner or by those who purchased through license agreement, the right to exploit it commercially, in such a way as to induce the consumer to believe that the product or goods are of Italian origin, establishing the application of a fine ranging from 10 thousand to 250 thousand euros[18]. The provision therefore referred to the Community Customs Code EEC 2913/1992, Article 24, according to which “goods whose production involved more than one country shall be deemed to originate in the country where they underwent their last, substantial, economically justified processing or working in an undertaking equipped for that purpose and resulting in the manufacture of a new product or representing an important stage of manufacture”[19]. This was then replaced by the new updated Code, Regulation EEC 450/2008, which regulates in Article 36 two principles [20]:

> a) Goods wholly obtained in a single country or territory shall be regarded as having their origin in that country or territory;

[18] See Law 350 of 24 December 2003, art. 4, comma 49, 49-bis.
[19] See COUNCIL REGULATION (EEC) No 2913 /92 of 12 October 1992, establishing the Community Customs Code, art.24.
[20] See REGULATION (EC) No 450/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2008, laying down the Community Customs Code (Modernized Customs Code), art.36.

b) Goods the production of which involved more than one country or territory shall be deemed to originate in the country or territory where they underwent their last substantial transformation.

Reference is made here to non-preferential customs origin. Regardless of the percentage of domestic or foreign goods used in production. The indication of the origin mark is therefore not granted if the processing activity is not carried out in Italy or if, even if carried out in our country, it is marginal. False or misleading indications of source or origin are punishable pursuant to Article 517 of the Penal Code.

In 2009, Italian legislation took a further step with Decree 135/2009, aimed at distinguishing between those who produce exclusively in Italy and those who only carry out the last processing on the product. This decree modifies art. 4, paragraph 49, of Law 350/2003 through art. 16, which defines the obligation of the trademark owner to give precise indications on origin or provenance, also introducing the criterion that a product is defined as "100% Made in Italy" or "100% Italy" or "All Italian", if entirely made in Italy and if the design, design, processing and packaging are carried out exclusively in Italy[21]. The Italian regulation is more restrictive in the qualification of a Made in Italy product, unlike the regulations on Made in Germany, which refers to all the essential steps of manufacturing, and on Made in USA, which refers to all the steps or virtually all.

Then we come to law 55 of 8 April 2010, concerning textiles, leather goods and footwear. This law, through Article 1, paragraph 3, requires the traceability of the place of origin of each of the stages of processing, in order to identify the company, qualify the production and offer information to consumers. According to this law, paragraph 4, products can be labelled as Made in Italy only if the processing steps, specified by the same law, have taken place mainly in the national territory and if at least two of the processing steps for each sector have been performed in the same territory and if for the remaining steps is verifiable traceability. Finally, it is important to underline an aspect concerning the definition "origin" of a product, which many times can lead to misunderstanding. According to a well-established principle of case law, the origin of a product refers to its origin from a producer, who guarantees the quality of the product to consumers, and not to the origin from a place of manufacture. Therefore, according to this principle, it is possible to affix one's own mark and place of establishment to the Italian goods without incurring in the crime, provided for by art. 517 of the penal code for the sale of

[21] See Decreto-legge 25 settembre 2009, n. 135; "Disposizioni urgenti per l'attuazione di obblighi comunitari e per l'esecuzione di sentenze della Corte di giustizia delle Comunità europee. (09G0145)", Gazzetta Ufficiale n. 223 del 25 settembre 2009

industrial products with false signs. But one thing is to indicate the name of the manufacturer and the place where it is located, another is to apply the words Made in Italy.

3.3 "CHAMPIONS": THE WINNING FIRMS

The development model of Made in Italy is based on small and medium enterprises, but also on relatively large enterprises. The data highlighted in the previous paragraph show that the Italian recovery that began in 2017 is due, above all, to the intervention of small and medium-sized Italian companies that have driven the Made in Italy abroad, offering products mainly related to the manufacturing sector. But part of the merit of this growth must be attributed to a group of companies for which the new phase of globalization, which began with China's inclusive trade agreements, and the crisis of 2007-2008 represented an opportunity for strategic reorganization, processes and markets. Companies that, growing against the trend, have understood the changes in the market, anticipating the Italian recovery already in 2010, through the development of strategies, which have enabled them to overcome the credit and banking crisis and innovate processes and products to compete on international markets[22]. We are photographing a new business reality, characterized by companies whose business models are efficient, even in the presence of adverse factors [23]. These are not a few large companies, such as Brembo, but a large group of small companies. The companies in question are identified as *Champions*, as defined by Filiberto Zovico in his book *Nuove Imprese*. They are companies that have achieved excellent economic and financial performance: compound annual growth rate (CAGR) of more than 7% in the period 2010-2016; average gross operating margin (EBITDA) of more than 10% in the last three years; debt to total assets ratio (Debt ratio) of less than 80%; positive net result in 2016. We are talking about companies with at least 20 employees; they have a turnover between 20 and 120 million euros; they are not subsidiaries of multinationals or foreign groups but are privately owned, with Italian owners; they are industrial and service companies, except for construction, waste management and disposal and activities concerning lotteries, betting and management of gaming rooms[24]. Firms that remain out of the spotlight to focus exclusively on their business.

[22] M. Bettiol, *Come crescere molto senza essere disruptive*, VeneziePost, 29 settembre 2017.
[23] F. Zovico, *Nuove imprese. Chi sono i champions che competono con le global companies*, ed. Egea, 2018.
[24] Source: *ItalyPost Research*. Available on: https://www.italypost.it/le-500-imprese-champion-vinto-la-crisi-competono-sui-mercati-globali/

3.3.1 The distinctive characters

The Champions have as their objective not to become large in terms of size, like the global companies, but to be the leader of the specific niche market in which they operate, they want to move towards what Giovanni Costa identifies as *adequate size*.[25]. As Zovico (2018) states, for these companies we must more correctly speak of *large, hyper-technological artisan enterprises,* since they now perform those functions that in the past were performed by artisan enterprises. But what are the distinctive features of the Champions? Paolo Gubitta[26] says that what distinguishes the so-called champions companies from other companies in the sector are mainly the established methods, which entrepreneurs apply in their companies, adapting them to their business and integrating them with the history, skills and values of their companies, until they obtain a combination of methods, approaches, knowledge and original and unique values. Recent managerial studies have shown how these companies stand out because they have developed skills such as the ability to undertake profound processes of change; the ability to understand the environment, understand what is the willingness to change, to take initiatives when there is uncertainty about the possible evolution of a situation; they have achieved a solidity that allows them to withstand unforeseen and unpredictable situations, maintaining operations and efficiency. They were able to adapt to different situations when the parts of the organization were in stable communication with each other but were not dependent on each other for their operation; the error is seen as a source of learning for the entire organization. A further feature of the champions is the so-called sensitivity to operations. Entrepreneurs make each person within the organization aware of the entire process in which they participate, promoting a broad view of the individual activities carried out. In addition, they have managed to manage innovation processes, which have led to greater efficiency in operations, and to develop an outside-in mindset, which starts from the market and then tries to produce products and services creatively on the basis of the opportunities offered by the market itself, which is very different from the inside-out approach, which pushes the company to place itself on the market on the basis of the narrow point of view of its customers, which observes it only through the lens of its products. Moreover, in champions companies, unlike other companies, there are no problems concerning the generational passage between father and son at the helm of the companies, with possible conflicts. This is because they have been adopting different strategies:

[25] G. Costa, *La sindrome del turione. Nordest, mercato globale e imprese adeguate*, Marsilio, 2012.
[26] Full professor of Business Organisation and Entrepreneurship at the University of Padua and scientific director of "Centro per l'Imprenditorialità e le Imprese Familiari" (CEFab) CUOA Business School.

either through the involvement of family members within the board of directors to make them more involved in the life of the company, or through putting at the helm an external person with a strong determination to grow the company. Finally, Filiberto Zovico (2018) highlights another point that distinguishes the champions, namely the attention paid to the employee. The drive to create ever better working conditions and the definition of a strategy that aims to convey passion and a sense of belonging are fundamental elements that can no longer be left in the background in today's companies. Because it's the people who make the company.

3.3.2 ItalyPost: 500 "Champions"

There are 500 new champions of Made in Italy, which fall within the parameters and characteristics seen above, identified through careful research, conducted on data Infocamere and Bureau Van Dijk, on behalf of the Italypost Study Center, and with the support of Auxiell, by a team of financial analysts of Credit Rating Agency ModeFinance and experts in Corporate Finance of the independent financial advisory Special Affairs. This has allowed, on the one hand, the use of a certified methodology for data extraction and processing and, on the other hand, a professionally rigorous approach to the vertical analysis of individual companies.[27]. This research allows us to understand how, in the economic and territorial context of Lombardy-Venetia, there is a great diffusion of companies able to excel and compete with the big players thanks to their sense of belonging to their own land, to the community's workforce and to the wealth of our territories which, over time, have been able to invest capital in the best natural and social resources. Lombardy places the largest number of companies with142, followed by Veneto 99 and Emilia-Romagna 73 (fig. 28); a further confirmation of the new industrial triangle that has emerged in recent years. In the North, Piedmont has 50 companies. Relatively well the Trentino-Alto Adige with 11 champion enterprises, as well as the Friuli-Venezia-Giulia. The figure for Liguria is slightly lower with only 6 companies. At the Centre they are distributed mainly in Tuscany, which supplies 37 companies, in the Marche 14 companies, slightly higher than Lazio, which stops at 12 champion companies. In the South, on the other hand, it is Campania that has recorded an important figure: it is the region that, with 22 companies, settles better and far exceeds Puglia, the 7 champion companies. The presence in the other regions of the South is not very significant, with Sicily at 2 and Calabria at 1.

[27] Source: *ItalyPost Research*. Available on: https://www.italypost.it/le-500-imprese-champion-vinto-la-crisi-competono-sui-mercati-globali/

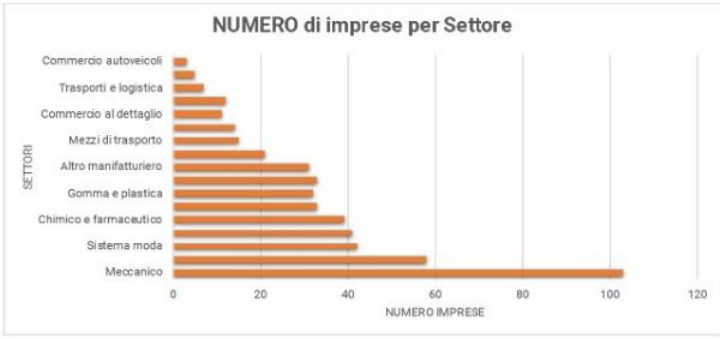
AREA GEOGRAFICA	IMPRESE		FATTURATO	
	Numero	%	Euro/000	%
NORDOVEST	**203**	**40,60%**	**8.907.983**	**41,02%**
Lombardia	142	28,40%	6.208.107	28,59%
Piemonte	55	11,00%	2.484.313	11,44%
Liguria	6	1,20%	215.563	0,99%
Valle D'Aosta	0	0,00%	0	0,00%
NORDEST	**194**	**38,80%**	**8.451.983**	**38,92%**
Veneto	99	19,80%	4.255.249	19,60%
Emilia Romagna	73	14,60%	3.260.924	15,02%
Friuli Venezia Giulia	11	2,20%	456.601	2,10%
Trentino Alto Adige	11	2,20%	479.209	2,21%
CENTRO	**66**	**13,20%**	**2.795.860**	**12,88%**
Toscana	37	7,40%	1.539.541	7,09%
Marche	14	2,80%	489.473	2,25%
Lazio	12	2,40%	653.003	3,01%
Umbria	3	0,60%	113.843	0,52%
SUD e ISOLE	**37**	**7,40%**	1.557.742	**7,17%**
Campania	22	4,40%	908.526	4,18%
Puglia	7	1,40%	364.004	1,68%
Abruzzo	5	9,09%	164.002	6,60%
Sicilia	2	0,40%	71.204	0,33%
Calabria	1	0,20%	50.006	0,23%
Molise	0	0,00%	0	0,00%
TOTALI	500		21.713.568	

Fig.28. Champions distribution for geographic area (Source: ItalyPost)

In terms of subdivision by province, in first place we find Milan with 49 companies, followed by Bergamo with 31 and Vicenza with 30. In fourth place Turin with 28; in fifth place Treviso and Bologna with 21; in sixth place Padua and Florence 20. More detached, in seventh place, Brescia and Verona with 15; in eighth place, Modena and Naples with 13; in ninth place Novara with 10, and in tenth place Lecco and Rome with 9 companies. To mention other important industrial provinces in the north, the next ones are Monza and Brianza, Varese, Como, Parma, Venice with 8 companies each.

However, it is from the analysis of the aggregated data that the strength and relevance of the phenomenon fully emerge. We are talking about a nucleus of companies that develop, considering all 500 companies, an aggregate turnover of almost 22 billion euros, a profitability of over 4.3 billion and a total of about 77 thousand employees. It is interesting to highlight, through graph 29, how, even if the champions operate in different sectors, the weight of the mechanics is relevant. In addition, it should be noted that these companies represent the champions of the Made in Italy; all sectors of the Made in Italy are represented (food, clothing-fashion, automotive).

SETTORE	Numero aziende	% sul totale
Meccanico	103	20,60%
Prodotti metallo	58	11,60%
Sistema moda	42	8,40%
Alimentare e bevande	41	8,20%
Chimico e farmaceutico	39	7,80%
Elettrico ed elettronico	33	6,60%
Gomma e plastica	32	6,40%
Commercio all'ingrosso	33	6,60%
Altro manifatturiero	31	6,20%
Servizi alle imprese	21	4,20%
Mezzi di trasporto	15	3,00%
Mobile e arredo	14	2,80%
Commercio al dettaglio	11	2,20%
Altri servizi	12	2,40%
Trasporti e logistica	7	1,40%
Carta e stampa	5	1,00%
Commercio autoveicoli	3	0,60%
TOTALE	500	



SETTORE	Fatturato	% sul totale
Meccanico	4.416.391	20,35%
Prodotti metallo	2.249.633	10,36%
Sistema moda	2.063.970	9,51%
Alimentare e bevande	1.957.762	9,02%
Chimico e farmaceutico	1.582.634	7,29%
Elettrico ed elettronico	1.436.793	6,62%
Gomma e plastica	1.435.629	6,61%
Altro manifatturiero	1.312.645	6,05%
Commercio all'ingrosso	1.268.989	5,85%
Servizi alle imprese	882.872	4,07%
Mobile e arredo	713.279	3,29%
Mezzi di trasporto	699.262	3,22%
Commercio al dettaglio	526.556	2,43%
Altri servizi	467.449	2,15%
Trasporti e logistica	307.044	1,41%
Carta e stampa	285.212	1,31%
Commercio autoveicoli	99.845	0,46%
TOTALE	21.705.965	

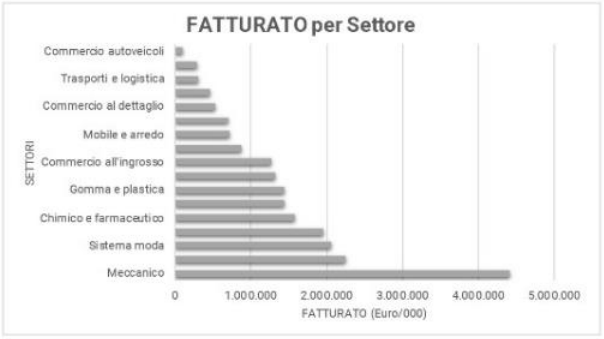


Fig. 29. Champion firms' sectors (Source: ItalyPost)

Therefore, through this study, Centro Studi ItalyPost has carried out an initial mapping of this *cluster* of excellence, with the aim of identifying the sectors and compartments of belonging, size, performance, corporate affiliation. In fact, in the last six years they have reinvested profits of 7.3 billion euros, making the most of the opportunities that have arisen, with excellent profitability thanks to the momentum on the product and the continuous refinement of production processes, a vocation for internationalization that allows you to compete in global markets with continuity and often with positions of absolute leadership and thanks to the prudent but pressing graft of new technologies.

CHAPTER 4

INDUSTRY 4.0 IN “CHAMPIONS”

SUMMARY: 4.1 Introduction – 4.2 Research objectives and methodology – 4.3 Characteristics of the sample – 4.4 Champions: adopters of Industry 4.0 – 4.5 Industry 4.0 investment and ICT – 4.6 Reasons, benefits and difficulties of Industry 4.0 investment – 4.7 Industry 4.0: impact on the product and sustainability – 4.8 Investments in Industry 4.0: impacts on employment – 4.9 National Industry 4.0 Plan incentives

4.1 INTRODUCTION

Industry 4.0 is a new emerging economic paradigm capable of replacing growth models based on a linear vision, aiming at improving the efficiency of business processes and a radical rethinking in the design of products and their use over time. An important challenge, especially for the Italian production system, which requires the adoption of activities and production processes capable of supporting international competitiveness. Italy could be the leader of this new industrial revolution and thought, with top performing firms labelled as “Champions” by a research by *ItalyPost*,[1] which have understood the changes in the market and developed strategies that have allowed them to gain huge margins of advantage over competitors. To do this, however, we need strong guidance and coordination at the national level, which introduces rules, economic instruments and removes non-technological barriers to the birth of a real industrial revolution in Italy and Europe. In this transition to a new 4.0 economy, manufacturing, understood as the transformation of inputs into outputs starting from innovation processes, plays an important role. Through the adoption of strategies and business models oriented to technological innovation, manufacturing companies can play a decisive role, redesigning internal processes, chain relations, promoting innovative products or services with which the consumer can benefit. The emerging scenario designed by digital technologies related to industry 4.0, can further push towards new spaces for innovation in design and production, as well as for the implementation of processes that allow the traceability of consumption, resources and products. This chapter presents the results of the research focused on the relationship between Industry 4.0 and “Champions", conducted in part by me and coordinated by Professor Bettiol Marco and Professor Di Maria Eleonora in the Digital Manufacturing Laboratory. The data and analyses emerging from the research are compared to the data of the Report of Industry 4.0 in Italian SMEs of the University of Padua in 2017 and give an interesting picture of how 4.0 technologies have a significant impact on the various business processes and on the business value chain of “Champions" and of the aspects on which it is necessary to work in the future.

[1] ItalyPost: https://www.italypost.it/frontpage-champions/

4.2 RESEARCH OBJECTIVES AND METHODOLOGY

In order to analyze the strategies of the "Champions" companies, a study was conducted on the Italian companies with the following characteristics, according to the numerical criteria of extraction reported in the analysis conducted by the *ItalyPost* Study Centre:

REVENUES 2016	**between 20 and 120 million of euros**
CAGR[2] 2010-2016	**higher than 7%**
EBITDA[3] (average on the last three years)	**greater than or equal to 10%**
DEBT RATIO[4]	**lower or equal to 80%**
NET DEBT/EBITDA[5] (average on the last three years)	**lower or equal to 1,85**
NUMBER OF EMPLOYEES	**greater than 20**
NET INCOME[6] 2016	**Positive**

We refer to companies with an aggregate turnover of almost 22 billion, a profitability of over 4.3 billion and a total of 77,000 employees.

The universe was composed of 500 Italian companies, which meet the above requirements, as reported in *ItalyPost's* research, after a detailed mapping from 14,632 companies between 20 and 120 million euros in turnover.

[2] CAGR (Compound Annual Growth Rate) is the rate of return that would be required for an investment to grow from its beginning balance to its ending balance, assuming the profits were reinvested at the end of each year of the investment's lifespan.
[3] EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization) allows to verify if the company makes positive profits from ordinary operations. It is obtained in the following way: Revenues - Cost of sales.
[4] The debt ratio is defined as the ratio of total debt to total assets. It can be interpreted as the proportion of a company's assets that are financed by debt. It is a financial ratio that measures the extent of a company's leverage
[5] The net debt to earnings before interest depreciation and amortization (NET DEBT/EBITDA) ratio is a measurement of leverage, calculated as a company's interest-bearing liabilities minus cash or cash equivalents, divided by its EBITDA. It shows how many years it would take for a company to pay back its debt if net debt and EBITDA are held constant.
[6] NET INCOME is equal to profit calculated as sales less cost of goods sold, selling, general and administrative expenses, operating expenses, depreciation, interest, taxes and other expenses.

From the universe was obtained a sample of 74 enterprises defined Champions (15% response rate). Through a telephone survey (CAWI), it has been given to entrepreneurs and managers a questionnaire to collect information about:

- sector and production specialization;
- reasons, results and difficulties related to the adoption of technologies 4.0;
- investment in industry 4.0 technology;
- investment areas and organizational impact;

The research has several objectives, the main ones are:

- investigate the profile and business model of “Champions" adopting 4.0 technologies;
- analyze the reasons, the results achieved and the critical points of the process of adoption of technology industry 4.0;
- explicitly investing in industry 4.0 and supporting the investment;
- highlight how the adoption of industry 4.0 technologies has affected business results.

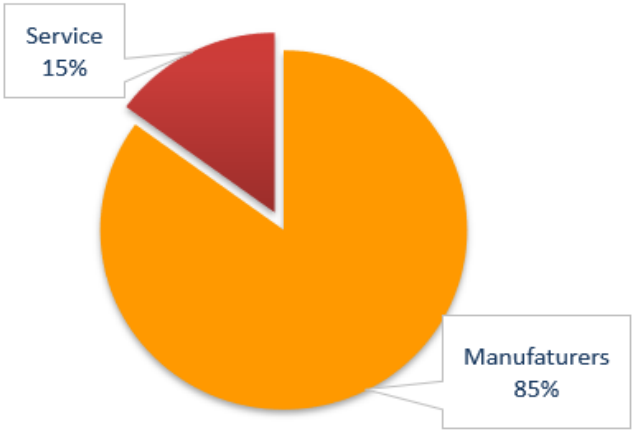
In doing so, we will consider the 2017 *Report of Industry 4.0 in Italian SMEs*, conducted by Digital Manufacturing Lab of University of Padua on a sample of 7,293 manufacturing firms, whose just 1,020 interviewed firms (14% response rate). They have been selected as follows (source AIDA database):

- Made in Italy industries (Home furnishing, Mechanics, Fashion);
- geographical location: Northern Italy (Piedmont, Lombardy, Veneto, Trentino-Alto Adige, Friuli-Venezia Giulia, Emilia-Romagna);
- firms with 2015 turnover > 1 Ml € (firms with 2015 turnover < 1Ml € in industries characterized by industrial districts).

We will make a comparison to analyze the differences between Industry 4.0 investments in SMEs and Champions’ reality.

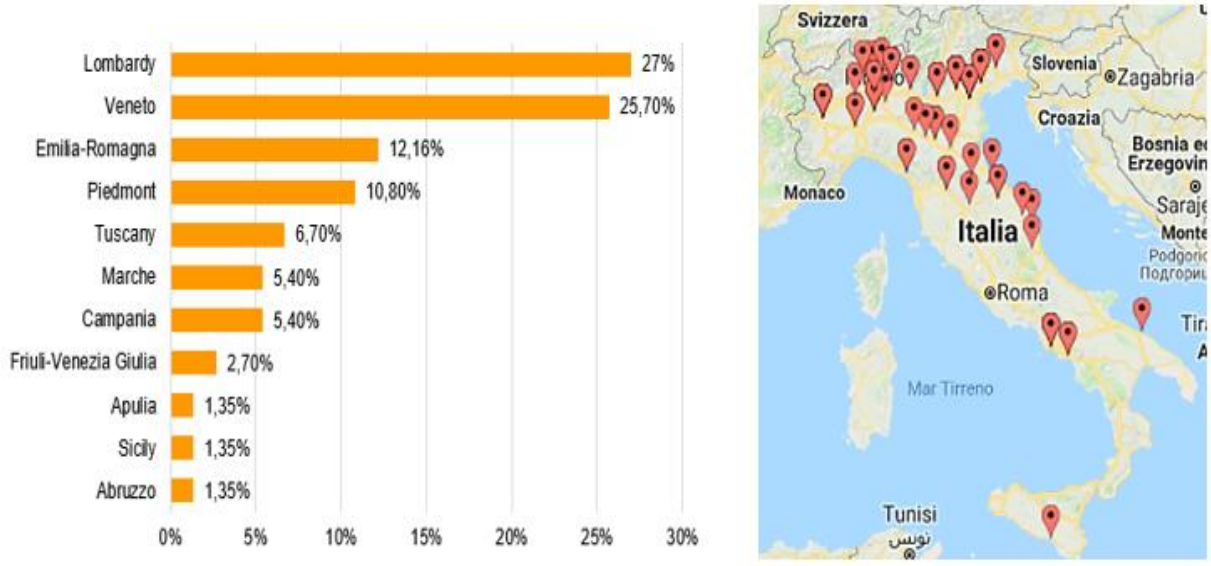
4.3 CHARACTERISTICS OF THE SAMPLE

The research refers to a sample of 74 companies (14.8% of the universe), the 85% manufacturers and the residual one (15%) provide services.



Champions' industries

Interesting data to describe the profile of the adopting Champions is their location. From the following map it can be seen that the companies interviewed are mainly located in the North, mainly Lombardy (27%) and Veneto (25.7%) and in the Centre, mainly in Emilia-Romagna (12.16%).



Map of Champions' localization

Considering the analyzed sample, 81% of the adopting "Champions" of are medium-large companies, which have an average turnover of 64.7 million euros and have an average of 152 employees on average 2017 (fig. 32).

Figure 32 shows the main characters that outline the profile of “Champions”adopters.

Average turnover (2017)	64.7 MI Euro (average weight 1° client on turnover: 12.65%)
Employees (average 2017)	152 total 87 in operation 10 in R&D 4 in marketing
% Export (average 2017)	61% (first market 27%)
R&D expenditure (% on turnover)	7%
Production output	33% bespoke products 25% customized products 42% standard products
Location of manufacturing (value)	67.5% Region 19.5% Italy 13% Abroad
Location of suppliers (% on total suppliers)	28.7% Region 44.7% Italy 26.6% Abroad

Fig.32. Profile of Champion adopting Industry 4.0

The companies interviewed represent the upper part of the “Champions", the average turnover being about 65 million euros, considering that the range of turnover of these companies, according to the criteria of selection of *ItalyPost*, ranges from 20 to 120 million euros.

Figure 32 also shows a further interesting fact about the location of suppliers. “Champions" still buy a lot in Italy, in fact about 73% of suppliers are located in Italy, 28.7% in the Region and 44.7% in the rest of Italy. Suppliers located abroad are worth as much as those located in the Region, exactly 26.6%.

If we consider the report on SMEs of the University of Padua of 2017, we still notice a strong prevalence of suppliers in Italy, respectively 35. 6% in the Region and 47% in the rest of Italy, while only 17. 3% of suppliers are located abroad (fig. 33).

Average turnover (2016)	14.8 Ml Euro
Employees (average 2016)	58 total 35.6 in operation 4.6 in R&D 2.5 in marketing
% Export (average 2016)	47% (first market 28.4%)
R&D expenditure (% on turnover)	6%
Main activity	40% B2C – 60% B2B (average weight 1° client on turnover: 28.3%)
Production output	47.7% bespoke products 18.9% customized products 33.4% standard products
Location of manufacturing (value)	63.0% Region 29.0% Italy 8.0% Abroad
Location of suppliers (% on total suppliers)	35.6% Region 47.1% Italy 17.3% Abroad

Fig.33. Profile of SMEs adopters (Source: Digital Manufacturing Lab)

From the figures above (fig. 32-33), as far as the location of manufacturing is concerned, a substantial prevalence of activities in the region emerges, both for the Champions and for the SMEs, respectively 67% and 63%, with the Champions having, however, a greater propensity to outsource activities, about 13% compared to 8% of the SMEs.

4.4 CHAMPIONS: ADOPTERS OF INDUSTRY 4.0

An important element of the research concerns the study of the role played by industry 4.0 technologies in the different business processes of Champions and whether these have positively influenced their performance. In particular, the research analyzed how many of the companies surveyed had adopted 4.0 technologies.

The research carried out shows that 81% of the companies interviewed adopted innovative solutions in Industry 4.0 key (fig. 30). These results are the exact opposite of the results conducted by the Digital Manufacturing Laboratory at the level of companies in Northern Italy in the sectors of Made in Italy, where it appears that only one company in four has invested in the industry 4.0, the adopting companies are only 18.6% (fig. 31).

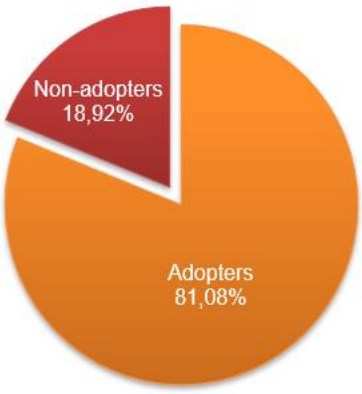


Fig. 30. Adoption industry 4.0 by “Champions”

If for the SMEs the innovative technologies 4.0 are still an element to be discovered, as it emerges from fig. 31, and therefore the margin of improvement for the whole Italian economic fabric is still wide, for the “Champions" the industry 4.0 represents a well known topic.

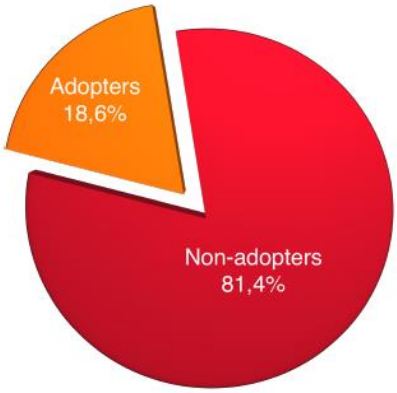


Fig.31. Adoption Industry 4.0 by SMEs (Source: Digital Manufacturing Lab)

It is possible, therefore, to deduce that the investment in technologies Industry 4.0 depends on the size of the company.

The Champions adopting industry 4.0 technologies recognize as the first source of competitive advantage the quality of the products offered (30%) and as the second product innovation (27%). Flexibility in production, however, is very low in Champions, only 17% of adopters recognize it as a competitive advantage (fig. 34).

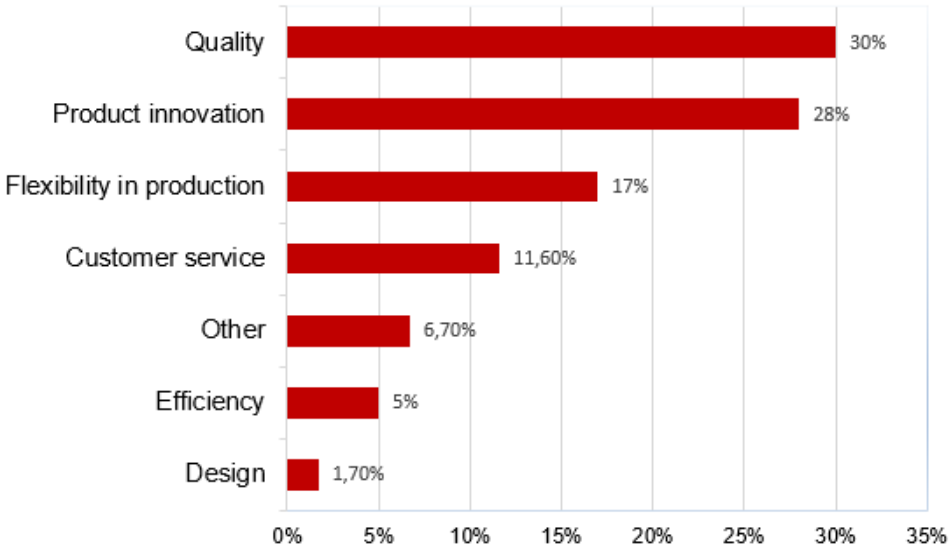


Fig.34. First source of competitive advantage for Champions adopters

For SMEs is the opposite, the production flexibility is the second competitive advantage for 22% of the companies interviewed (fig. 35). This is because SMEs are more likely to change production processes in order to meet different consumer demands. While product innovation is in fourth place with 10.7%, very low considering the 28% of consideration for the Champions. It confirms, therefore, the fact that, as already mentioned, the investment in innovation is due to the size of the company.

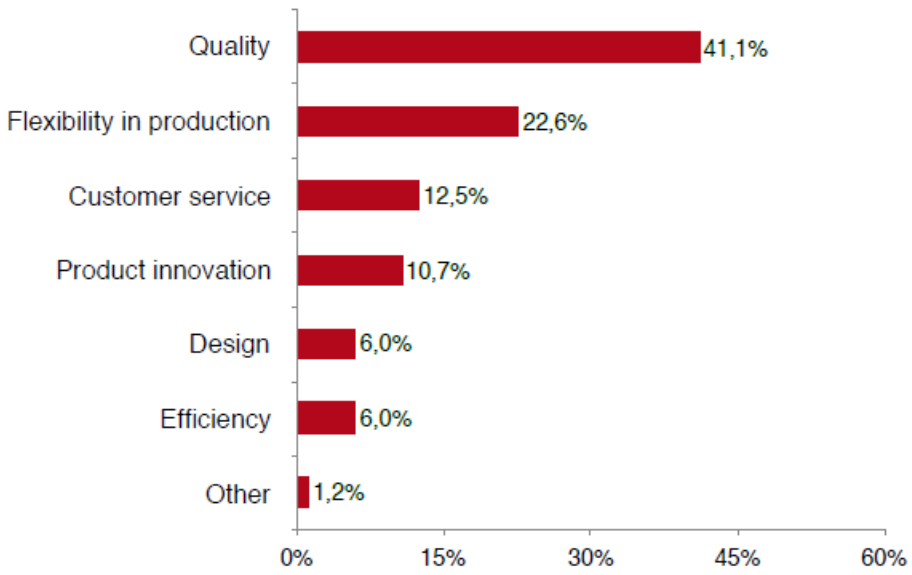


Fig.35. First competitive advantage for SMEs adopters (Source: Digital Manufacturing Lab)

4.5 INDUSTRY 4.0 INVESTMENT AND ICT

Within the research it was asked which technologies Industry 4.0 are adopted by the Champions and in what number are adopted. The average investment in Industry 4.0 project was 6.5% of total turnover. From the interviews with the 74 Champions' companies, as can be seen in figure 36, it emerges that 65% of the adopting companies have invested mainly in Cloud computing, 58.3% in Big-Data, more than 46% in Robotics, about 37% in IoT technologies and only 13% in laser cutting.

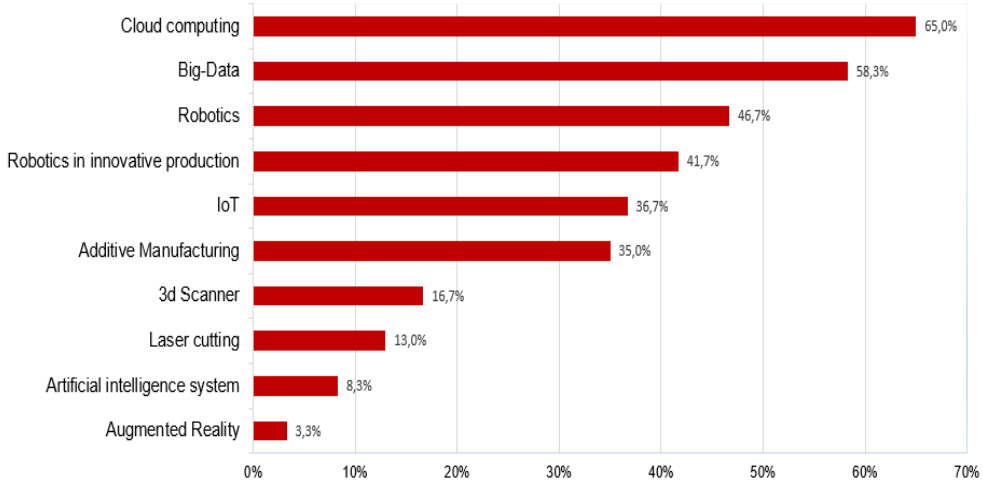


Fig.36. Industry 4.0 investments by Champions

This shows a considerable difference with SMEs. Figure 37 shows, in fact, how small-medium Italian companies invest more in hard technologies, such as Robotics, adopted by about 45% of the SMEs interviewed, and Laser cutting, whose adoption is significantly higher than the Champions, with 44%. These results confirm one of the main factors of advantage for the Champions, production innovation and highlight the increased IT dimension of these companies.

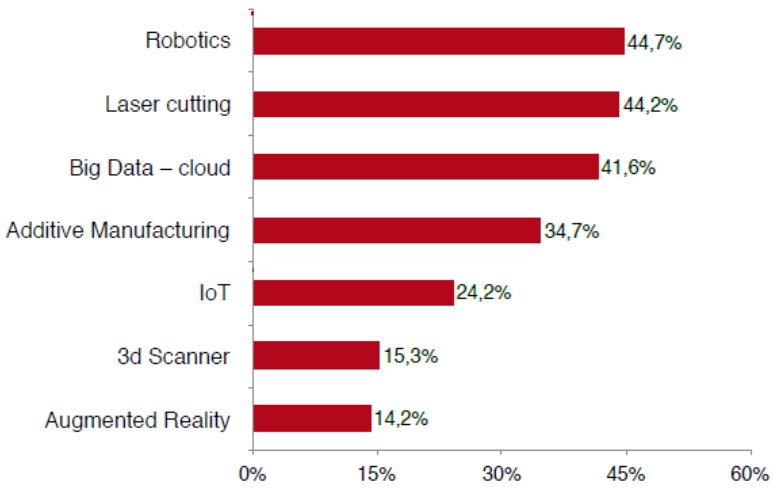


Fig. 37. Industry 4.0 investments by SMEs (Source: Digital Manufacturing Lab)

We could say that the Champions are AI oriented enterprises, it means they have the apparently correct structure to be able to exploit the new revolution of artificial intelligence, having data and processes now digitized at their disposal.

Figure 38 shows how the Champions have adopted more than one industry 4.0 technology. In fact, 77% of the companies surveyed implemented 3 or more than three technologies; only 15% one technology and 12% two technologies.

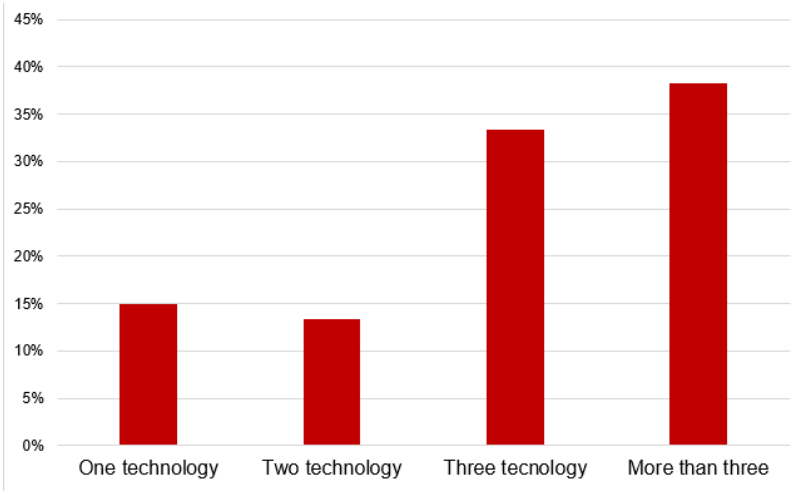


Fig.38. Number of adopted technologies by Champions

Taking into account the report on small-medium domestic enterprises, we note how, in terms of number of adoption of Industry technologies 4.0, the exact opposite happens (fig. 39). Most of the small to medium sized enterprises adopted one technology or two technologies (75%). While only 16.9% more than three technologies and 12% only three.

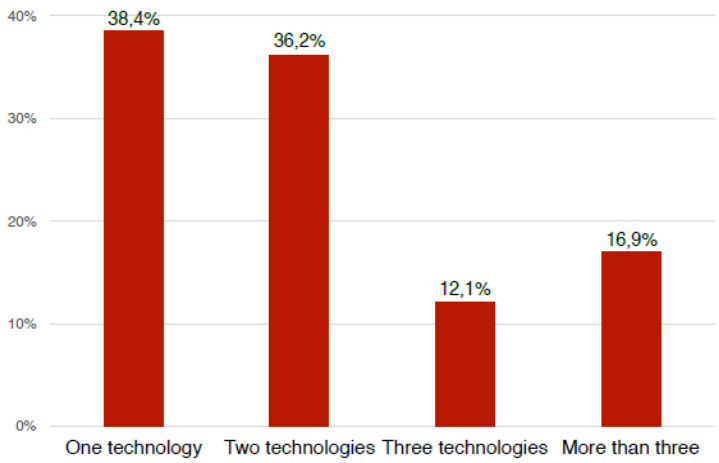


Fig.39. Number of adopted technologies by SMEs (Source: Digital Manufacturing Lab)

The adoption of industry 4.0 technologies, for the Champions companies, appears to be very recent. From fig. 40 it can be seen that most of the technologies adopted by these companies were implemented from 2014 onwards. This is because the main technologies adopted by the Champions, as can be seen from the research, are Cloud computing, Big-Data and Internet of Things, technologies that allow data processing.

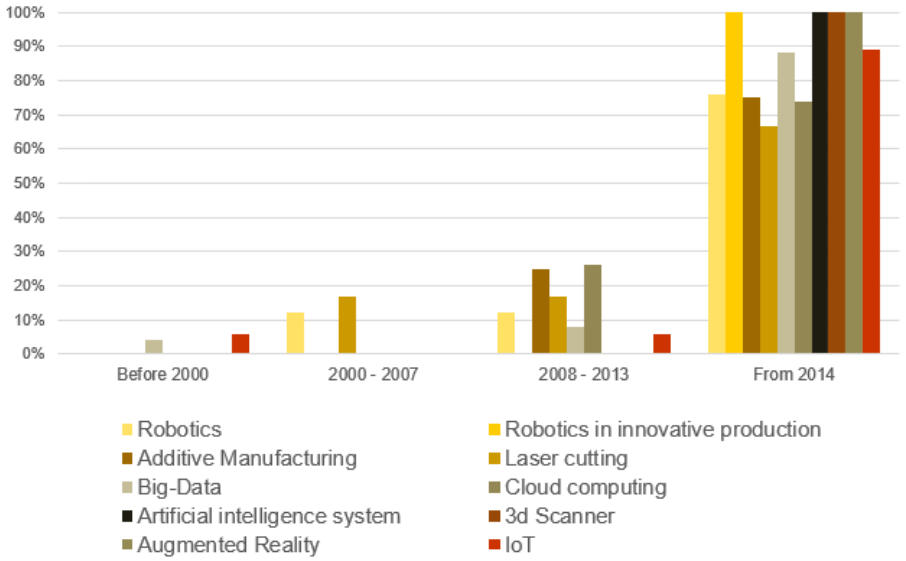


Fig.40. Industry 4.0 by year of adoption by Champions (on average)

In the research on small and medium national companies, we note how the implementation of innovative technologies, such as Big-Data and Cloud computing are recent, as they are also for the Champions, while the adoption of some technologies such as robotics and laser cutting date back to years before 2014, even before 2000 (fig. 41).

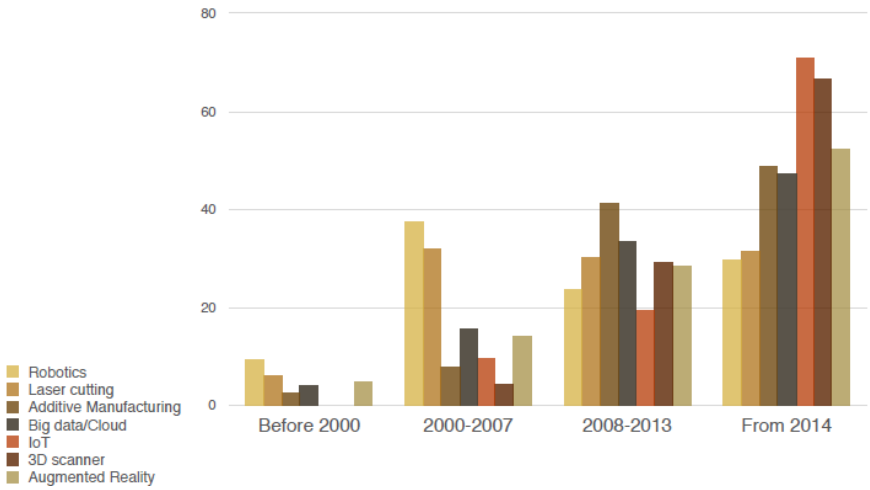


Fig.41. Industry 4.0 by year of adoption by SMEs, on average (Source: Digital Manufacturing Lab)

Another question that has been asked is in which activities of the Champions' value chain these 4.0 technologies have mainly been implemented.

Figure 42 shows how the main technologies adopted by the Champions, namely Cloud computing, Big-Data and Internet of Things, have been implemented in soft activities. Big Data was implemented by 33% of adopters in Operations Management, 23% in R&D and Supply Chain Management. Cloud computing technologies have been implemented in Operations Management by about 20%; Internet of Things is adopted in R&D by about 12% of companies. Instead, technologies such as Robotics are mainly used in so-called hardcore activities. In fact, about 35% have implemented robotics in production activities (operations).

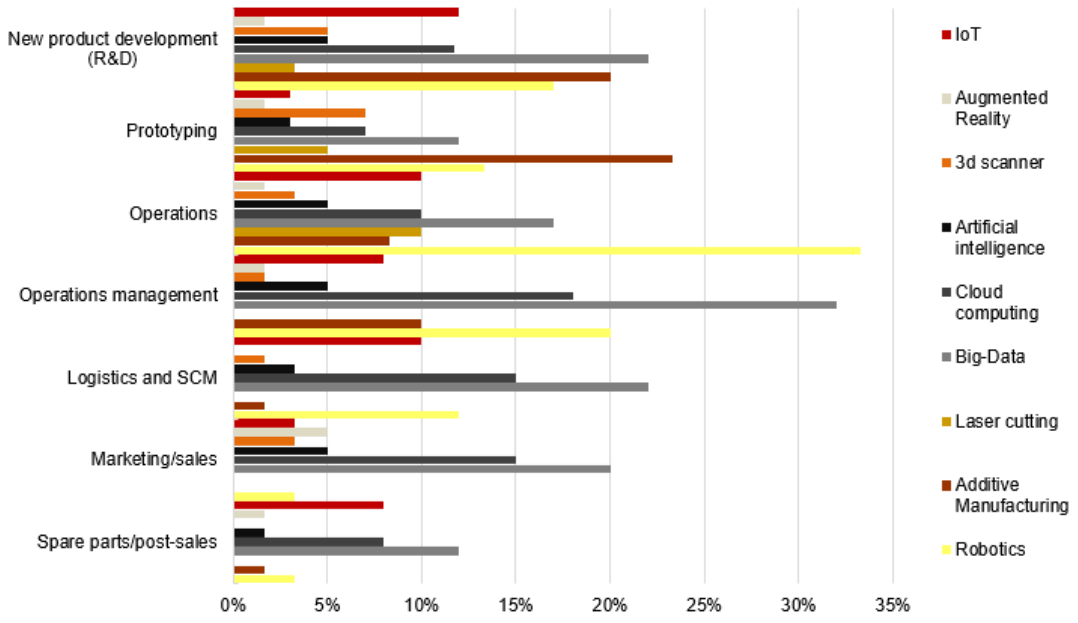


Fig.41. Value chain activity and Industry 4.0 of Champions

For SMEs, as emerges from the research of the Digital Manufacturing Lab, the main technologies are implemented in hard activity (fig. 42). This is due to the fact that SMEs are companies with less digitized processes than the Champions. The technologies adopted by SMEs are mainly Robots: about 40% of SMEs adopting 4.0 technologies implement robots for operations. In addition, also for SMEs, Big-Data are used in operations management and marketing, although in different quantities than the Champions.

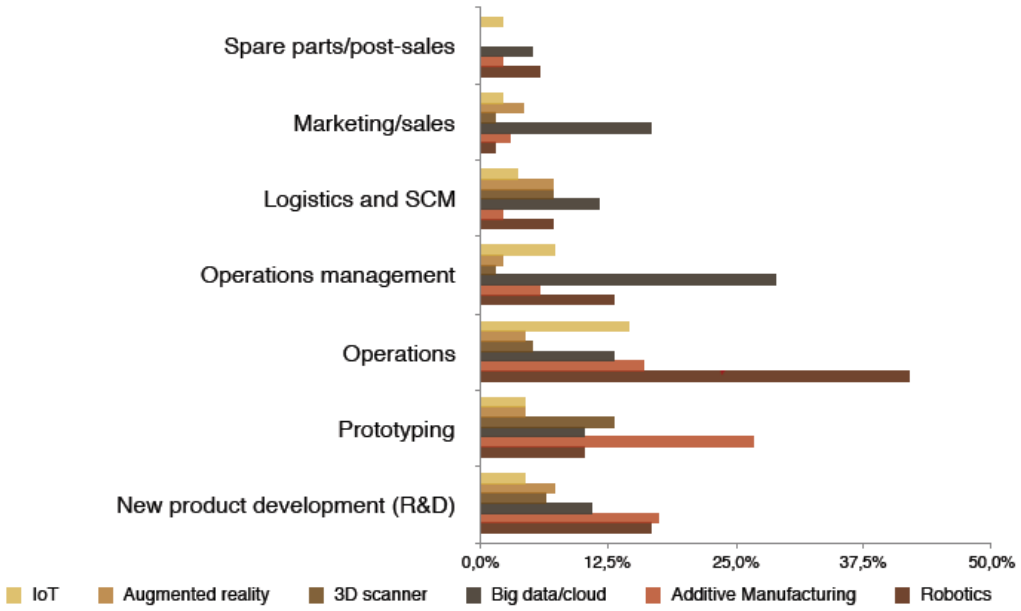


Fig.42. Value chain activity and Industry 4.0 of SMEs (Source: Digital Manufacturing Lab)

The adoption of these technologies appears to have a positive relationship with the adoption of ICT[7] technologies. As previously stated, the Champions adopt more than three technologies labelled 4.0 and, at the same time, they are in possession of more than one ICT technology. Figure 43 shows that 66.7% of the Champions adopting 4.0 technologies are in possession of five or more ICT technologies. Much further away are four ICT technologies (18.3%), three technologies (6.7%), two technologies (5%), one technology (3.3%).

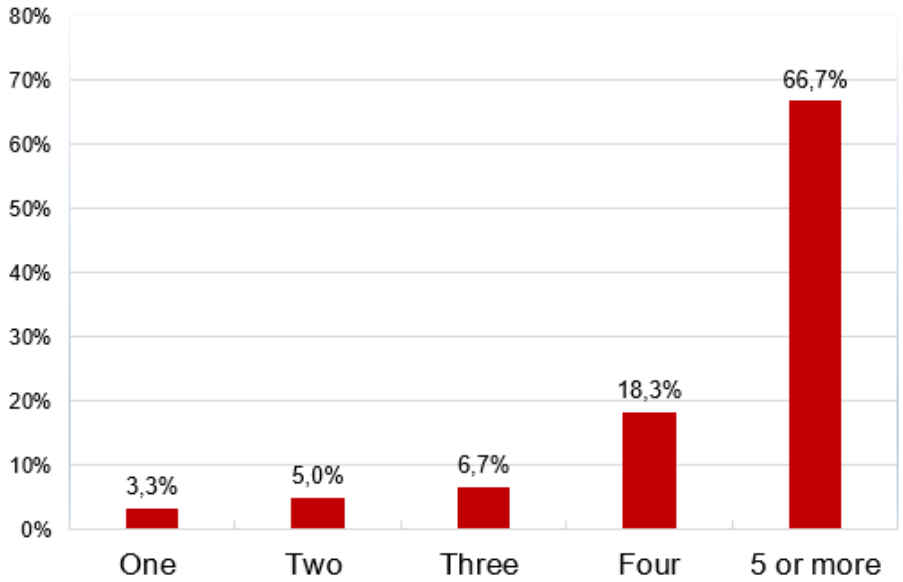


Fig.43. Number of ICT technologies adopted by Champions

[7] ICT, or information and communications technologies, are the infrastructure and components that enable modern computing

The same consideration emerges from the research of the University of Padua. There is a positive relationship between the adoption of 4.0 technologies and the adoption of ICT technologies, as can be seen from figure 44. SMEs have implemented an industry 4.0 technology, as seen in Figure 39, and at the same time have more of a single ICT technology (26%).

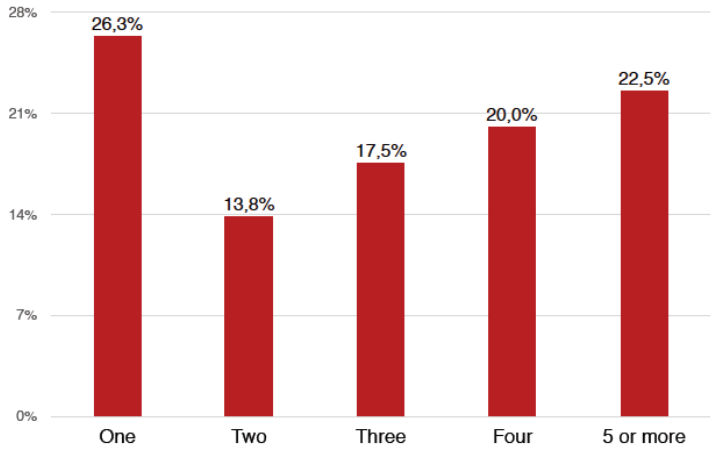


Fig.44. Number of ICT technologies adopted by SMEs (Source: Digital Manufacturing Lab)

Figure 45 shows the main ICT technologies adopted by the Champions

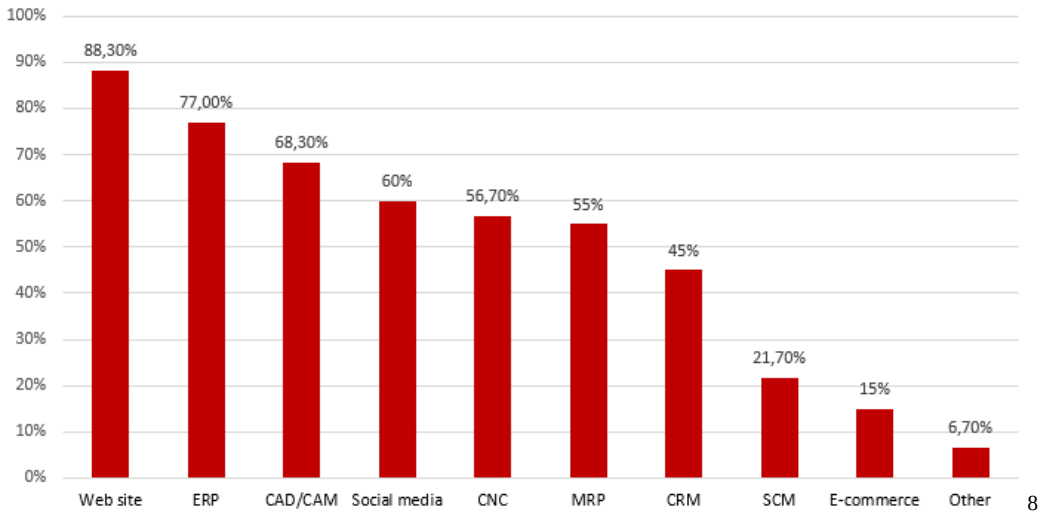


Fig.45. Technologies ICT adopted by Champions

[8] Computer-Aided Design (CAD) refers to the joint and integrated use of software systems; CAM refers to Computer-Aided Manufacturing (CAM).
CNC (Computer Numerical Control) are machine tools whose movements and operations are controlled by an electronic system equipped with programmable logic, called numerical control.
MRP (Material Requirements Planning) is a technique that calculates the net requirements of materials and plans production and purchase orders.
CRM (Customer Relationship Management) defines a category of software consisting of applications that help companies and organizations of all kinds to manage, analyze and optimize interactions with customers and all related data.
SCM (Supply Chain Management) a system of organizations, people, activities, information and resources involved in the process of transferring or providing a product or service from the supplier to the customer

Figure 45 shows how the web-site represents one of the most adopted ICT technologies (88%), even if in clear reduction if we consider the data of the report on SMEs of the University of Padua, where the website is adopted by 96% of SMEs (fig. 46). This is because there is a significant increase in the use of social media (60%) by the Champions, especially for web marketing activities, compared to 45% of SMEs. A very interesting fact that results from the research is the high adoption of ERP[9] by the Champions. While only 26% of small and medium enterprises use ERP, 77% of adopters in the Champions use ERP. This result shows, once again, that these companies have more digitized processes, use much more data and have a much higher IT dimension than SMEs.

Champions' use of e-commerce remains very low (15%). This is very much in line with the findings of a recent *Istat* study[10] on ICT adoption by European companies. The average adoption of ICT technologies by Italian companies is 14%.

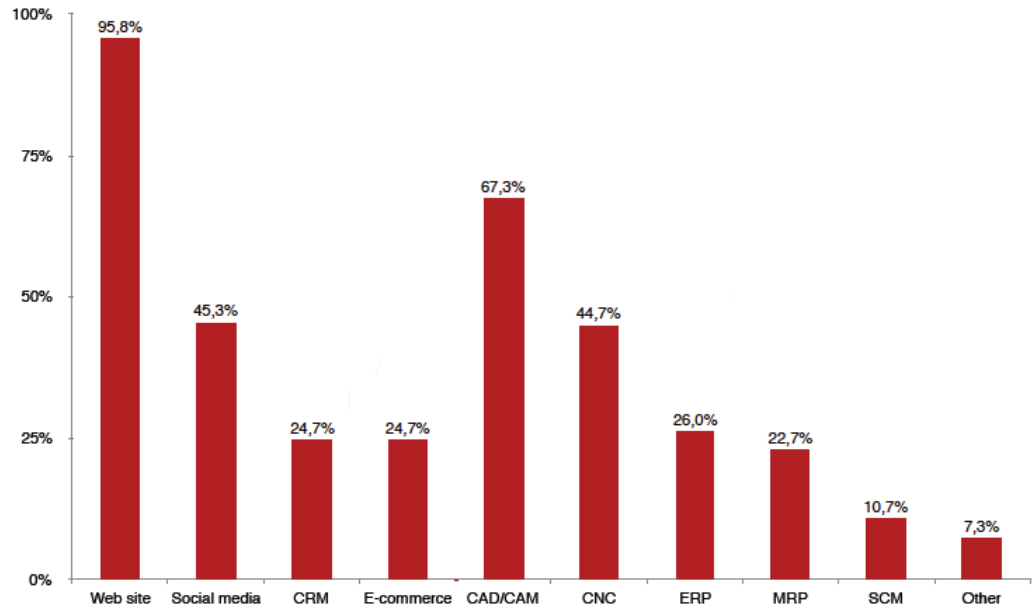


Fig.46. Technologies ICT adopted by SMEs (Source: Digital Manufacturing Lab)

[9] Enterprise Resource Planning (ERP) is business process management software that allows an organization to use a system of integrated applications to manage the business and automate many back office functions related to technology, services and human resources.

[10] Istat data, available on: https://www.istat.it/it/files/2017/12/ICT_Anno2017.pdf

A further question asked to the interviewed enterprises is if in order to be used in the enterprise these technologies Industry 4.0 have to be adopted. As shown in Figure 47, 82% of the Champions adopting 4.0 technologies have modified their technologies.

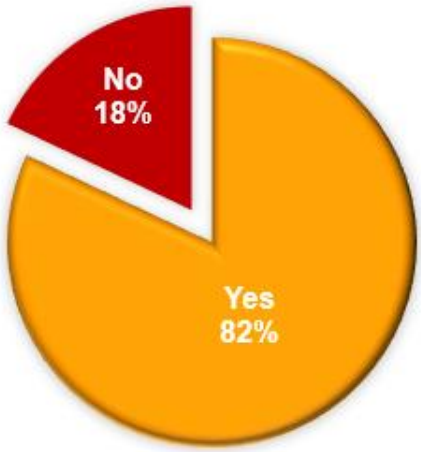


Fig.47. Customization of Industry 4.0 technologies adopted by Champions

The customization of these technologies has taken place with a fairly high intensity. On a scale from 1 to 5, where 1 indicates a level of intensity in the change almost zero and 5 a level of intensity very high, the companies have mainly modified the software part of the technology, with an average intensity of 3.76 with a high integration of the system with the technologies already in place (fig. 48).

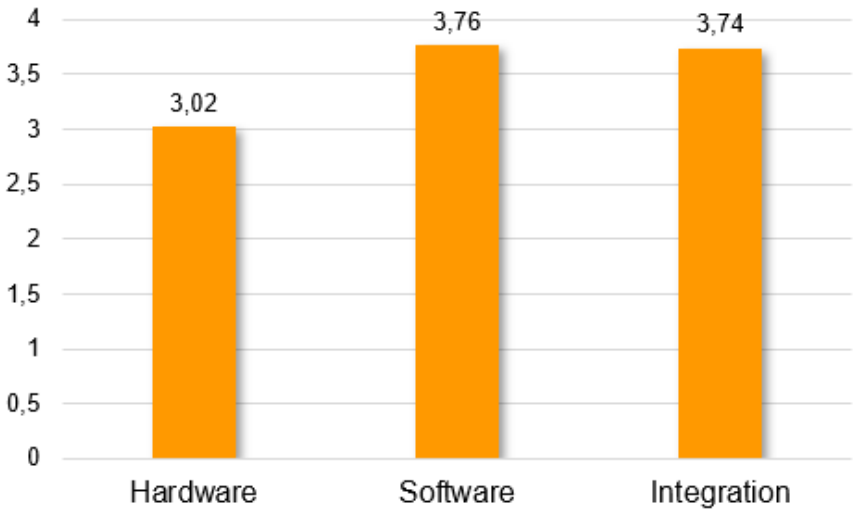


Fig.48. Domain of customization of technologies 4.0 by Champions (average value - 1 not at all/5 very high)

The same consideration can be given to SMEs (fig. 49). Around 72% of the small-medium enterprises surveyed, which invested in Industry 4.0, had to make changes to the technologies adopted, with a fairly high level of intensity both in the software component and in the integration with other technologies present in the company.

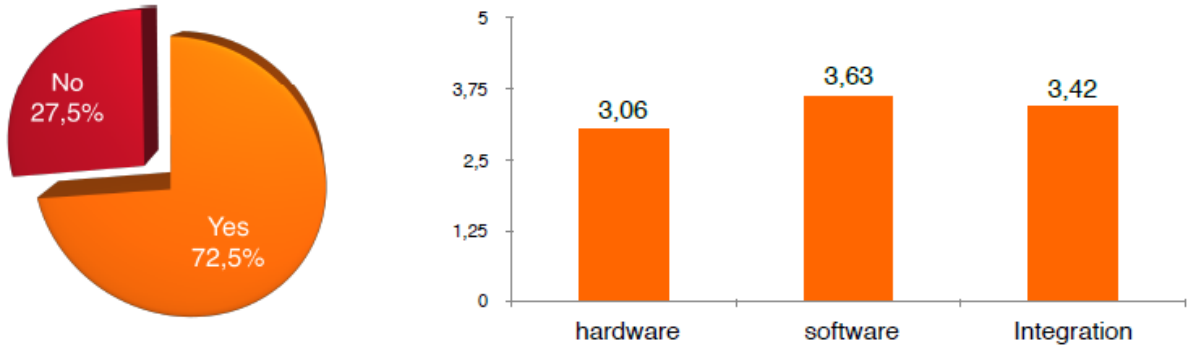


Fig.49. Domain of customization of technologies 4.0 by Champions (average value - 1 not at all/5 very high)

But which were the main actors that pushed the 60 companies to invest in Industry 4.0 projects? Figure 50 shows the main partners for selecting and developing industry 4.0 projects.

As can be seen from Figure 50, 60% of the Champions interviewed stated that to carry out a 4.0 project they collaborated with 4.0 technology suppliers, 42% with Machinery/Plant suppliers, 38% with consultants, 20% with system integrators and 11. 7% collaborated with universities or research centres. It emerges that the drive for innovation and collaboration with suppliers of 4.0 technology is the key to an innovative business system.

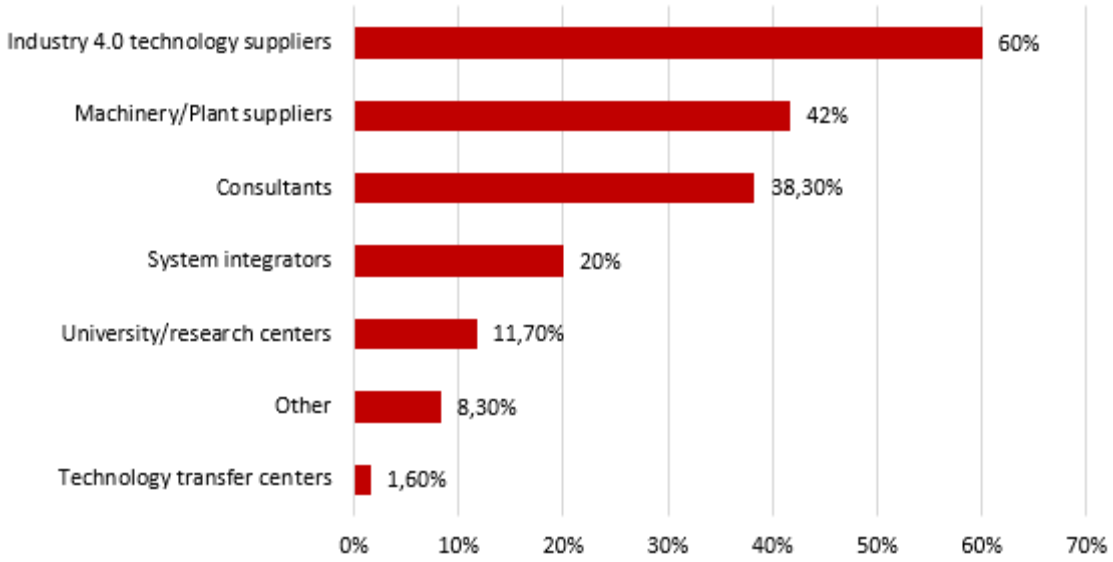


Fig.50 Partners to select and develop Industry 4.0 projects for Champions

If, on the other hand, we take into consideration the research of the University of Padua (fig.51), we notice how machinery/plan suppliers (64. 5%) have played an important role for SMEs, for investment in 4.0 projects. Followed by Industry 4.0 technology suppliers (39%), Consultants (31.9%), system integrators (14%), University/research centers (8.5%), much lower than the Champions, Technology transfer centers (2.1%).

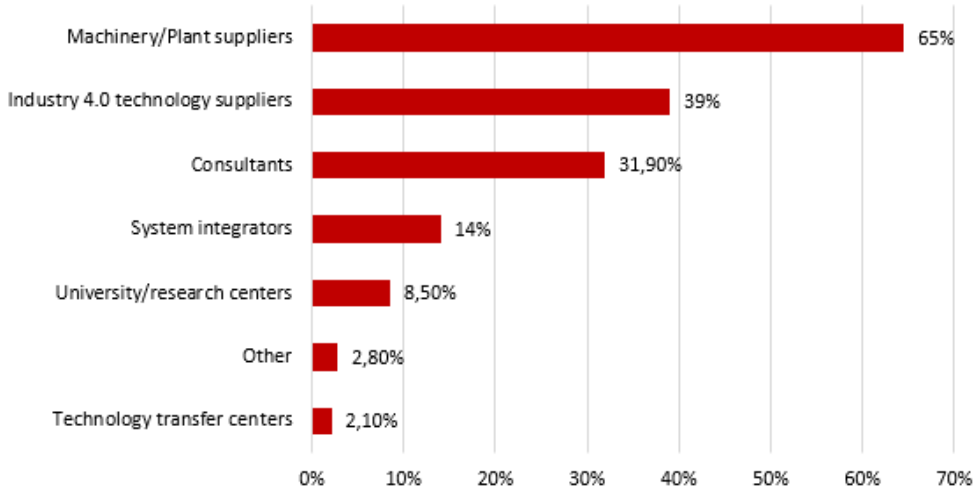


Fig.50. Partners to select and develop Industry 4.0 projects for SMEs (Source: Digital Manufacturing Lab)

4.6 REASONS, BENEFITS AND DIFFICULTIES OF INDUSTRY 4.0 INVESTMENT

After analyzing how strongly the Champions have invested in industry 4.0 technologies, in this section we try to understand what have been the main reasons and benefits that have led these firms to implement these technologies, also investigating the difficulties encountered by companies during the implementation process. Figure 51 summarizes the main reasons that led the company to implement 4.0 technologies.

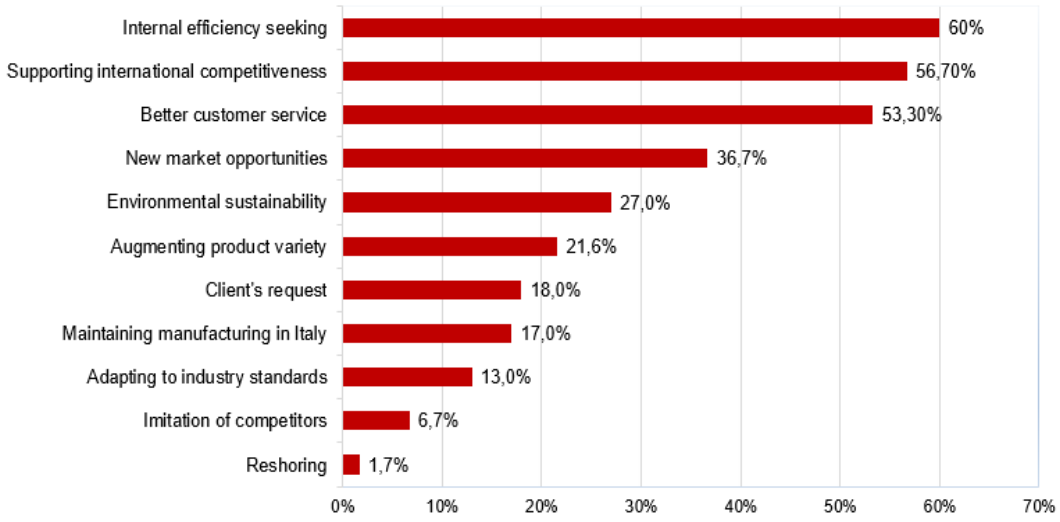


Fig.51. Champions' reasons investments in Industry 4.0

Figure 51 shows that among the main reasons that push a company towards the adoption of such technologies are the search for internal efficiency (60%), the maintenance of international competitiveness (56.7%) and that of offering a better service to the customer (53.3%). With greater detachment emerges the reason for new market opportunities (36.7%), environmental sustainability (27%), increasing the variety of product (21.6%), client's request (18%), maintaining manufacturing in Italy (17%), adapting to industry standards (13%). The imitation of competitors (6.7%) and reshoring (1.7%) are more distant.

For SMEs, however, as shown in Figure 52, the main reason for implementing 4.0 technologies is to offer a better service to the customer (75%). This is followed by the search for internal efficiency (65%), maintaining international competitiveness (58%), new market opportunities (52%), increasing product variety (44%). Here, as in the case of Champions, the imitation of competitors and reshoring are the reasons of lesser importance, 9% and 5% respectively.

Fig.51. SMEs' reasons investments in Industry 4.0 (Source: Digital Manufacturing Lab)

We also asked the question about what are the reasons that led the other 14 companies interviewed not to invest in industry 4.0 projects.

Figure 52 shows the main reasons for the non-adopters Champions.

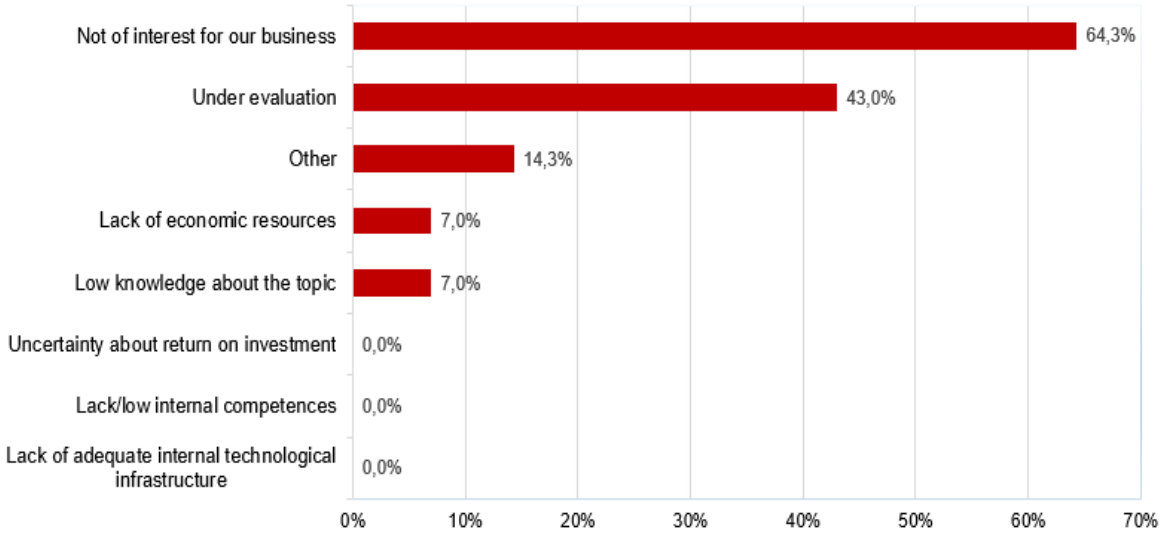


Fig.52. Champions reasons for not investing in Industry 4.0

The main reasons why a company does not invest in 4.0 technologies are the fact that this investment is not of interest to their business (64%) or is under evaluation (43%). Other reasons follow (14%), such as, for example, buying from third parties. Interesting is the data on the lack of economic resources and the low knowledge of the topic, only 7%. This fact underlines the economic soundness of these companies, which do not invest in 4.0 not for strictly economic reasons or because they do not know the subject, but mainly because their business does not require it.

In SMEs, on the other hand, we notice a high percentage in not of interest for their business (66%), being small businesses and above all artisan businesses, and a low knowledge of the subject (15%). This emerges from figure 53.

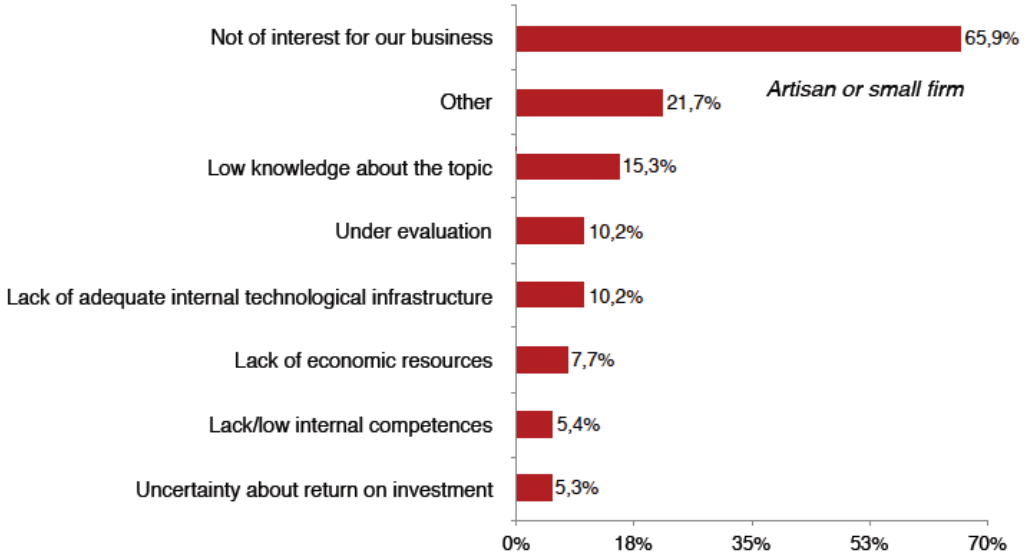


Fig.53. SMEs' reasons for not investing in Industry 4.0 (Source: Digital Manufacturing Lab)

Faced with the reasons that pushed companies towards the adoption of 4.0 technologies, we investigated the main benefits that this model has generated within the company.
But what are the benefits perceived by the Champions?
Figure 54 provides an answer to this question.

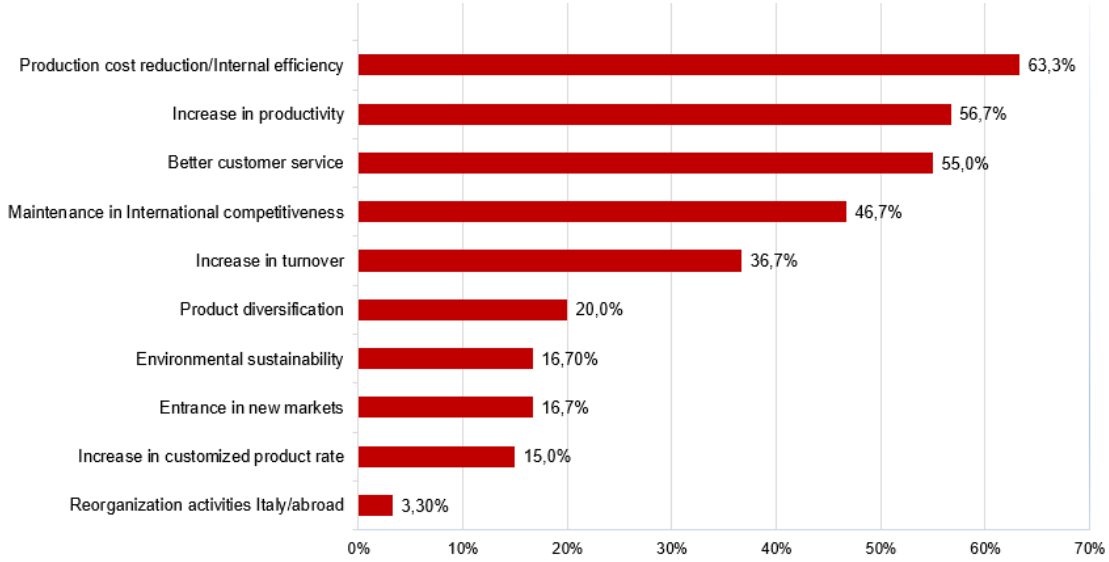


Fig.54. Champions' benefits investments in Industry 4.0

Around 63% of companies surveyed said that the adoption of technology 4.0 led to an improvement in internal efficiency and a reduction in production costs, 56.7% said that productivity improved, 55% that led to an improvement in customer service, 46.7% maintained international competitiveness, 36.7% found an increase in turnover, 20% that led to product diversification, 16.7% that increased environmental sustainability and entered new markets, 15% increased the rate of product customization, while only 3% that led to a reorganization of activities in Italy or abroad.

The same considerations can be made for national small and medium-sized enterprises, as can be seen from Figure 55.

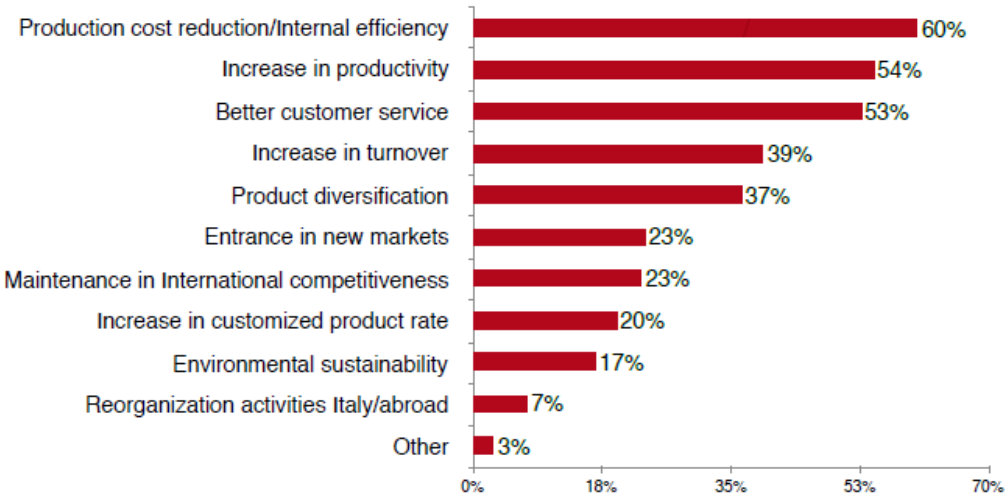


Fig.55. SMEs' benefits investments in Industry 4.0 (Source: Digital Manufacturing Lab)

Figure 56 highlights the main difficulties perceived by the companies interviewed during the process of implementing 4.0 technologies.

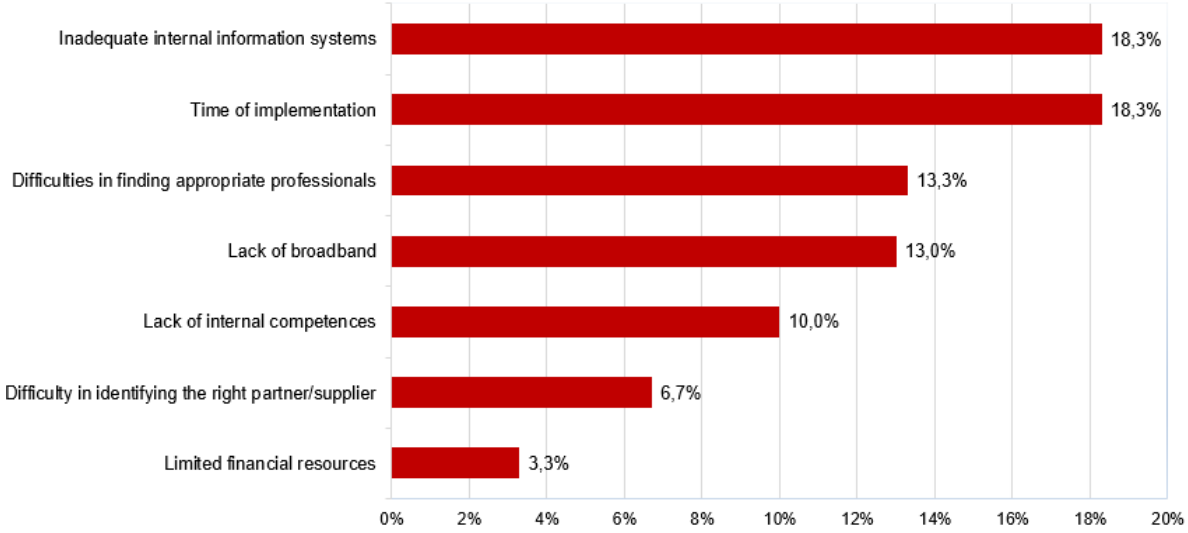


Fig.56. Difficulties of Champions in adoption of Industry 4.0 technologies

Figure 56 shows how the main difficulties are represented by inadequate internal information systems (18.3%) and by the time of implementation of these technologies (18.3%). Approximately 13% of the companies involved in the research stated that they encounter obstacles in finding appropriate professional figures. In addition, 10% also point out difficulties in the lack of internal competences, 6.7% point out difficulties even upstream of the supply chain, underlining a lack of confidence in the ability of suppliers to meet increasingly high-performance requirements, while 3% finds difficulties in the limited financial resources. With

the adoption of 4.0 technologies, companies discover that they have further shortcomings, despite having many ICTs.

Considering instead the results of the report of the University of Padua, it is possible to notice a considerable difference compared to the Champions (Fig.57). If for the Champions the main difficulties were the inadequate information systems and the time of implementation, in the SMEs the difficulties are related to the professional figures and the lack of broadband. Precisely, 25.4% of small and medium enterprises stated that the main difficulties they encounter are represented by the lack of appropriate professional figures, 24% identified an obstacle the lack of broadband, 23% emphasized the limited financial resources, 22.9% the implementation time, 22% the lack of internal competences, 20% saw a difficulty the inadequacy of internal information systems, 17.8% emphasized difficulties in finding the right supplier.

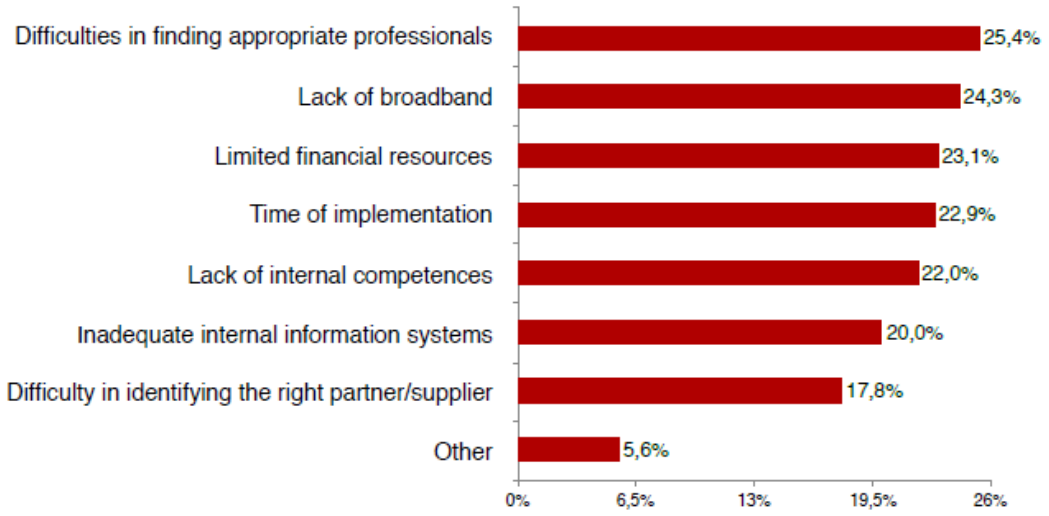


Fig.57. Difficulties of SME's in adoption of Industry 4.0 technologies (Source: Digital Manufacturing Lab)

4.7 INDUSTRY 4.0: IMPACT ON THE PRODUCT AND SUSTAINABILITY

This section analyses the impact of the adoption of Industry 4.0 technologies on the product and the extent to which the adoption of these technologies has had an impact on the environment.

Figure 58 shows how the adoption of 4.0 technologies by the Champions has led to greater control over the product during its use (33%), thanks to the implementation of technologies

such as Cloud computing and Big-data, an improvement in product performance with the new added services (23%).

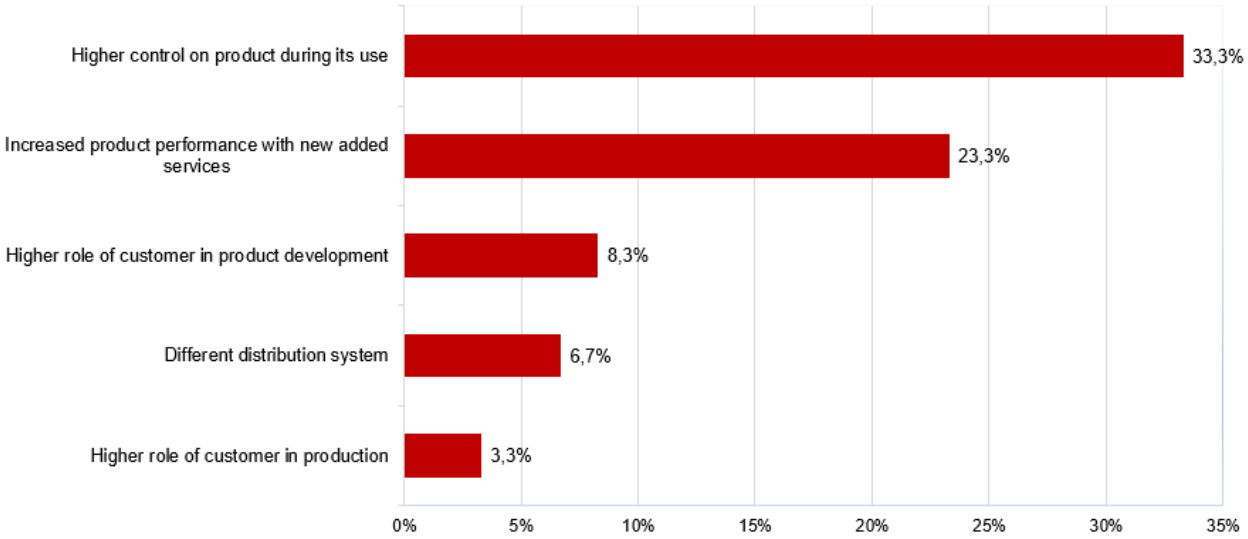


Fig.58. Impacts of Industry 4.0 tecnologies on Champions' product

Considering, however, the analysis on SMEs we note that the main impact of 4.0 technologies on the product of such enterprises is a higher consumer involvement on product development (30%), Figure 59. This is due to the fact that SMEs are mostly artisan firms, which make product customization an essential element. However, Champions customized less.

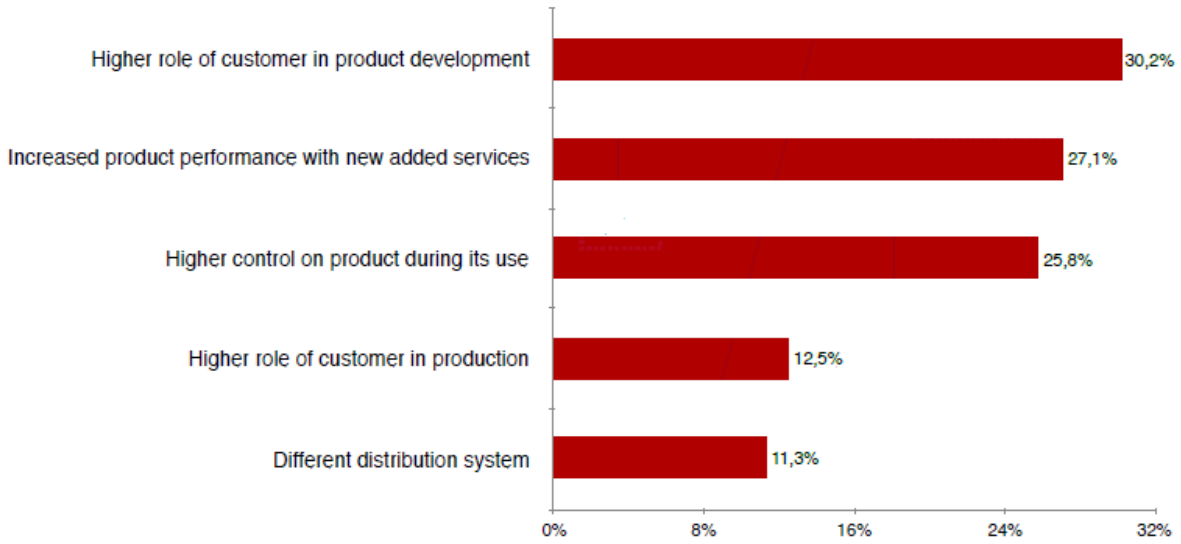


Fig.59. Impacts of Industry 4.0 tecnologies on SMEs' product (Source: Digital Manufacturing Lab)

Figure 60 shows the impact of Industry 4.0 technologies on the environment.

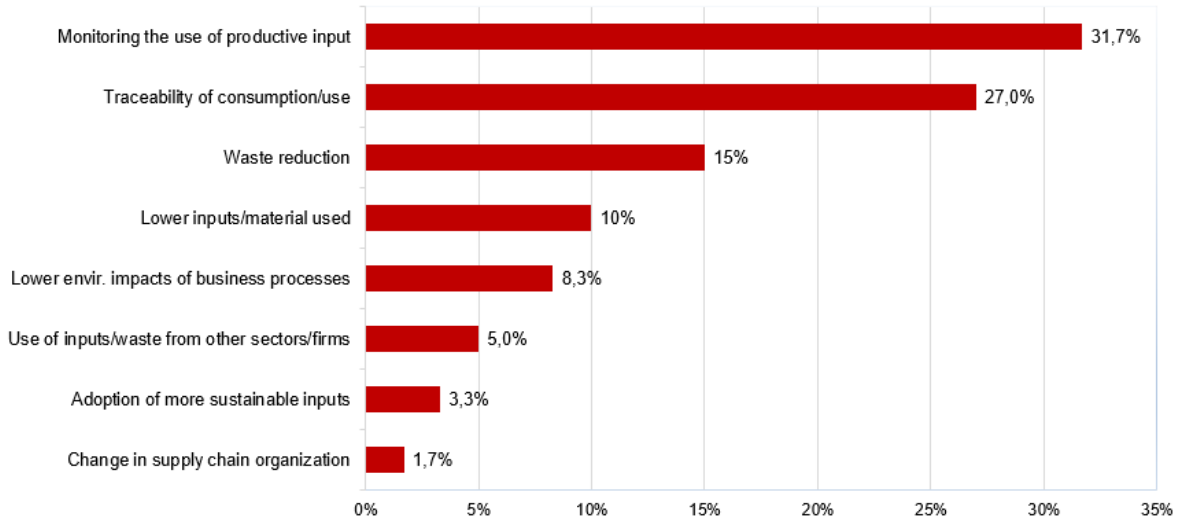


Fig.60. Industry 4.0 and sustainability for Champions

The implementation of 4.0 technologies have led the adopting companies to monitor the use of productive inputs (31.7%) and work on the traceability of consumption (27%). The Champions are aiming for a greater guarantee to the consumer. Only 15% of the time the adoption of 4.0 technologies have led to a reduction in waste.

These results are in line with what has been studied by the Digital Manufacturing Lab on SMEs (fig. 61).

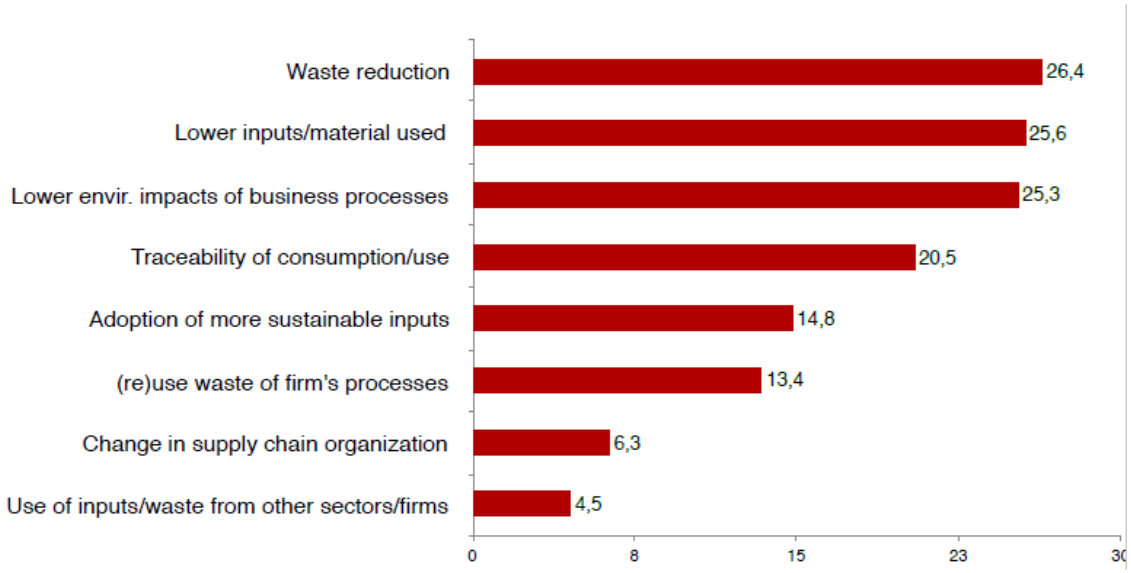


Fig.61. Industry 4.0 and sustainability for SMEs (Source: Digital Manufacturing Lab)

4.8 INVESTMENTS IN INDUSTRY 4.0: IMPACTS ON EMPLOYMENT

The research questioned whether the adoption of 4.0 technologies has also had an impact on employment. The question was therefore also raised as to whether Industry 4.0 could be a major problem for workers, leading to high unemployment, or whether it could be a way of improving the labour market.

Figure 62 shows what the 60 companies adopting Industry 4.0 technologies responded to about the impact on employment.

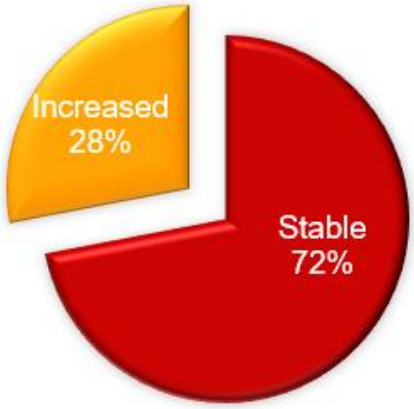


Fig.62. Impact of investments in Industry 4.0 on employment of Champions

As Figure 62 shows, 72% of the Champions said that as a result of the adoption of 4.0 technologies employment has remained stable; 28% said that it has increased.

Also, as far as SMEs are concerned, employment remained stable for 61.7% of the enterprises, it grew for 34%, while it decreased for 4% of the small enterprises (Fig. 63).

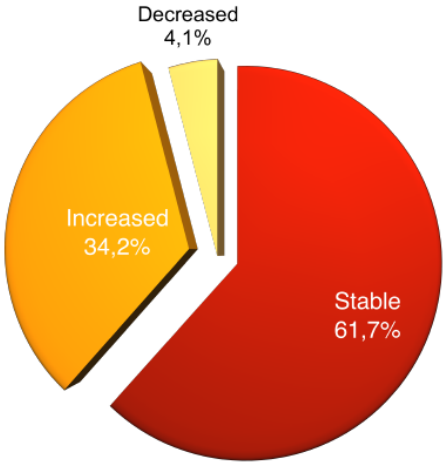


Fig.63. Impact of investments in Industry 4.0 on employment of SMEs

(Source: Digital Manufacturing Lab)

However, in order to implement innovative technologies in the company, the Champions were faced with a change in factory work: on the one hand they had to invest in the training of new specialized professionals, on the other they had to provide an update of the skills of their employees, so that they understood and were able to manage the change in business. Figure 64 shows the results obtained in percentage terms.

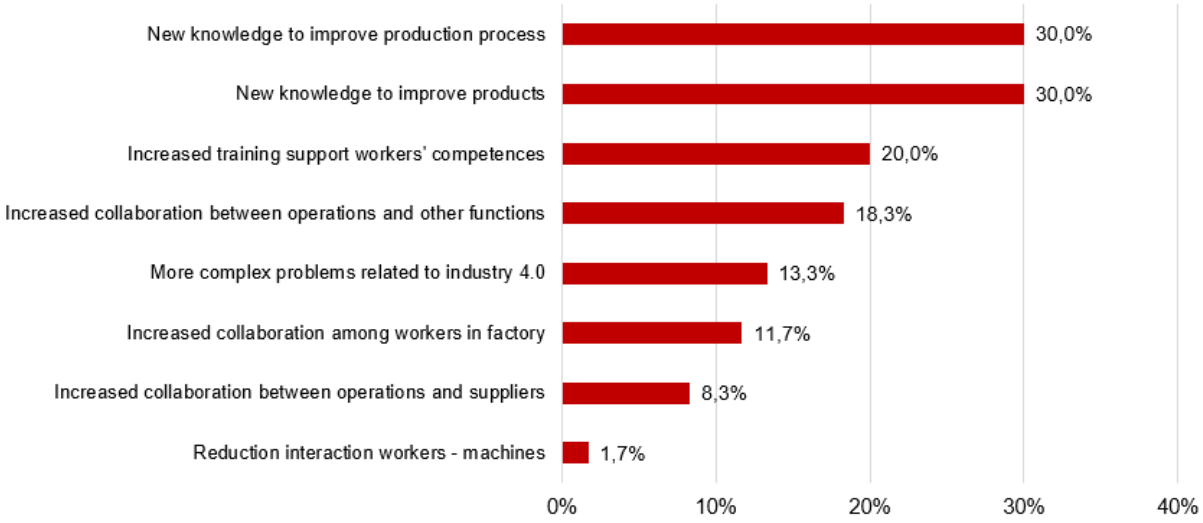


Fig.64. Industry 4.0 and changes in Champions' factory work

The 30% said they had implemented new knowledge to improve production processes and products; 20% said they had increased training support workers'; competences.
The same considerations can be made for SMEs (Fig. 65). Enterprises must train workers in order to better integrate technologies and people.

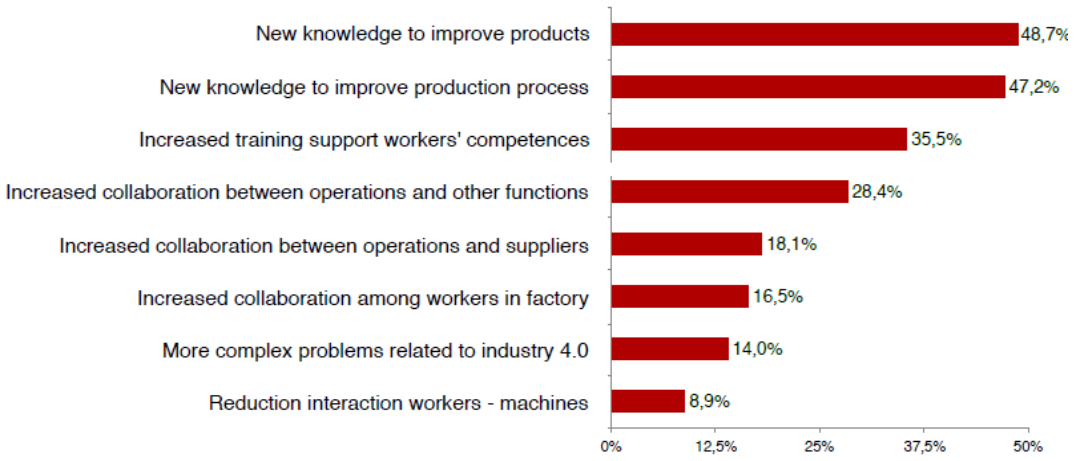


Fig.64. Industry 4.0 and changes in SMEs' factory work (Source: Digital Manufacturing Lab)

4.9 NATIONAL INDUSTRY 4.0 PLAN INCENTIVES

Another question that has been asked is whether the companies adopting Industry 4.0 technologies were aware of the benefits provided by the Piano Calenda. The research shows that all the companies interviewed were aware of this Plan and that more than half of them had taken advantage of the benefits provided in order to encourage investment in innovative technologies. As can be seen from the graph, 59% of the adopting Champions have benefited from the incentives, they have benefited from ***Hyper-depreciation*** and ***Super-depreciation***; the 26% have not used them but will do so in the future and 15% have benefited from these incentives with further financing. Interestingly, in any case, all the companies interviewed have benefited or will benefit from the incentives provided by the Piano Calenda. Therefore, it is possible to say that the Piano Calenda had a strong influence to encourage investments in Industry 4.0. Incentives have been used by Champions which have seen in this tool a way to increase their technological equipment by reducing the costs and risks of investment.

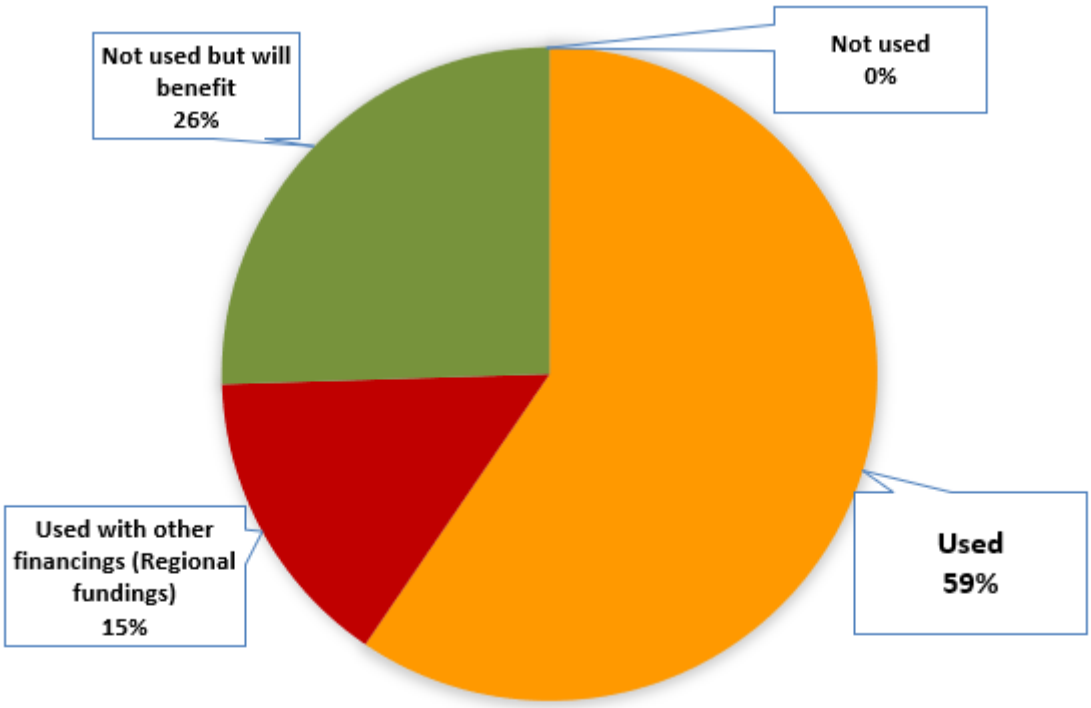


Fig.65. Incentives of National Industry 4.0 Plan (about Champions)

CONCLUSIONS

The research is a first attempt to analyze the paths of adoption of Industry 4.0 technologies by that group of "Champions" that represents one of the most important actors of the Italian recovery. Those companies for which the economic crisis of 2007-2008 represented an opportunity for the strategic reconversion of processes and markets. These are companies that are proving efficient even in the presence of adverse factors and that are facing a new challenge, digitization. Industry 4.0 responds to a desire for innovative and sustainable growth in the face of the emergence of new challenges facing companies. The results of the research show that the reasons behind investments in technological innovation are represented by a constant search for internal efficiency and the desire to support international competitiveness. In view of the results obtained, we can say that if the adoption process is still limited for small-medium Italian companies, because there is a lack of a real culture of innovation, which makes it difficult to understand the benefits deriving from an investment in 4.0 technology, for the so-called Champions the adoption process is much more advanced. They have a higher adoption intensity than small-medium Italian companies and, therefore, adopt many more technologies 4.0. The Champions adopting these technologies are innovative companies, which have already made an investment path on the ICT front. There is, in fact, a positive relationship between 4.0 technologies and ICT technologies adopted. The research also shows that technological investment is closely linked to the size of the company. The Champions are medium-large companies, with excellent levels of profitability and financial solidity. This allows him to invest in innovation and gain margins of advantage over his competitors. The main Industry 4.0 technologies adopted are soft, mainly Cloud computing and Big-Data: this highlights the IT size of these companies, much larger than SMEs. Hard technologies, on the other hand, are less widespread: robotics remains important, but technologies such as laser cutting, which are important in the operations of SMEs, are decreasing in the reality of the Champions, while the adoption of IoT (Internet of Things) technologies is increasing, a substantial difference with respect to what emerges from research on SMEs. The Champions are enterprises that we could define Artificial Intelligence (AI) oriented. They have a seemingly more correct structure to exploit the new revolution of artificial intelligence, having more digitized processes at their disposal. An interesting element that emerges from the research is that Industry 4.0 technologies are adopted differently within the company between different functions and business processes. Cloud computing and Big-Data are mainly adopted in soft activities: for example, in operations management, in the production management part, in R&D, Supply Chain Management and marketing. While technologies such as robotics are adopted in hard work, such as production.

Industry 4.0 technologies, adopted by the Champions, are mainly aimed at the production of standard products, while in the reality of SMEs these technologies are adopted to produce customized products. This is because SMEs are mainly artisan work. Investment in industry 4.0 technologies or projects has increased the company's innovative capacity. The impacts are mainly related to efficiency, productivity and improvement of customer service, with a different role of individual technologies. There is greater control over the product during use, an increase in the value of the product with new added services and traceability and control over the product, to provide greater assurance to the consumer, as well as on the front of environmental sustainability, where we have a high monitoring of the use of production inputs. An encouraging result from the research is undoubtedly the fact that the investment and implementation of Industry 4.0 technologies have had a positive impact on employment. More than 72% of adopters have kept employment stable, while 28% have increased it, with an impact on factory work in terms mainly of investment in new product or process knowledge or skills development through training. The research reveals a variety of partners with respect to the technologies adopted, with a prevalence of suppliers of Industry 4.0 technologies and an increase in the importance of universities. The main difficulties encountered in adoption are inadequate internal information systems and implementation time. Champions through the adoption of 4.0 technologies discover that they have some shortcomings, despite having already implemented several ICT technologies, also the implementation of these technologies takes quite a long time, so there is a greater organizational complexity in the adoption of these technologies. In addition, it can be said that the Piano Calenda has played an important role for the Champions in investing in 4.0 projects. All companies were aware of the Plan and have proven to appreciate the incentives provided, mainly super-amortization and hyper-amortization. In fact, it emerges that 74% of the adopting Champions have benefited from the incentives and the residual one (26%) will benefit. As far as the non-adopting Champions are concerned, what emerges is that the main reason is not economic-financial, but strategic-cultural, since most of the companies declare that they are not interested in their business or that they are still in the evaluation phase of such technologies or projects. In this context, the transformation towards an innovative manufacturing 4.0 is a path that requires an active, strategic role of companies in rethinking business models, in which technical product and process skills are linked to commercial skills to enhance the innovative path made in order to seize the new opportunities offered by digital, as demonstrated by these new business realities. Particular attention should be given to regulatory measures that support and push for the adoption of 4.0 technologies, financial measures and incentives to facilitate access to digitization. Such investments are essential to

rethink the way of doing business and to be able to make this extraordinary entrepreneurial heritage a real engine of recovery for the whole country.

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