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IMPACT of TECHNOLOGICAL CHANGE ON WORKERS' SKILLS

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Abstract

Over the past few years, technological development has increasingly impacted job activities and structure, both in a negative and in a positive way. This thesis aims to study and evaluate the effects of technological advancement on workers, focusing on a skill-biased technological change. In the first part of the essay, the consequences of digitalization are examined, then, the study presents the professional on-the-job training applied in Italy, evaluating if it can help employees to measure up with digital transformation. After having inspected the general behaviour and circumstance in the country, the thesis brings the attention to the specific case of the company Robert Bosch Gmbh Branch in Italy, focusing on the offices seated in Turin. Profiles of workers, skills, technological training and channels through which training is provided are pointed out and analyzed. Then, to understand if the actual educational framework is sufficient for workers to keep up with technological advancement, a survey has been conducted to find out more information about employees' opinions regarding this topic.

Contents

Introduction

Digitalization is a term that describes the phenomenon of adopting digital technologies in business and society. It requires updated skills by workers and implementation of innovative and technological tools and machines by firms. Technological development brings significant changes, mainly affecting employees and the way they apply their competences. The main goal of the thesis is to study the effect that technological change has on workers and, to do so with a concrete example, a survey has been proposed to a group of employees of the well-known company Robert Bosch Gmbh Branch in Italy. This topic is really important for managers to understand how laborers feel about digitalization and how it affects their productivity and autonomy. The project consists of four different chapters. The first chapter analyses the characteristics of technological change, its stages, its long-run perspective and its relationship with workers. Then, educational system in Italy is examined in detail, starting from compulsory schooling and then focusing on Continuing Training. The latter is analyzed meticulously, considering how firms changed their way of providing courses in relation to technological change, how it is financed and which are the consequences for workers. After that, the third chapter presents the firm Robert Bosch and its relationship with digitalization and connectivity. The company provides a complete academy called TEC to

its employees, which are supplied with all the means necessary to keep up with digital transformation. Lastly, the results of the survey proposed to workers are assessed and conclusions are drawn. The project funds its study based on two starting hypothesis. The first one is willing to confirm the positive effects of digitalization and automation on workplaces. The second hypothesis affirms that Continuing Training is important inside of a company, because it is the only method enabling employees to keep up with technological change.

Chapter 1

Effects of Technological Change on Workers

1.1 What is Technological Change

The definition of technological change refers to the improvement of the already existing technologies and the invention of new ones to improve the existing products in the market while also creating others. The word *technology* comes from two Greek words, transliterated *techne* and *logos*. The first one means art, skill, craft or the way, manner, or means by which a thing is gained. The second one means word, the utterance by which a thing is expressed, a saying, or an expression. So, literally, technology means words or discourse about the way things are gained. Nowadays, the term has come to mean something wider, enclosing different definitions. It can be considered as the rational process of creating means to order and transform matter, energy and information to realize certain valued ends, but it can be also used to define the set of tools, services and systems created by technological process. Moreover, it consists of the facts and procedures necessary to order and manipulate matter, energy, information, as well as how to

discover new means for such transformation. Technology can be otherwise thought of, in narrow sense, as *tools*: it is true that technology can be seen as tangible items but it is also stratified, in the sense that it is composed of materials and components, combined into devices and linkages that, in their turn, are combined into an overall working system. This is how modern technology is organized: a configuration that works and captures the aspects neglected or at least black boxed by the focus on tools. Technology has become an important element of the self-image of Western culture because it has been, and continues to be, a key factor in transforming societies and it has become associated with modernity, progress and rationality. The emerge of technology policy, assessment and the recognition of controversies about new technologies are all indicators of reflexive technological development. Technical change can be studied in a variety of forms and it can be precisely thought of as increasing the amount of a product that can be produced from a given amount of inputs, or as expanding the universe of opportunities for substitution of inputs and products. Its sociological relevance is quite basic, because any change in technology almost necessarily entails a shift in the way of life, affecting individuals' ideas, and it should not be seen as an external driver of societal transformation but rather as part of it. Technology can change the world in ways that are unimaginable until they happen: for example, talking with someone halfway around the world would have been unthinkable for our ancestors and, as they would have struggled to imagine a world connected by the Internet, it is hard for us to imagine the arrival of all those technologies that will fundamentally change the world we are used to. This development was extremely slow in the past but, in contrast, today's time is a period of extraordinarily fast techno-

logical change. Technologies are becoming increasingly complicated and increasingly interconnected, making it more difficult and imperative than ever to probe how technological advancements are altering life in both positive and negative ways and what social, political and legal tools are needed to help shape the development and design of technology in beneficial directions. Our technologies may be more advanced and complicated than ever but so, too, are our understandings of how they can best be leveraged, protected and even constrained: in facts, these are exciting times not just for technological development but also for technology policy (Technological Change, Rip and Kemp, 1998).

1.2 Stages of Technological Change

Technological change is made of three important stages: Invention, Innovation and Diffusion, and they can be discussed as follows.

1.2.1 Invention

Invention is the process of creating new technologies or developing a product or a technological process by applying knowledge that was already in use, but in new ways. Inventions always start as basic working models in which essential features are developed. Then, after that, an improvement that includes addition, subtraction or modification is carried out to the basic working models until every improvement that could be added to the essential features is exhausted. Since this stage requires a lot of trials and errors, patents are usually handed over to the inventors, giving them exclusive rights to sell the products or method invented.

1.2.2 Innovation

The second stage of technological change refers to applying the inventions patented or discoveries, to produce a useful product or a process. This represents an idea, behavior, or product that is new to the adopters. There are two types of innovation: product one and process one. The first refers to the development of improved products, while the latter concerns using an improved method of production to create superior products. Despite the line between invention and innovation being marginal, innovators can not patent their modernization; trade secrets however act as possible patents as employees have to sign a contract of nondisclosure.

1.2.3 Diffusion

Last stage involves the spread of improved technology throughout the industry so that the pioneer company can remain competitive. This is the process during which new ideas or products are accepted by the market. Diffusion occurs in two steps: emulating and copying a competitor's company or processes. A company inspects the new goods produced by their competitors and works their way around producing the same goods or improving the already produced goods but without patenting the other inventors' ideas. Patents are narrow in scope and copeting firms can reverse engineer the product to find a way around remodeling the product or improving it further.

1.3 The long-run perspective on technological change

Figure 1.1 represents a visualization of a long-term perspective of the history of technology (Technology over the long run, Roser (2023)).

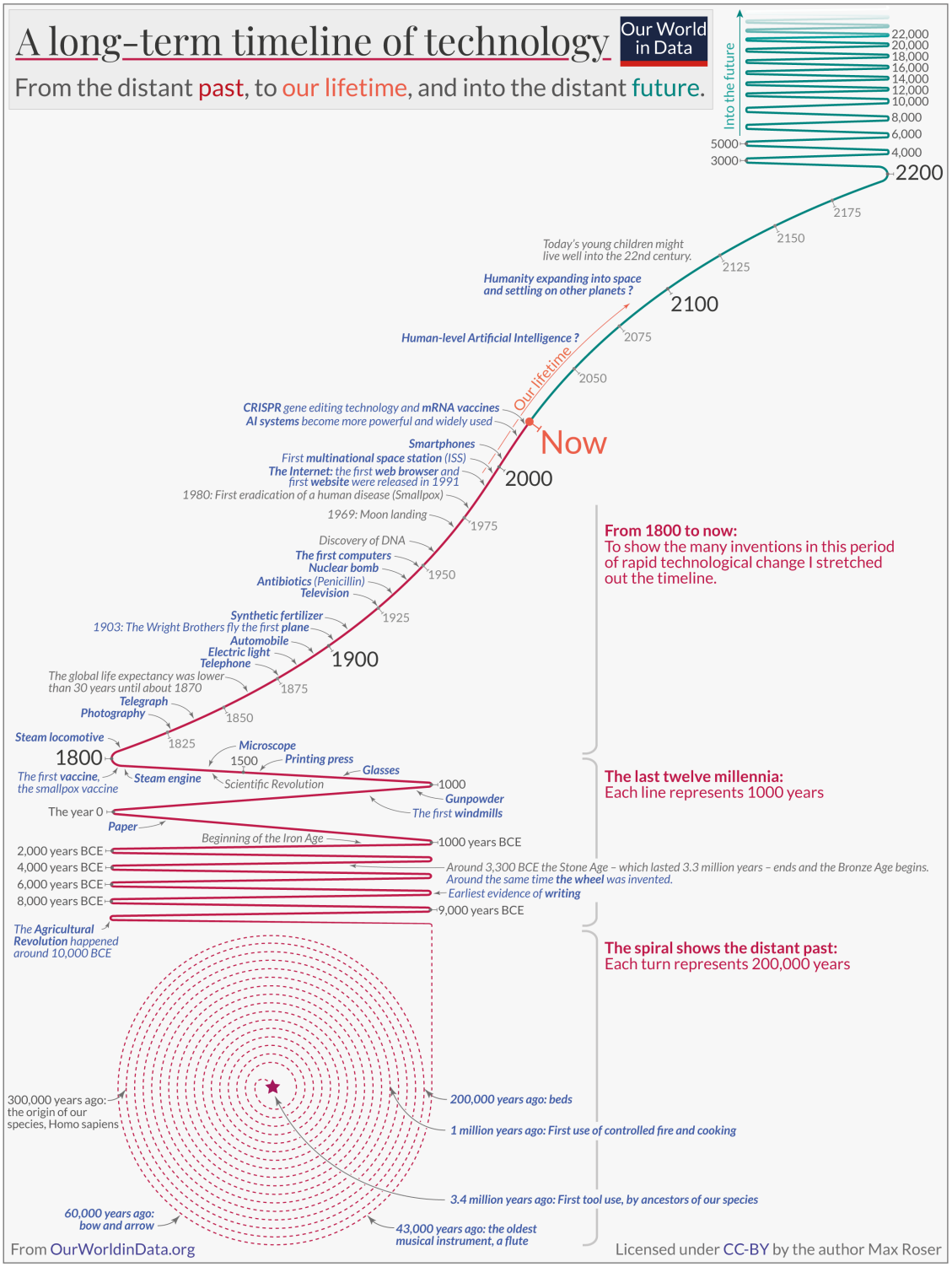

Figure 1.1: Technology over the long-run, Source: Our World in Data

The timeline starts from the star sited in the center of the dotted spiral, it goes on with the pink line and the orange dot, and it ends up

with the green route. The spiral shows the distant past: the beginning of the history of technology is marked by the first use of stone, 3.4 million years ago, and it carries on with 12 windings, each representing 200,000 years of history. Then, unrolling the spiral, it is possible to visualize inventions of the last 12,000 years: Agricultural Revolution happened around 10,000 Before Common Era, earliest evidence of writing occurred approximately 7,000 years BCE and around 3,300 years BCE the wheel was invented. During this eras, technological change was faster, but still relatively slow because several thousand years passed between each one of these inventions. The timeline is extended in the last twelve millennia, where each line represents 1000 years and main inventions are pointed out: after the year 0, we the first windmills were built, gunpowder, glasses and printing press were created and, with Scientific Revolution, the earliest vaccines were conceived. From 1800 onwards, the line is unfolded to show the many inventions of rapid technological change that happened until 2000. The maiden steam locomotive was constructed in 1802, the telegraph and the telephone were firstly used respectively in 1844 and 1869, and electric bulbs began being commercialized in 1880, a year after electric light was discovered. Prior to 1900, the first automobile was driven and, right after, in 1903 the foremost plane took off and, just 66 years later, Armstrong was the pioneer man to land on the moon. Thanks to this visualization, it is possible to see how technology developed in each particular domain and to highlight the wide range of technology's impact on our lives, including both beneficial innovations, such as the vaccine that allowed humanity to eradicate smallpox, and terrible ones, like the nuclear bomb. The red timeline reaches up to the present and then carries on in green into the future: new vaccines,

progress in clean, better cancer treatments and a range of future innovations will improve living conditions and the environment. The one technology that could profoundly change our world is Artificial Intelligence (AI), because it is the main driver of innovation itself. The fast-paced technological change could speed up even more if it is driven not only by human intelligence, but also by artificial one and the change which is currently stretched out might happen within a very brief time span.

1.4 The power of Technological Change

The structures of technological systems have tremendous implications for social organization and agency, ranging from open source, open systems that are highly distributed and decentralized, to those that are tightly controlled and closed, structured according to stricter and more hierarchical models. The governance of technology is developing in new and interesting ways, so, too, is our understanding of the social, cultural, environmental, and political dimensions of emerging technologies. It can be a source of tremendous optimism, helping overcome some of the greatest challenges our society faces: for those who believe in the power of innovation and the promise of creative destruction to advance economic development and lead to better quality of life, technology is a vital economic driver. On the contrary, it can also be a tool of tremendous fear and oppression, embedding biases in automated decision-making processes and information-processing algorithms by creating new weapons. Impacts are often unpredictable as technologies are adopted in new contexts and come to be used in ways that sometimes diverge significantly from the use cases envi-

sioned by their designers. One of the major ways in which technology has positively changed or impacted our lives has been in improvements in industry and economic growth. It has also made it easier to perform daily tasks without struggling and machines have been created to help with increase of efficiency with lower costs. Moreover, since economies have evolved over time, the growth has been motivated by the growing technological inventions and physical capital. Technological changes like process automation have made it possible to produce high-quality output through increased production leading to industrial and economic growth. In contrast, it has negatively impacted our lives by making workers less valuable to employers. As technology keeps evolving, humans are getting more self-reliant because they can efficiently do most of the tasks themselves, impacting the industry as services the employees offer have been replaced by machines which are more efficient and do a better job (Wolff, 2021).

1.5 Automation and New Tasks

At this point, it is clearly possible to admit that two points of view exist: the ongoing process of automation can be seen as the harbinger of widespread joblessness or as the intensifier of labor demand and thus employment. Production requires tasks that can be allocated to labor, intended as human workers, or to capital, meant as machines. New technologies impact the productivity of capital and labor at tasks they currently perform and also influence how these factors of production are allocated. Consequently they affect labor demand, because automation enables some of the tasks previously performed by labor to be produced by capital. Therefore, as Acemoglu and Restrepo

proved in their article *"Automation and New Tasks: How Technology Displaces and Reinstates Labor"* (2019), automation results in different effects on production. Firstly, new technologies enable capital to be substituted for labor in a range of tasks, so a *displacement effect* takes place because workers are replaced and the labor share of value added decreases. Simultaneously, digitalization increases productivity of automated tasks, requiring the same level of capacity in non-automated tasks and resulting in a higher demand for labor, called as a *productivity effect*. Moreover, displacement effect of automation is counterbalanced by technologies that create new tasks in which labor has a comparative advantage, changing the contest of production in favor of labor: this is the so called *reinstatement effect*. Summing up, it is possible to admit that, apart from replacing workers, automation has also created new duties related to design maintenance of equipment that can only be performed by employees: future of work depends on the balance between these effects. There are two kinds of technological change: Skill-Biased (SBTC) and Routine-Biased Technological Change (RBTC). SBTC puts a premium on skills, so occupations entailing higher skills are at an advantage, while RBTC replaces repetitive, routine tasks and puts a premium on non-routine tasks, irrespective of skill-level.

1.6 Digital Transitions and Jobs

Digital transition is a challenge that requires updated skills by workers and implementation of innovative and technological tools and machines by firms. According to the Job Report 2023 of World Economic Forum, 23% of workplaces will change by 2027, creating 69 millions

new jobs and eliminating 83 million ones. The adoption of technology and the increase of digital access will lead to the rise of the employment rate because of the generation of new job opportunities, as AI specialists, business intelligence analysts and cybersecurity experts. These people are able to use technology to create and capture value, so these jobs are considered to be sited at the top of the skill ladder and, instead of being substituted by automation, they will be complemented by it. By 2027, all businesses should adopt technologies linked to big data, cloud computing and artificial intelligence so training in using AI and big data will be one of the priorities of firms, together with creative and analytical thinking education. At the same time, other jobs, such as counter clerks, cashiers and data entry specialists, which are "routine" jobs which often involve repetitive tasks, will be replaced by technology and robots, and the employment rate in these sectors will dramatically reduce. These workers are considered to only have "ordinary" skills and abilities to offer, so computers and other digital technologies are able to acquire these attributes: they follow meticulously procedures laid out by programmers and, completing the sequence of steps required to perform the "routine" task, they are able to accomplish it using the identical procedures that a human would have followed, but in a more precise and cheaper way. Because core tasks of these occupations follow simple procedures that might frequently reoccur, they can be fully codified in computer software and performed by machines. This causes firms to have a strong economic incentive to replace workers with cheaper computing power. On the other hand, there are two categories of "non-routine" tasks for which a defined path can not be found, making it difficult to computerize them. The first group is made of all those tasks that require problem-

solving capabilities, intuition and creativity, and that can be classified as "abstract" tasks: they usually employ workers with high level of education and capabilities, and they include all those high-skilled employees we already talked about, which are complemented and not replaced by automation. The second category of duties consists of all those functions requiring situational adaptability, visual and language recognition, and in-person interaction, usually considered as "manual" tasks. These jobs must be produced and performed largely on-site or in person, so they represent a challenge for automation, which can not take their place. The supply of workers who can perform these jobs is very large, so they are usually found at the end of the occupational skill spectrum. Summing up, the main effect of technological progress is to replace "routine" labor which tends to be clerical and craft jobs, leading to a concurrent growth of employment both in high-skilled jobs and in low-skilled manual tasks: the result is a sort of a hollowing out of the employment structure and the phenomenon is known as *Job Polarization* (Autor, 2015).

1.7 Effects on Workers

With the implementation of technology, more physical, psychological and environmental requirements appeared, and significant changes in employment conditions emerged, as the contractual and social conditions of the work. Therefore, it is important to know how employees feel about digitalization and how it impacts their satisfaction and their work/life balance. Digitalization, meaning the growing use of information and communication technology in every area of life, has created keen changes in the world of work and it has impacted all lev-

els of the society, influencing the way business is done. Technological change has created many challenges, as well as excellent opportunities in the workplace and life in general, increasing the time of daily life. Technology actually allows to complete tasks and activities easier and faster but it has also generated more and more of them. If there are more activities, less time can be spent on each of them, so workers feel more pressured. On the other hand, one of the best impacts of digitalization is the fact that information has become more accessible and transparent, allowing organizations to share more with all other employees. At the same time, information and communication technology enables employees to focus more on complex tasks that require human knowledge, because repetitive tasks can be done automatically by computer. All these aspects influence job satisfaction, which can be perceived as one's total feeling about their job and the views he has toward multiple aspects of his job. Technological change leads to reduction of costs, improved customer services and enhanced operations ans communications, resulting in high-quality products, more valuable services for customers and a smarter way of working. Therefore, it may seem that digitalization increases job satisfaction and that it will continue to do so, as new technologies come into business activities, but, in reality, this high work pace can lead to negative outcomes. Technology, in facts, offer mobile flexibility so people are free to choose when, where and how they will work: this means that it is impossible to get away from work, as if technology blurred the boundaries between job and personal life (Cijan et al., 2019).

Chapter 2

On-the-job training and Technological training in Italy

2.1 Italian Education System

Italian education system includes all education levels, from primary education to university and continuing training. It is based on two main principles: subsidiarity, which is the independence of a subject authority from its superior one, and autonomy of educational institutions. The government has the legislative power on education regulations and it has to determine which services have to be equally guaranteed on all national territory and which principles regions have to respect when applying specific competences. Schooling is compulsory for 10 years, for all children going from 6 to 16 years old (Ministero dell'Istruzione e del Merito, Governo Italiano). Education starts with ECEC (Early Childhood Education and Care), which is not mandatory and which is based on infants' age: parents of newborns going from 0 to 3 years old can take their babies to chargeable daycare centers that could be public, private or managed by the municipality. These centers are guided by ministry of education and they have to

follow regional criteria. For children going from 3 to 6 years old, free infant schools exist: ministry of education has the responsibility to set guidelines and to finance centers, while local authorities manage their organization. Compulsory education starts at 6 years old with primary school, which lasts 5 years and which provides basic education for all kind of subjects: children are supplied with fundamental knowledge and instruments to apply active citizenship and they learn how to process their experience. Mandatory education carries on with 3 years of first grade secondary school: study skills are reinforced, students develop their attitude toward social interaction and they are provided with the necessary tools to continue their educational path. At this point, there are two choices that students can take: second grade secondary education or regional professional education, both compulsory until sixteen years old. The first one lasts 5 years and it includes high schools, technical college or professional college, all releasing a degree that enables the access to university. The second one consists of regional courses lasting 3 or 4 years, organized by accredited agencies that quickly prepare students to enter the job market. Then, people can decide whether to continue their studies with tertiary education, that consists of universities, institutes of high artistic, musical and dance institutes, or with ITS Academy (technological superior institutes). Educational path also includes adults education, which consists of continuing training and all those activities aimed at acquiring a qualification in adulthood (Organizzazione e struttura del sistema educativo, Commissione Europea).

2.2 What is Continuing Training?

Continuing Training refers to training and programs organized by a company and offered to employees to improve their skills, knowledge and competences. Thanks to the training, the company is able to improve human capital and enhance performance, productivity and career development, aligning employee growth with the firm's goal: in facts, training in a company is essential both for employee development and organizational success, ensuring that the workforce remains competitive, engaged and capable of meeting the company's objectives. Business education is addressed to all staff, from labourers and office workers, to managers and directors, and it is supervised by the Company's Training Manager of the HR Team, who has to identify a learning program that guarantees growth and development of the firm. Nowadays, one of the main problems of the job market, that continuing training tries to overcome, is the so-called *Skill Gap*: it represents the difference between the required and the effective competences possessed by employees for a specific job. Skill Gap mostly happen because of the lack of a specific training: if employees do not receive enough training they could lose the knowledge required to optimally carry out their job. Another reason of this difference could be the development of technology and digitalization, which are completely transforming workplaces and that could cause shortcoming in the performance, if employees are not able to keep up with them. Moreover, the aging of the working population may be a source of the gap, because as people get older, they may lose some capacities acquired during their career or they may be not able to understand some new technologies. When a company decides to invest in con-

tinuing training, it is important to understand the difference between hard and soft skills, to propose focused learning activities according to the area that should be enhanced more. Soft skills include those abilities related to emotional intelligence and personal characteristics that everyone owns: they are innate and they depend on personal experience, such as empathy, flexibility, time-management or teamwork. Hard skills correspond to technical competencies which are acquired through work experience or education and that can be tested and challenged, as digital competencies, language certifications or degrees. After the analysis of the competencies, a specific educational path must be followed and the perfect training course can be created. Besides the possible negative effects on skills, nowadays digitalization represents one of the most powerful tool to increase the effectiveness of continuing training: a part from helping out HR team to streamline the entire process, it can also provide employees with e-learning courses that can be followed from remote (IFP, CedeFop, 2014).

2.3 Continuing Training in Italy

Nowadays, people should continuously update their portfolio of competences, to be able to deal with economical, working and demographic developments that are profoundly changing Italian society: there should be a "lifelong learning" to qualify people, employed or not, to meet market needs. As we know, technological development leads to the automation of more and more workplaces, while demographic decline implicates that less young people are entering job market: for these reasons, competences of workers and of people looking for a job should always be updated to reach the benchmarks of Adult

Learning set by European Commission. Italy is way behind, with a percentage of 39,3% of adult population participating in training activities, compared to the European goal of making it to 47% by 2025 and to 60% by 2030. In this country, participation rate of people in training courses is inversely proportional to their age (Fadda, Rapporto INAPP 2022): as shown in the graph **??**, youngest workers from 25 to 34 years old are the most involved with a percentage of 17,1%, followed by people from 35 to 44 years old whose rate is 9,8% and people from 45 to 64 years old which are the least engaged with a rate of 8,7%. Levels of engagement in training are increasingly declining, with a mean of 9,6% of population going from 25 to 64 years old actively participating in educational activities in 2021, 0,3% less than previous year. This downfall signals a diversion compared to the growth trend observed between 2007 and 2011, fruits of the great efforts of *fondi interprofessionali*. Italy's place is really behind and this is mainly due to the restriction of private and public investments in training, caused by the difficulties in including weaker segments and also because of the low educational level. These results are coherent with the OECD report *Education at Glance* of 2023, that analyses all levels of education and provides data on topics such as attainment, enrolment, finance and the organisation of education systems of OCSE countries. OCSE (Organization for Security and Co-operation in Europe) is an organization of 57 states that has a comprehensive approach to security that encompasses politico-military, economic, environmental and human aspects and that addresses a wide range of security-related concerns. The OECD report shows that, in these countries, only 4% of adults with an education level lower than a high school degree attends job training courses. This rate reaches 6% among people with

a high school degree and it arrives at 14% for people with a bachelor or master degree.

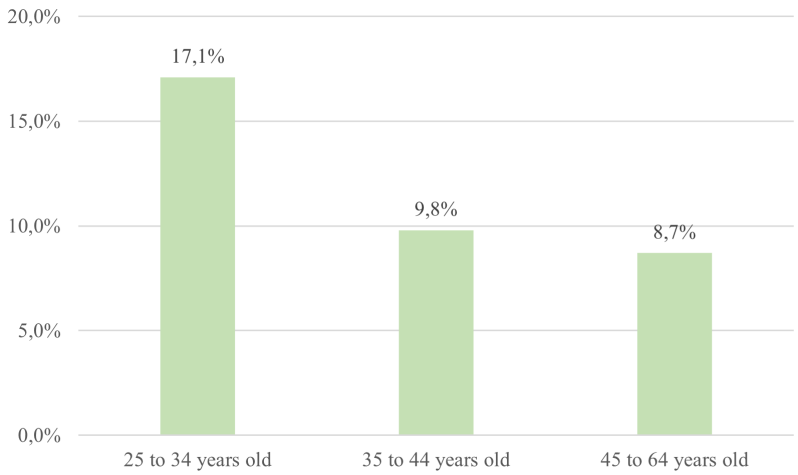

Figure 2.1: Participation rate in training activities in Italy based on age, Source: OECD, Education at a Glance (2023)

According to a report made by the Tagliacarne Study Center of Chamber of Commerce (2023) on a sample of 4000 companies having from 5 to 499 operators in the manufacturing sector and services, 30.7% of firms investing in educational training between 2022 and 2024 aim to go beyond the production levels of the period before Covid-19. At the same time, 46.5% of companies that are combining investments both in digital and green areas with educational ones, forecast to improve their production results, against the 21% of ones who did not spend money on it. In facts, while some years ago businesses did not see investments on human capital as one of the main element to focus on for their development, the advent of 4.0 technologies and sustainability concepts has brought out the strong relationship of this sector with their advancement. Nevertheless, the rate of firms investing in training between 2022 and 2024 is 75.2%, a value that decreased com-

pared to the one of the 3-year period before Covid-19, corresponding to 78.6%. This value rises up to 79.3% in case of enterprises led by young people while it falls down to 73% for the ones managed predominantly by women, as figure 2.2 shows. Another aspect that must be considered is the location of the firm in the country: South of Italy appears to be less sensitive to workers' education, where less than 20% of companies of the area provide employees with training activities, compared to regions as Trentino Alto Adige or Friuli Venezia Giulia, that almost reach 30%. There are different reasons why this gap exist: firstly, North of Italy's economy is more developed and diversified, while the South hosts smaller firms that can not always afford education activities and which lack of financial resources. At the same time, both digital and physical infrastructures in the south are not as much advanced as those in the north, so this makes the access to training opportunities more difficult. Territorial inequalities are also due to cultural reasons: south of Italy is more devoted to traditions, so there is less propensity towards innovation in some traditional sectors. Firms that seem to be more inclined towards training investments are those that already did in 2022 with PNRR resources: 89.4% of companies will use these funds for training purposes, to better exploit PNRR advantages, and 37.6% will do that for the first time.

There are different types of training activities planned by firms between 2022 and 2024, which are listed in figure 2.3. *Up-skilling* is the most used one, chosen by almost all firms (96.9%) and immediately followed by *Re-skilling*, preferred by 81% of companies. *Intrapreneurship Training* and *Managerial Training* are important, as well, but they are not completely exploited yet, adopted by respectively 58.2%

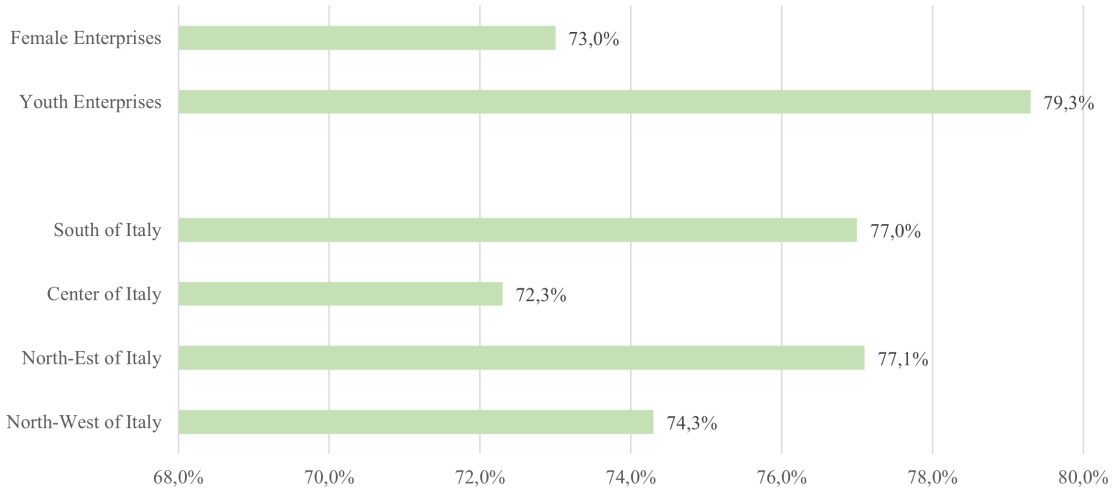

Figure 2.2: Firms Planning to invest in training Activities between 2022 and 2024, Source: Tagliacarne Study Center of Chamber of Commerce

and 47.1% of businesses. (Tagliacarne Study Center of Chamber of Commerce, 2023)

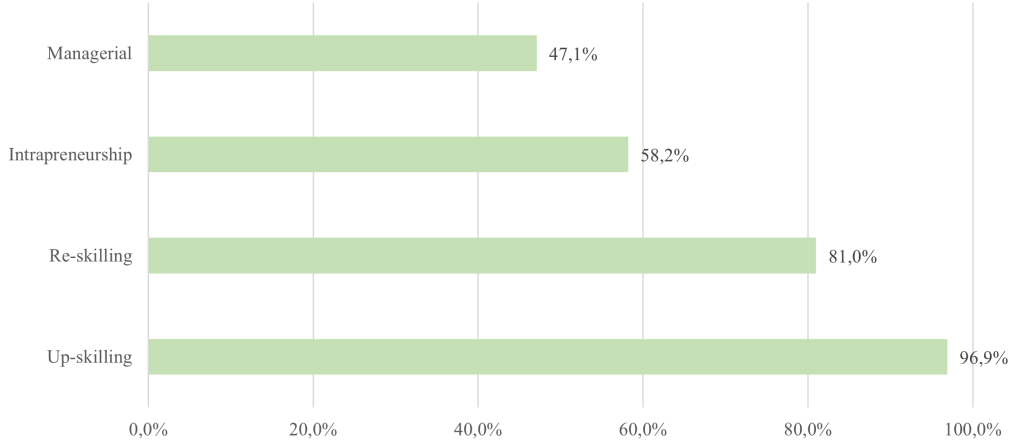

Figure 2.3: Training Activities planned by firms between 2022 and 2024, Source: Tagliacarne Study Center of Chamber of Commerce

2.3.1 Up-skilling

Up-skilling can be considered as the improvement and development of the competences of the worker, that enable him to upgrade his skills. It is strictly related with continuous training, that allows the employee to perform his tasks in a more efficient way and to lead him rapidly towards a career advancement. This kind of training is really important for companies working in digital sectors: the constant development in the area force to frequently update knowledge of the workers, so that they can keep up with new technologies. The main goal is to improve competences of current employees, to avoid hiring new ones. The first step of an up-skilling strategy is to identify weak competences to offer specific training programs. Once the training needed has been defined, the company can choose to develop it internally or to entrust it to agencies or services.

2.3.2 Re-skilling

Re-skilling is the ability of an employee to acquire new competences needed to perform an activity which is totally different from the one he already conducts. In this way, the firm can move the worker from one sector to another one, without the need of recruiting someone new. Apart from the advantage of saving the costs of new hiring, it also keeps the company competitive on the market: thanks to re-skilling, employees' competences are always updated and they are continuously stimulated to learn skills belonging to other sectors. Moreover, this strategy creates a workforce able to deal with any type of change. This training progresses according to business goals or to internal changes and it can be supplied through online platforms, courses or directly

flanking less experienced workers with trainees.

2.3.3 Intrapreneurship Training

Intrapreneurship consists of all processes that sustain the development of innovative and entrepreneurial ideas in a company. This is a kind of training that has the aim to strengthen accountability, skills of initiative, and innovation of processes and products. It builds employees which are able to act as entrepreneurs in a company, producing new ideas, products and services, and contributing to the continuous growth of the business. The main goal of this training is to keep the firm competitive, exploiting internal competences to obtain new aspirations, without the need of being influenced from outside.

2.3.4 Managerial Training

Managerial Training is dedicated to everyone whose desire is to hold a position of management and control of resources or of human capital. A manager must be the leader of a group of employees, so he must be able to assume his responsibilities and to analyse at best activities that mark his role. Specific competences can be learnt only thanks to experience or extensive courses thhat enable him to develop new business models. (FormaLab)

Propensity towards business education and activities grows with the size of the firm (OECD, Education at a Glance (2023)): in facts, small and medium firms don't usually have the possibility to offer training courses to their employees. In 2022, in small firms, only one worker out of 5 attended at least one course, while in bigger companies

the rate corresponded to 3 workers out of 5. These results are in line with the values registered in OCSE countries, where workers inside of bigger firms have more chance to attend training courses related to their job. As it is displayed in figure 2.4, in Italy, 11% of employees of companies with staff that goes from 10 to 49 people participated in education activities and job training. This value rise up to 13% for firms that have from 50 to 249 employees and it reaches 15% for businesses with more than 249 workers (Vallauri, Rapporto INAPP 2023).

Figure 2.4: Firms investing in training activities in Italy based on the number of employees, Source: OECD, Education at a Glance (2023)

With regard to the category of business, each sector has different requirements in terms of competences needed, so the type and intensity of training that has to be provided to workers depends on these characteristics. After the period of Covid-19, significant changes have impacted processes and technologies of every business, affecting working methods and organizational practices. Almost two third of

industries had to redefine their own production processes, reconvert production, develop new products and services or expand their sales channels and supplying methods. In this framework of technological and organizational evolution, continuing training plays a fundamental role: after 2020, more than 70% of firms that had to innovate their processes and technologies or their working programs invested in training activities. Figure 2.5 exhibits the percentage of firms investing in training activities in Italy based on the sector of activity (BenedettiandCo, Le imprese italiane investono in formazione? (2023)). Firms of ICT sector appear to be the most affected ones, so, immediately after the pandemic period, this category was at the top of continuing training financing, with a percentage of 85,2% of industries investing in training. Because of continuous technological development, the value is not so different in 2022, where around 82% of industries operating in the sector spends money for preparation of employees. This category is immediately followed by financial and insurance services, which is the only branch interested more in internal courses rather than external ones and whose percentage of industries involved in workers' education is 74,5%; they are succeeded by private and public health and social assistance services, whose rate reaches 69,6%. After the pandemic period, chemical and pharmaceutical industry developed a lot, as well, so about 67,2% of companies decided to invest in training activities. Moreover, sectors of utilities organizing continuing training are growing (64,2%), followed by consultation (61,2%), construction (57,4%), services for business (55,7%), services for people (54,1%) and manufacturing industry (52,6%). Businesses related to tourism which are developing educational activities are growing, although they are still far from the other sectors, with a rate of 39,1%.

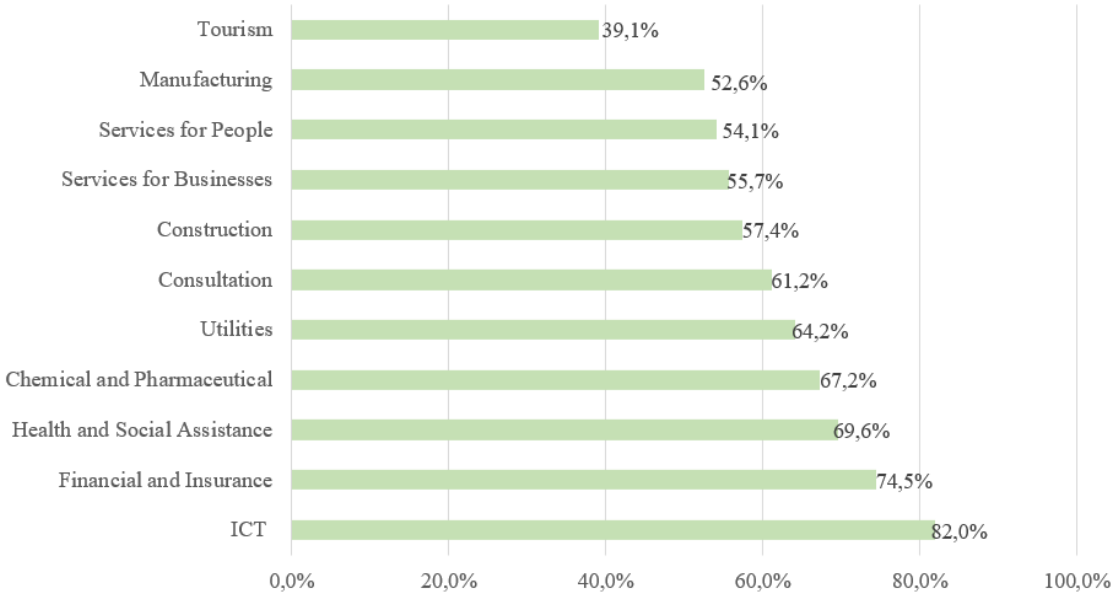

Figure 2.5: Firms investing in training activities in Italy based on the sector of activity, Source: BenedettiandCo, Le imprese italiane investono in formazione? (2023)

Firms are supported in the choice, implementation and management of continuing training by specialized people working in the sector. As it is displayed in figure 2.6, 42,4% of industries that decide to invest in training activities considers career counselors as the most appropriate subjects to rely on for strengthening education of employees (Unioncamere ANPAL, 2022): these experts carry out a series of activities related to personnel management, supplying services mainly to small and medium businesses. Among these occupations, one of their main competences is the direction of continuing training and the reasoning of its importance to industries. Other entities that assist firms in this setting are: training institutions, chosen by 27,9% of companies, professional associations (26,7%), chambers of commerce (10,2%), local entities (5,1%) and labour agencies (4,6%).

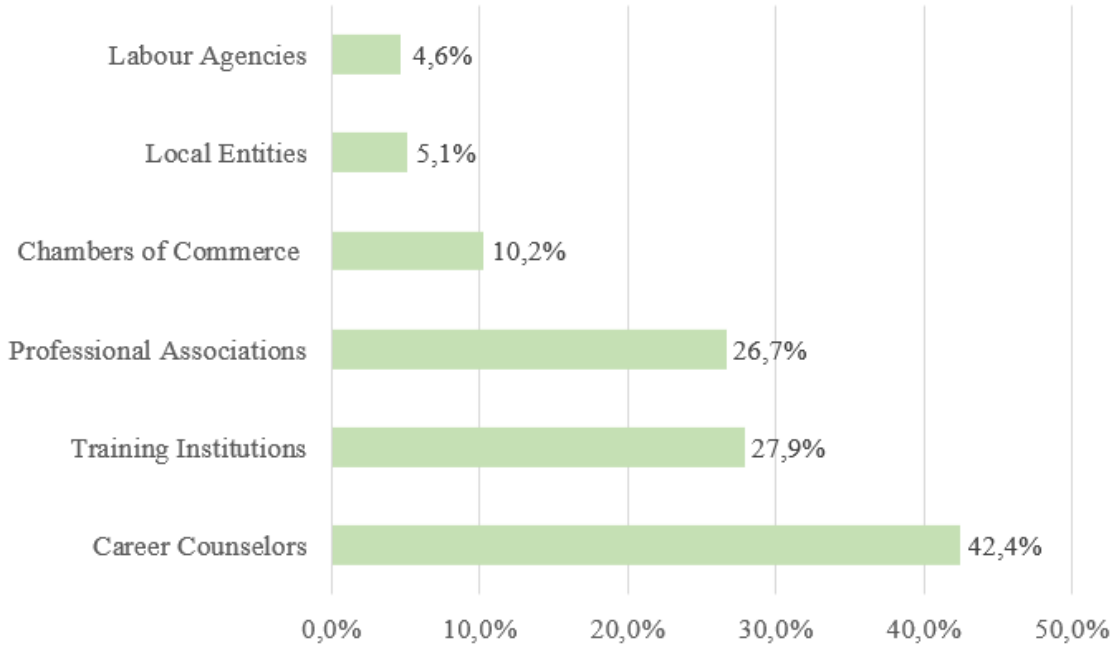

Figure 2.6: Percentage of entities supporting continuing training chosen by firm, Source: Unioncamere ANPAL, La domanda di professioni e di formazione delle imprese italiane nel 2022 (2022)

2.4 Obstacles to Continuing Training

Obstacles to continuing training are related to organizational, economical and cultural factors (BenedettiandCo, Le imprese italiane investono in formazione? (2023)). The first difficulty that firms have to face is the high cost of training, which grows by a small percentage every year: it doesn't only include direct costs, but also the opportunity cost of time spent by employees in attending courses instead of working. Another aspect that influences the propensity of firms towards training is the lack of time: educational activities will lead to benefits in the long term, so firms find it difficult to interrupt tasks that will immediately generate a profit and prefer to carry on with their routine instead of dedicating time to training. Lack of resources is an issue as well, including both funds, human capital and equipment: on

one hand, infrastructures may not be completely developed and tools such as e-learning and digital platforms may be not suitable, on the other hand it may happen that managers or employees are not prone to modify their habit to learn new skills or attend courses. In addition to that, another possible obstacle to continuing training is the closed-mindedness of people thinking that their knowledge is sufficient to carry on with their job, not considering the continuous technological change requiring ongoing upgrade.

2.5 Continuing Training Financing

Italian Continuing Training is financed through different types of channels, both private and public. Companies mainly use their internal resources to pay for training but, seeing as there is a huge financial difference between larger and smaller firms, public administration should intervene. Primary sources of public funding are *Fondi Interprofessionali*, *Fondo Nuove Competenze*, *Fondo Sociale Europeo* and *PNRR*.

2.5.1 Fondi Interprofessionali

Fondi Interprofessionali are the most used instruments to finance corporate training for managers and employees' education in Italy (Fondimpresa, 2024). These are organizations that back up business education by reducing or eliminating the costs of training that firms should pay, supporting training activities that are appropriate for workers' needs and for the trade context of the period. They are financed using the compulsory tax of voluntary unemployment, which is a contribution paid by firms and employers to INPS (law 845/1978), corresponding

to the 0.3% of the wage of each employee. Each company can obtain this grant back in the form of "free training" by assigning it to a *fondo interprofessionale* that will receive money from INPS and that will use it for training of workers (law 388/2000). Adhesion to a *fondo interprofessionale* is voluntary and free and the procedure is handled by an accountant or a consultant who works for the company. Resignation or change of the fund is possible at any time. Training is supplied in two different ways: companies can either directly use the resources saved or they can present a training project by attending a tender announced by a *fondo interprofessionale*, that will evaluate the plans proposed and will choose one. In the first case, bigger companies will surely have more supplies than smaller ones because of the higher number of employees, while with the second option, it could be possible for the winning firm to take advantage of a higher amount of money than the one saved. In addition to that, some funds provide vouchers that companies can use to pay for external courses, such as masters, specialization classes or online courses. Some of the most famous *fondi interprofessionali* are *Fondimpresa*, *Fon.Coop* and *For.te*. In 2022, about 750 thousand of firms adhered to *fondi interprofessionali*, counting more than 9 million 830 thousand employees. In facts, in the period from 2018 to 2022, 358 tenders have been announced and more than 611 million euros have been allocated for educational purposes. Considering all financing channels, this is the most used one and it is mainly preferred by large companies with more than 50 employees (Unioncamere ANPAL, 2022). In 2022, 51,5% of firms with more than 500 workers decided to take advantage of *fondi interprofessionali*, while only 11,8% of small businesses with less than 10 employees did. Other values can be found in figure 2.7.

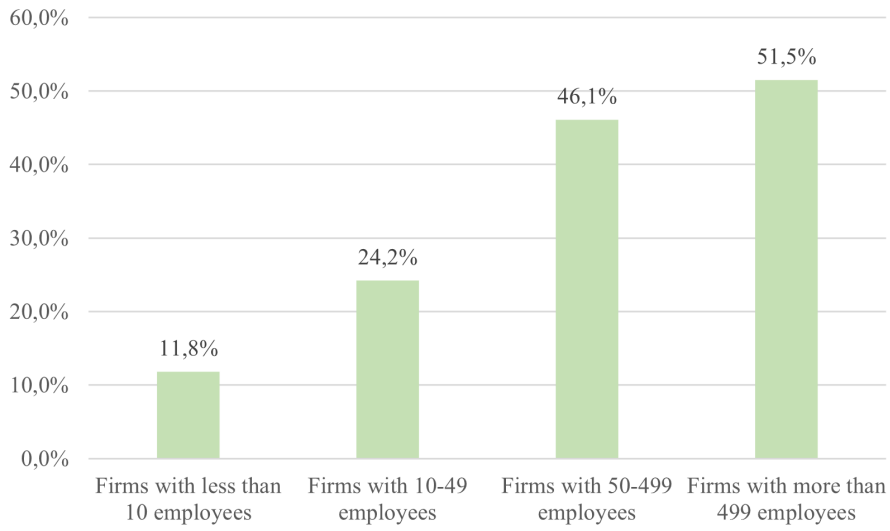

Figure 2.7: Firms in Italy using *Fondi Interprofessionali* based on the number of employees, Source: Unioncamere ANPAL, La domanda di professioni e di formazione delle imprese italiane nel 2022 (2022)

2.5.2 Fondo Nuove Competenze

Another instrument that can be used to finance corporate education is *Fondo Nuove Competenze* (Ministero del Lavoro e delle Politiche Sociali, 2023) : it supports firms to adapt to new organizational and productive models, training workers to respond to ecological and digital changes that need new skills and competences. Its goal is to simplify the acquisition of new competences, especially digital ones, to meet specific market demands. It is used by companies that wish to invest more in workers' training, offering them financial resources in order to cover up for part of the costs related to it. Thanks to *Fondo Nuove Competenze*, specific courses or workshops are organized, contributing to professional development of each employee and supporting new training initiatives, such as firm management, digitalization and technological development. *Fondo Nuove Competenze* pays back firms for

each working hour used for trainings, offering a complete reimburse that includes social security contribution: basically, companies can reduce working hours for staff involved in training activities and the fund will pay them back for the work time lost. In this way, even if their productivity is lower, wage of employees does not change. It was created in 2020 to contrast the effects of Covid-19 that damaged almost all economical activities and it is managed by ANPAL. Now it is not active anymore, but previously two tenders were announced: 6710 firms obtained the approval of their application in 2021 and other 7513 companies got it in 2022, with a total of 14223 businesses. A total of 2.33 billion euros was used to finance 93 million hours of continuing training. Main difference between *Fondo Nuove Competenze* and *Fondi Interprofessionali* is the type of expenses covered: the first one is used to pay for trainings and activities, while the second one covers work hours costs of employees involved in training. A firm can choose to use both financing channels at the same time, combining academic prices with the cost of work.

2.5.3 Fondo Sociale Europeo

Fondo Sociale Europeo is one of the most important European funds, used to finance both national and regional initiatives and activities (Ministero del Lavoro e delle Politiche Sociali, 2023). National or regional government prepares projects according to the specific needs of each area, in fields such as unemployment, education, internships or social inclusion then *Fondo Sociale Europeo* pays for them. In the period between 2018 and 2022, Italian regions and provinces, announced about 132 tenders attributable to training for employees and 508 million euros were used. These resources were mainly used to

promote technological and digital skills to facilitate and update workers' competences and to strengthen economical system of the country (Vallauri, Rapporto INAPP 2023).

2.5.4 PNRR

PNRR stands for "Piano di Ripresa e Resilienza Nazionale", which is a program used by the government to manage funds to recover from losses caused by Covid-19. It consists of six different missions, that could be investments or economic interventions, that concern different subjects, such as education, justice, health care and digital transformation. Thanks to PNRR, Italy was able to create the GOL Program, a politic measure to support employment of people looking for a job. It has also been used to upgrade skills of workers, after the advent of digitalization. PNRR had a huge impact on Italian companies: 33.3% of firms invested in training activities for the first time, while 89.4% decided to focus on it more.

2.6 Training and Technology

In such a rapidly changing context of technological development, the Industry 4.0 model, based on automation and data connection, can add value to businesses only if specific training is provided. In absence of technological training, new technologies become a tool to simply redistribute activities instead of being the driving force of a more efficient and effective value creation. Scarce training and extreme corporate identity represent obstacles to integration of value added technologies, so continuing training should be involved in digital transformation. A part from resorting to multimedia tools and

digital platforms to impart technical competences, a lot of businesses rely on technological training to develop skills needed to deal with digital change. As a matter of fact, in this developing era, new strategies should be defined and improved projects must be monitored, such as the introduction of new application tools and software, organizational improvement and new tactics definition. In Italy, digital innovation is evolving and employees do not believe to have the skills necessary to keep their business competitive on the market. To keep up with technological change, industries should try out new projects, integrate new work modalities and strategies, include new professional figures and enhance workers' competences. So, first of all, it is necessary to acquire awareness of the importance of digital transformation for business' future: to do so, many training projects apply the ACT method. This system is based on three main principles: Awareness, Choice and Trust. It is intended to value professional potential starting from its *awareness*, which helps to understand that, once the negative effects of rigidity are overshadowed, new possibilities can be considered. Doing so, it will be easier to make the *choice* of dealing with variable situation, introducing new tools and submitting corrections, all towards the direction of improvement. Then, self-confidence (*trust*) condition is reached and the process of change can be embraced. Once the awareness of digitalization and its benefits are acquired by employees, the industry can define the best strategy to face technological change. As for any typology of continuing training of soft skills, one of the possible instruments useful for better outcomes is *peer to peer coaching*, that consists of two colleagues working together, reflecting and developing new competences, both in class activities and afterward, in a follow-up section. In this way, a part from supporting a contin-

uous discussion between members of the same team, new skills are developed and assimilated.

2.7 Initiatives for Digital Training

To modernize the country, efforts in the field of digital training proceeds both in form of public and private commitment. Numerous projects have been launched to increase the number of digital services and platforms on the public side, while, for the private sector, a decree has been issued, to develop new skills among workers. To guarantee an effective learning, an hybrid approach is preferred, because it alternates different kind of methodologies that take account of needs, time management, effort and engagement. On the public side, the Transition 4.0 Plan has been developed: Italian firms investing in new technologies, digitalization and Industry 4.0 can benefit from support and government incentives. Moreover, courses for public employees are supplied by the *Agenzia per l'Italia Digitale (AgID)* and by *Formez*. AgID is responsible of guaranteeing the fullfilment of the goals of *Agenda digitale italiana*, and of guaranteeing to spread the use of new technologies, fostering innovation and economic growth. In addition to that, it also promotes digital competences and their diffusion, working together with institutions and international, national and local entities. Its main goal is to support digital transformation of public andministration, firms and citizens, to make society more and more connected. On the other hand, *Formez* is an association focused on implementing reforms and modernization politics for public administrations: one of its main fields of intervention is, in facts, the promotion of innovation and digitalization. On the private side,

the decree regarding Bonus Training 4.0 has been issued: it consists of the recognition of a tax credit to firms of the country financing the acquisition or the consolidation by its employee of the technological competences relevant to technological and digital transformation process, which is required by *Piano Nazionale Impresa 4.0*.

Chapter 3

Bosch Gmbh Branch in Italy Case Study

3.1 The Bosch Group at a glance

Robert Bosch Gmbh is a German multinational company, which is considered the biggest producer of automotive components all over the world and which has business relationships with the most powerful car manufacturers. Bosch is one of the largest firms in Germany and it is sited in over 150 countries with hundreds of branches and dozens of plants, contributing each day to the success of the company. The Bosch Group is a leading global supplier of technology and services and it employs more than 429 thousand associates worldwide. Its operations are divided into four business sectors: Mobility, Industrial Technology, Consumer Goods, and Energy and building Technology. In addition to the production of components for cars, which represents 90% of revenues, there are other important final outputs, such as industrial machines or machine tools, households appliance and heating systems. With its business activities, the company aims to use technology to help shape universal trends such as automation, electrification,

digitalization, connectivity and an orientation to sustainability. Bosch uses its proven expertise in sensor technology, software and services, to offer customers cross-domain solutions from a single source. It also applies its expertise in connectivity and artificial intelligence, in order to develop and manufacture user-friendly, sustainable products. With technology that is "Invented for life", Bosch wants to help improve quality of life and conserve natural resources.

Figure 3.1: Bosch Logo

3.2 Business Sectors

As we mentioned in the previous subchater, Bosch Group works in four different business sectors. As a supplier of original automotive equipment, Bosch is engaged in a wide range of Mobility activities, which are organized into six divisions. This division also includes the Mobility Aftermarket and Bosch eBike Systems divisions. Further activities involve two-wheelers, commercial as well as off-highway vehicles and engineering and software services. Then, the business area of Industrial Technology comprises the Drive and Control technology division, with its other activities including the Bosch manufacturing Solutions unit, which focuses on manufacturing equipment and automation solutions and the Bosch Connected Industry business unit.

The third sector is the one of Consumer Goods, that includes the two divisions Power Tools and Home Appliances. In the end, Energy and Building Technology segment consists of the Building Technologies, Home Comfort (formerly Thermotechnology) and Bosch Global Service Solutions divisions.

3.3 Bosch relationship with Digitalization and Connectivity

Bosch's research in the areas of digitalization, connectivity and artificial intelligence is becoming increasingly important for the entire Bosch product portfolio and it is being used more and more both in development and in the products themselves. Digitalization and connectivity are key areas at Bosch, and they are built on each other. By researching digitalization, connectivity and artificial intelligence (AI), Bosch Research allows secure and efficient digital system. Nowadays the employ of Internet and AI is rapidly increasing: objects are all connected and synchronized to each other and to the user, aggregating the data necessary for operation in accordance with legal requirements. These data can improve the interaction of machines with each other as well as interaction between humans and machines. The same is happening in industrial automation, where software-designed manufacturing represents the future, using machines that communicate through the entire supply chain. Bosch carries out research in both areas and also develops artificial intelligence methods that are able to achieve their full potential when combined with digitalization and connectivity: the first one is able to turn data into information, the second one makes it available in real time to everyone while the latter

one, AI, generates knowledge out of it. Experts in these fields develop new connectivity technologies, define standards for connettivity and work on innovative, data-driven business models. As a matter of fact, connecting products with the Internet opens the door to new functions and business models. A key aspect of digitalization is software, which allows complex, faster and more efficient processes and applications in everyday devices as well as machines. Bosch group is looking for ways of making software development per se even more efficient and sharing this knowledge with every division. For example, in materials simulation and research, software-based virtual development methods are opening up completely new approaches. Model is, in facts, the starting point of virtual engineering and digital development. Another important step of digitalization is Quantum computing: it can calculate complex relationships in specific use cases quickly. The basis for connected products is the technology into which the group is carrying its research: it includes standards as 5G, 6G and mobile networks with high transmission rates and low latency. Thanks to the Internet of Things (IoT), physical objects equipped with sensors can exchange data with other devices and systems via the Internet. When artificial intelligence is used with IoT, value is added: this enables to reach the right conclusions from huge amount of data in just a few seconds and to adapt the product development accordingly. Good and secure software is essential for digital and connected products and processes. Bosch focuses on Safety, Security and Privacy, paying attention to verification and validation. While safety means that a system functions reliably under defined conditions without causing unacceptable risks, security describes the protection against digital attacks. The term privacy describes the protection of the data that is created and used

in a system. Ongoing digitalization results in data and these data are available in real time thanks to connectivity. From this data, AI can extract and combine information differently and it can help to identify objects and further improve recognition of patterns and outliers thanks to comprehensive data analyses.

3.4 Research on Digitalization and Connectivity

3.4.1 Research on Connectivity Technologies

It is impossible to imagine industry without connectivity technologies: they depend on large amounts of data being exchanged quickly, securely and in a targeted manner, in most cases wireless. High-performance, reliable networks are the basis for all these applications, so they have to be guaranteed at all times. To do so, Bosch group is researching innovative connectivity technologies and it is working on connectivity standards. Seeing as in 2030 the new 6G mobile standard will be introduced, additional features will be allowed: vehicles will be able to detect not only connected vehicles or road users, but also passive objects with a radar system. These new systems will have ultra reliable communications, with a latency of less than half a millisecond. Bosch is also working on building connected applications: a range of products with wireless conference systems that can be connected among each other. For example, technologies for home networks are being developed. To achieve the required level of reliability in the connection, Bosch is working on a predictive quality of service with the help of algorithms and artificial intelligence. This describes the ability of a system to predictively guarantee data rate, latency and connection quality. In addition to that, development of connectivity

technologies for connected vehicles is carried on, considering traffic safety and traffic efficiency. In facts, it has developed a communication mechanism between vehicles, that, in an ideal scenario, negotiate together, sending each other messages and possible routes, and adjusting routes accordingly. Vehicle connectivity is also linked to the so-called teleoperated driving: a vehicle is remotely controlled from a control center.

3.4.2 Research on Virtualized Engineering

Bosch pursues a wide variety of interdisciplinary research approaches in the digital development of products and, at the same time, it establishes an international research network with institutions around the world. Virtualized engineering is the development of technical systems, parts and components based on three-dimensional models, that helps to significantly reduce the overall development time of products and services. Nowadays, all steps of a production system can be digitalized so that products and solutions can be tested, adapted and improved while they are still being developed: the so-called virtual development is the top priority. This digital twin of the real product allows the coordinated development and simultaneous testing of multiple steps. It is followed by virtual testing, the test phase and a targeted run-through of the entire system under real conditions, once again digitally. Successful completion ends up in the virtual release, digital release or rollout of the digital image of a product. These new methods and concepts further shorten the time from the idea to a marketable product and increase efficiency and sustainability. In this case, Bosch takes advantage of artificial intelligence to speed up computing times and to use its data-driven approaches: carrying out

development work in virtual space saves a lot of time and money while protecting the environment. Once again, Bosch benefits from being part of a global corporation, where all the data available in the company from physical and software-driven areas can be combined and used.

3.4.3 Research on Internet of Things

Bosch is working on IoT ecosystems made up of connected solutions that are developed on the basis of a user-centric approach to unlock valuable potential for businesses and consumers. The research on IoT solutions is focused on people's needs in the areas of living, working and mobility: connected devices have become an indispensable part of everyday life. The group offers end-to-end connected systems that can be integrated into various ecosystems, such as sensors, devices and data-driven services: the more frequently products and solutions are used, the more data from the field are available to the development department and the more connected products can be improved and tailored in line with customers' needs. The basis for these products is the usage data that are connected anonymously and securely by connected devices. Bosch has been able to create a sustainable platform for context-sensitive, intelligent and predictive services in the area of home and living, in facts, smart living applications in residential settings offer user assistance, efficiency and comfort while ensuring data security and privacy. ForeSight is a sustainable platform for smart living services focused on learning and understanding users' behaviour, routine and preferences and that, based on on users' experience, will be able to give specific educations to the customers: for example, in the case of the cooking assistant in a smart connected kitchen, the user's

behaviour can be used to model the cooking behaviour and, based on the information captured, the device will be able to give more detailed or less detailed step-by-step educations or omit steps where appropriate. Bosch is also working con communication protocols that must be compatible with products from a range of manufacturers and allow open ecosystems play a key role in user-centric connectivity solutions. For example, the "Matter" connectivity standard has been developed to make new products more "Matter-capable": it will enhance market penetration and stimulate growth of smart homes and user-centric connectivity solutions, using existing technologies such as Bluetooth Low Energy, Wi-Fi or Ethernet. This will shift the focus from compatibility and fragmented ecosystems toward a positive user experience with a full range of customization options. Intelligent connectivity also offers great potential at the interface to well-being, health and safety, for example with "brain-machine" applications, such as safety human helmet with integrated electroencephalogam. This device is able to detect whether, and to what extent, a wearer is tired: it can sense mental fatigue because it records signals directly from the human brain. Bosch is, indeed, working on developing an independent and complete ecosystem for fatigue detection, including portable low-power signal acquisition devices and high-precision fatigue detection algorithms on the basis of advanced AI.

3.4.4 Research on Software Development

Nowadays, a software is at the heart of virtually everything we use daily. It enables us to connect, automate tasks and create powerful devices, tools and services that help us achieve great things. Since 2022, Bosch products in all classes contain software or AI, whether

to control an electric motor, to predict maintenance intervals for industrial equipment or to ensure quiet and comfort in your home. The group is interested in software that adapts to the environment, that is smart and that can respond to changing conditions in real time. These types of software can help to make machines more precise and extend their lifespan by allowing them to adapt to the world around, for example taking into account production tolerances as well as physical or mechanical changes affecting the machine itself, such as wear or corrosion. Self-learning software can help to ensure that a machine operates accurately in the long term. Another key area is automating development and certification processes for software, such as tools and techniques to automatically support software development, testing, certification and operation. They also carry out research into new programming and modeling languages that make software development faster, more secure and more efficient.

3.4.5 Research on Security and Privacy

All over the world, Bosch is connecting sensors, devices and machines with users and enterprise applications to make work easier and life more convenient, so security of products must be ensured. The more devices and services are networked via the Internet, the more important security becomes: for example, hackers exploit vulnerabilities in software and hardware systems to spy on secret data. Bosch tries to avoid this danger by implementing IT-related security measures in all lifecycle phases of software: "DevSecOps" is a development paradigm that automates security and integrates it into every phase of product advancement, from initial design through implementation and validation, to delivery. So, in software development, troubleshooting is

considered from the very first line of code and, with the so called technology "Automated Security Testing", vulnerabilities are identified in the code automatically during the development. Moreover, the group is working both on "intrusion detection systems", that can automatically detect attempted cyber attacks from outside, and on "security multiparty computation", that keeps data encrypted during processing.

3.4.6 Research on Distributed Systems

As a result of the progressive networking of computer systems, embedded systems in addition to consumer electronics devices are being connected to the cloud. This tend towards Reliable Distributed Systems is leading to changes in both our everyday habits and the technical devices that we use. These systems are the basis for the digital transformation and are the backbone for modern products and services. Bosch is working on the technical basis for automated driving: it is developing components for future vehicles that will be autonomous, connected and intelligent and that will be supported by already existing data, such as high-resolution maps or functional updates from the cloud. Distributed System are thus becoming Reliable Distributed Systems with an even broader range of applications, from the automotive industry or industrial and building automation to robotics. The goal of the company is to research and realize technologies and methods that can improve distributed IT systems designed for average performance. Sensors and computing power are no longer bound to an individual technical system such as a vehicle or a production machine, instead, they can be shared efficiently by different systems. In Bosch's plants, a large number of automation processes are implemented, such

as "programmable logic controllers" which are directly coupled to the production machines on a dedicated basis. There are two challenges to keep in mind: the software must be adapted to machine-specific interfaces and specific hardware platforms with high computing power must be mantained at each production machine. RDS technology allows data from many individual sources to be collected and fused in real time in order to implement both time-critical automation solutions ans data-based methods for process optimization on that basis.

3.4.7 Research on Quantum Technologies

Bosch is developing quantum algorithms to make quantum computers useful, in particular for materials development, as well as quantum sensors for special future applications. Quantum technologies include sensors, computing and cryptography and allow the exploitation of phenomena of the small scale world. With its great expertise in quantum physics, microelectronics and MEMS technology, Bosch is ideally placed to drive the development of quantum technologies for important applications. Using quantum computing algorithms, it will also be possible to adequately simulate new materials in which quantum effects play a central role and conventional simulation approaches have so far failed. Bosch develops particularly high-performance sensors which use quantum effect to determine physical measured variables and which are based on the quantum mechanical properties of individual atoms, photons or elementary magnets. They are developing two kinds of sensors: quantum magnetometers, to measure very small magnetic fields with very high precision, and quantum gyroscopes, that can be used to track even tiny rotational movements. With these innovations, Bosch is consolidating its leading position in the develop-

ment of sensors for selected applications. Another important field is the one of quantum computing, particularly useful for the simulation of materials.

3.5 Bosch VHIT Example of Digitalization

Bosch VHIT is an industrial plant that operates in the field of vacuum and hydraulics and which fabricates products destined for the international automotive market. Main technologies used in these production activities are mechanics, pneumatic and electronics, and the primary item crafted is the *Vacuum Pump*, for which the plant represents the global competence centre for Bosch. Manufacturing is organized by Robert Bosch subdivision seated in Stuttgart and it is based on four main value streams, where the four product families are manufactured, assembled and tested: Mechanical Vacuum Pump (MVP), Oil Vacuum Pump (OVP), Combined Pump (CP) and Hydraulic (Hyc). Each branch has different variations and the total number of components is 30. There are three kinds of raw materials: cast iron, aluminium and plastic materials. 70 machines are used, each having an average age of 15.4 years and managing 30 tools to manufacture several types of untreated materials. The advantage of having such timeworn machines is the fact that these assets are completely amortized but, at the same time, using them carries a lot of disadvantages, such as frequent downtime or inaccurate values for remaining life. To solve complexities, an operation of digitalization of machine tools has been developed: the method consists of data acquisition while machines are working, elaboration of data to transform it into information and generation of new knowledge. This learning can be used for predictive maintenance ac-

tivities or to evaluate residual life of each tool. First step of machine digitalization consists of connecting devices to the network but, because of their obsolescence, retrofitting must be carried on: this stage includes the main difficulty of the job, which is the interaction with different communication protocols that have been used over time, so specific software called IoT Gateway are installed to allow to read variables and to send their value every time it changes. Each production line generates data that is normally used during line's functioning but which is usually unavailable for any afterward analysis: these software help to extract data produced by machines and to directly register it on database, to permit its use. Second step involves the creation of synoptics that allow to monitor machine tools, alarms and characteristics, as length, radius and residual life in real time, ending up with a system able to monitor the state of machinery, their relative alarms and the remaining life of each tool of the production chain. Moreover, the system enables to analyze the characteristics of devices and their quality measures, to find out the causes of potential errors in a complete and improved way. With the advent of digitalization, Artificial Intelligence becomes fundamental to improve productive efficiency of industrial machines and to be able to compete in a increasingly dynamic market, thanks to the development of predictive and prescriptive programs. Predictive maintenance consists of developing algorithms able to forecast the probability of failure of a component or the downtime of a machine, making it possible to plan operations to avoid plant stoppage. Prescriptive approach consists of determining actions to be done by the operator or the control system to improve the use and the management of the machinery or the plant. The main complexity of the project is to face the technological change: going

from an analogical to a digital system is surely challenging but it also carries a lot of advantages. Information flows linked to production are more dynamic and flexible, availability of data is smarter and acquisition of information is easier: this leads to processes which are more dynamic and flexible, but also leaner. In facts, digitalization acts as catalyst for Lean Production: they are both methodologies which contribute to waste elimination thanks to reduction of non-value-added activities. One of the most immediate example that one can think of is "Paperless" production concept: in the past, organization of production was based on compiling paper documents, resulting in long and useless activities, nowadays, with digital planning, data arrives automatically from lines, saving time and resources. Digitalization and Lean Production should go on in sync, so that digital transformation can reach its maximum expression of effectiveness. Technological change doesn't only bring benefits to production processes, but also to logistics area. Traditionally, warehouse of a plant is split in two macro areas: supply and shipping, for which the priority is to guarantee materials to clients. The primary risk is to not care about the right level of stock to have along the production chain that makes it possible to avoid inefficiencies: material of the plant consists of Raw Material, Finished Good or Work in Progress and they all represent a cost for the firm, so areas of the warehouse must be optimized and adapted to precise constraints. Volumes increase and product diversification linked to growth of logistic codes that have to be managed, leading to the necessity of understanding the right amount of stock to have for different materials. In VHIT warehouse, digitalization of logistics activities has been carried out: the goal is to transfer BPS principles and lean manufacturing applied from a paper structure to a digital

and shared form. The analysis has been developed for each product class, computing a minimum and a maximum value of stock according to production needs, thanks to visual monitoring tools (dashboard and charts) and Microsoft PBI (a Business Intelligence software combined with SAP information system). The most difficult part of the process is the management of a huge amount of data and the conversion into numerical information that can help to identify and classify the real cause of detours and be the base of reengineering of processes. The biggest advantage of having a "connected" warehouse is the monitoring of stock without physical control of storage but with direct back-office activities that allow to improve decision-making thanks to an overall vision of logistics processes.

3.6 Bosch Training Courses

Bosch offers consulting services and training in the areas of project management, development and business processes, software engineering, functional safety, quality management and new business building. The group is interested in supporting the professional and personal development of each worker, with a vast range of free and company-funded training courses available to everybody. The main goal is to develop a high variety of training programs, focused on extending technical, managerial and personal skills. Training courses and seminars cover a wide range of topics, including electromobility, internal combustion engines, cybersecurity, artificial intelligence, functional safety, vehicle connectivity and many more. There are four categories of trainings: online courses, virtual classes, in-person classes and training plans, and they all lead to an official certificate.

3.7 Bosch TEC Corporate Academy

The Bosch TEC Corporate Academy is an internal training and development initiative by Bosch branch in Italy born in 2002, designed to enhance the skills and the competences of employees. The acronym "TEC" stands for "Training, Education and Coaching" and the academy is a crucial part of Bosch's strategy to rise learning, innovation and leadership within the company. It relies on three basic concepts (uniqueness, experience and applicability) and it provides two categories of training: managerial training and specialist technical training. It is born to respond with concreteness, innovation and quality to the needs of managerial and technical training of Bosch and its client. In facts, TEC doesn't only train Bosch's employees, but it also offers courses to clients, suppliers or external companies willing to prepare workers in different sectors, from mechanics to industrial automation and industry 4.0. The academy develops tailored educational projects, thanks to its deep comprehension of business processes and industrial technologies, and it is appreciated by its client for its ad-hoc training courses. Bosch TEC collects the aspects of Bosch Group's experience and it is able to offer a wide range of detailed programs. Courses are not standard but hyper personalized: they have different topics, modalities or duration, according to the requirement of companies and of participants, in order to make education effective and experiential.

Figure 3.2: Bosch TEC Corporate Academy Logo

3.7.1 Managerial Training

Managerial Training helps employees develop human and soft skills, perfecting strategic and decision competences. It starts by setting the basis for interpersonal communication, providing managers a methodology to efficiently communicate in formal occasions and allowing them to be able to lead the talk. Apart from studying the concepts of effective and persuasive communication, it also teaches how to act in cases of disagreements and how to convert the divergences into opportunities. This category of training is mainly focused on leadership and resource coordination. Another considerable point is team building: it is important to keep united teams in the firm, where each member contributes to a common goal. This training follows a procedure called Sportshop: sport methods that could be efficient for the development of the management of the firm are followed, perfectly integrating experiential training with the traditional one.

3.7.2 Specialist Technical Training

One of the most determinant cause of productivity growth is the technical compentence of people who work in the firm, so training become a necessary investment for companies. Bosch TEC proposes a complete selection of training courses addressed to staff that deals with planning, installation and maintenance of industrial plants, which are

becoming more complex and advanced. This training also contains seminars about Lean Production: an innovative methodology that allows to obtain standardized and streamlined processes, getting rid of anomalies and reducing workload. Thanks to the experience gained in this matter, Bosch TEC boasts an extensive understanding of industrial processes and technologies, and it is able to offer specific training courses built around lean thinking. Specialist Technical training also include courses about Industry 4.0: the firm transmits the digital mindset to employees in and independent, objective and tested way. These courses support workers with appropriate training through the digital transformation of production and of logistics, with a professional change management. In addition to the technological changes of production, Bosch TEC also deals with improvements of machines. Specific courses are dedicated to employees that operate in the sector of design, assembly and testing of innovative and more digitalized equipment.

3.8 Industry 4.0 and "Digital Revamping"

Bosch TEC Academy offers consultation and training in the field of Industry 4.0. The basic concept from which this subject has been developed is data: in facts, optimization of productive processes starts with data analysis. After data has been collected, it can be transformed through simple algorithms, becoming information that will be used to have a higher knowledge of processes, leading to the possibility of actions of improvement. There are three kind of data: "limited data", production data and process data. Lean Production helps "limited" data collection, all those values collected on paper or ex-

tremely difficult to obtain, because it allows to map the actual state of production processes (Value Stream Mapping) and to identify main variables to monitor (KPIs) whose analysis lead to better information about processes and so to a possible improvement, even if actions are usually uncommon and costly. Production data consists of those values obtained through digitalized processes and monitored with IT tools, which are remodeled thanks to simple algorithms, as limited investments or digital transformation processes. Process data are quick and continuous and they are constantly collected from main business processes: to obtain them, it is necessary to have a Big Data IT Infrastructure, that is connected to physical procedures. Volume of data generated is huge and continuously growing, so it is transformed in information through complex algorithms, as Machine Learning, forecast and significant investments. TEC training of the sector consists of workshops, to create awareness of Lean Production, Technologies 4.0 and Value Stream Automation, together with training for managers, which is made up of a theoretical and a practical part, and training (base and advanced) for technicians and operators, to make them able to analyse processes and implement technological change. Main learning modules are:

- *Lean Manufacturing for Industry 4.0*, which aims to teach the basic concepts and the benefits of Lean Production combined with Industry 4.0. It uses a continuous improvement process system approach to explain digital methods to apply Lean to production processes and to arrange Value Stream Mapping (analysis of flows of materials and information in a company).

- *Industry 4.0 Understanding*, to comprehend the reality of Indus-

try 4.0, the advantages it can bring and the reason why it affirmed in this historical period.

- *4.0 Technologies: from data to actions*, provides an overview of the main digital technologies and their use in production processes 4.0.

- *Industrial Senior Solutions & Data Analytics*, that seeks to let workers experience practical use of multisensors devices (MEMS), to collect data and parameters.

- *Artificial Intelligence in Action*, which brings consciousness of AI, of its applications and of its possible impacts on businesses and society. It consists of an introduction to big data, statistical learning, machine learning and deep learning.

- *Digital Maintenance*, to provide tools to apply principles of predictive maintenance in a smart factory.

- *Logistics 4.0*, which shows how digital technologies can be applied to logistics processes and benefits brought.

- *Machine, Data and Information*, that aims to teach how to connect a production machine and how to change data into information.

- *Plant Tour 4.0*, an in person presentation of the plant.

Consultation 4.0 starts with Technological Assessment, necessary to understand the level of transparency of the productive process to be able to propose better 4.0 solutions. Analysis is conducted on technological infrastructure and on data: machines, protocols, sensors are examined and critical processes of the productive chain are inspected

in detail. The goal of the consultation is to highlight low added-value activities and to propose technological 4.0 solutions that reduce negative impact and improve quality. To reap the benefits of Industry 4.0, it is necessary to have stable basal processes, with a view to Lean Manufacturing.

3.9 Industrial Area Training

TEC Academy also deals with Technological Training of Industrial Area, which is split in three different topics:

- *Mechanical Sector* starts from the basics with mechanics and technical drawing, to carry on with lessons on traditional machine tools and numerical control machine tools.

- *Industrial Automation* teaches subjects as electrotechnics and electronics, electric industrial plants, industrial pneumatics, industrial hydraulics, functional safety, PLC systems, Bosch Rexroth drives and electrical controls, industrial robotics programming and linear handling tecniques.

- *Production Processes* concerns Lean Production, WAtS (Working According to Standards), SMC (Shopfloor Management Cycle), Value Stream Digital Automation and FMEA (Failure mode and Effects Analysis).

3.10 On the job Training Model

Sometimes, it may happen that workers decide to change their position, otherwise they decide to improve their knowledge: in this cases,

the educational model applied by Bosch is called "70 - 20 - 10 Model". This means that for 70% of the time, the employee will learn on the job, placed side by side with other colleagues or autonomously doing researches: in facts, Bosch Group believes that "Training it's up to you", so this means that, if interested, the worker can look up for information on the learning portal, TrainM website and Bosch tube, which are continuously supplied with updated resources. Another tool provided by Bosch is the "Bosch Club", which is a group of informal sessions between collaborators, where most experienced employees help less experienced ones, offering their knowledge. Then, 20% of the time consists of training courses which are done in presence and 10% is the overall time invested in events, such as workshops, conferences and external moments that allow the debate with experts of the field. Moreover, in cases where the employee is in difficulty because of a career move, a specific project lasting 48 hours exists for apprentices: it teaches a broad selection of subjects, starting from basic knowledge such as the reading of a paycheck. In addition to that, a wide range of WBT courses (Web Base Training) is compulsory for workers as a personal update and they include topics such as compliance and security, with a final test that they have to pass.

3.11 Social Sustainability Projects

The Bosch Group pays attention to social sustainability, providing training projects in partnership with the biggest employment agencies, as Randstad, Manpower, Adecco and Gi Group. These plans are primarily addressed to Neet, people between 18 and 30 years old which are not currently working neither studying. These courses are

supplied all over Italy following a standard procedure: the agency reports profiles which are currently required on the market and it selects a group of 12-18 guys that are not active right know, while Bosch supplies the material needed to train workers and arrange courses. Costs are sustained by the fund *FormaTemp*, which can be accessed only by employment agencies to supply unemployed people. Neets follow the training courses and, at the end, they can directly enter the labour market, as the agencies present them to companies in need. Their career usually starts with a leasing contract lasting 6 months or one year, then they are directly assumed by firms. In addition to projects for Neets, Bosch is also working on two others typologies of plans. The first one, done in collaboration with employment agencies, is dedicated to prisoners which are at the end of their sentence, to redirect them toward the job market. In 2024, these projects were developed in jails of Como and of Monza were most of the plans were designed to train e-bike technicians and jails of Ancona and Turin will be the next ones. The second campaign is really similar, but it concerns a completely different category of people and it has been done in collaboration with football league brand: it is called *Terzo Tempo* and it is addressed to professional football players of C Series which are at the end of their career. The education provided usually has economical topics with the aim to build salesman for sports companies. These players have played football for their entire life, but they have not earned as much as a major-league player and they did not have the possibility to get a degree so, at the end of their profession, they need a job. Seeing as this problem doesn't only concern football but also other sports, such as volleyball or basketball, Bosch is willing to expand this project. Bosch supplies training with a clear goal: to end up with a complete

figure, in facts, a part from technical training enabling him to become a technician or a salesman, it also includes behavioral education, to allow him to communicate and learn basic skills.

3.12 Bosch Training Financing

Seeing as Bosch Group strongly believes in employees' training, each of its fourteen divisions owns a budget which is completely allocated to training and which represents almost 60% of the total amount required for this purpose. Biggest plants, having about 1 or 2 thousand employees, invest almost 200.000 or 300.000 euros in continuing training. A part from internal funds, Bosch deposits a quote to *Fondi Interprofessionali* each year: while plants use *Fondimpresa* for financing regarding partners and employees, and *Fondirigenti* for projects specific to managers, sales offices, sited in Milan and Turin, exploit *For.Te.* and *Fondir* for trade contracts. A part from standard announcements of *Fondi Interprofessionali*, focus is turned to specific announcements for training dedicated to particular categories, such as *cassaintegrati*, people which are temporary suspended from their job because of economic problems of the firm they work for. Moreover, some of Bosch associated applied for *Fondo Nuove Competenze* but only one of them (BSH Appliance) managed to use it. In that period, the fund asked to present a training project but queues were so long, approval required at least six months and there were a lot of constraints to follow so, seeing as Bosch extremely cares about training, plants decided to pay for those projects with internal funding. When the training is supplied to external partners, Bosch is not interested in how the course is financed: clients can decide to pay courses

with their private funds or they can take the most of public ones and, in that case, the right reference and caption to report on the invoice must be selected, so that they can be partially or totally reimbursed by the fund.

Chapter 4

Survey on Workers - Robert Bosch Gmbh Branch in Italy

4.1 Sample and Data Collection

This project has the goal to examine the relationship between digitalization and workers' skills, specifically how technological change affects tasks and productivity. A survey has been developed on an online platform and it has been distributed through email to a sample of 55 employees of the offices sited in Turin of the company Robert Bosch Gmbh Branch in Italy. The form has been mainly formulated based on a qualitative approach: considering different articles and documents, 12 open questions and 3 multiple choices have been prepared. It was available from the 23rd September 2024 to the 2nd October 2024 and the average duration of the survey was 12 minutes 31 seconds. The sample for this study consists of workers of different roles, mostly from Italy. 46 responses has been received: 52,2% female, 43,5% male and 4,3% preferred to not specify their gender (Figure 4.1). Most interviewees were between the ages of 41 and 50 (43,5%) and the second largest group was people aged 31-40 (26,1%) (Figure 4.2). Seeing as

the test is primarily made of qualitative questions, answers have been analyzed one by one to assess the results of the survey. The findings of the study are important for the managers and supervisors, because they can help them understand how technological change impacts the way employees do their work and they can eventually make better decisions regarding their leadership method.

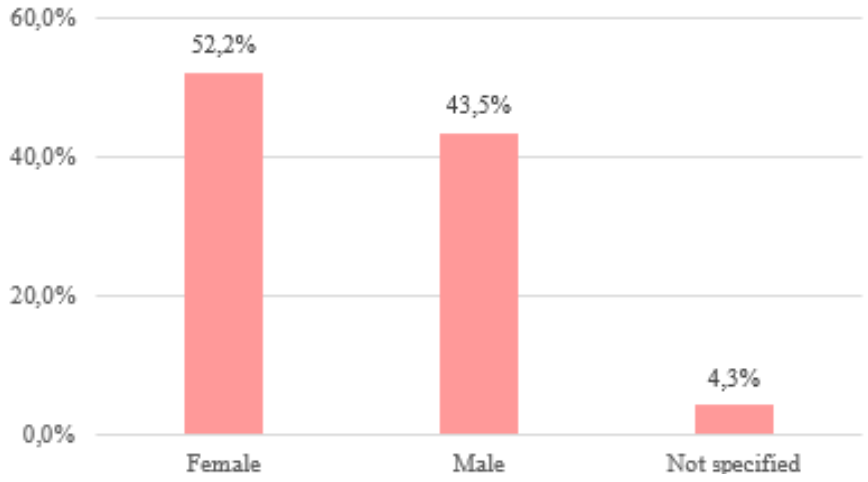

Figure 4.1: Genre of Respondents to the Survey

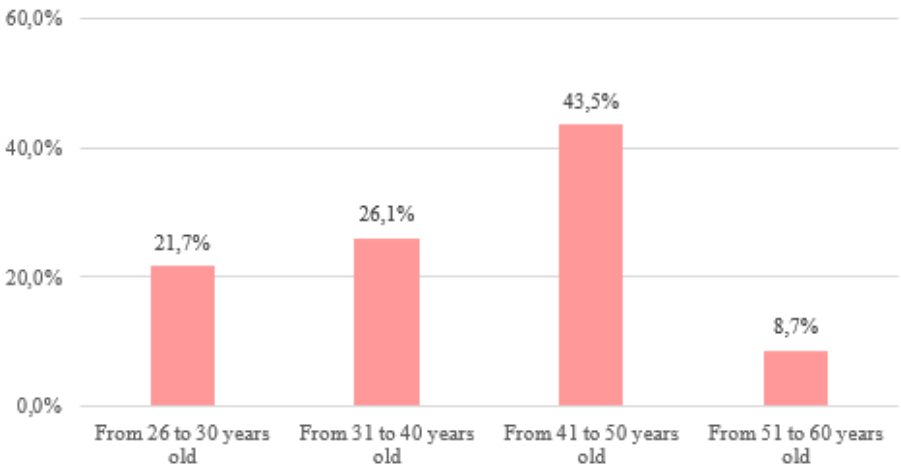

Figure 4.2: Age of Respondents to the Survey

4.2 Use of Technology on Workplace

After the questions concerning the age and the gender of the people being interviewed, the first information requested regards the impact of technology on the tasks that employees have to carry out and how much it is used on the workplace. Every respondent considers technology to be necessary for their job, to such an extent that it has been defined as "essential and unavoidable". It is fundamental, since it allows to speed every process, and different software and tools are used for several jobs, such as testing activities and data management. Each employee owns a business phone and a business laptop, that allow him to be constantly connected to its work and enables him to work remotely. This carries a lot of advantages because people can work from home, but some people consider it to have a negative impact on the work-life balance: workers are always connected and reachable, with no respect of personal time, working hours are extended over contractual ones, resulting addictive and increasing stress related to work. In the field of logistics, it has a big influence in terms of delivery forecasts, sales volumes, requests analysis, market and stock trends, life cycle of the product and client's backlog, while, in the area of human resources, digitalization helps the operational recruiting and the management of employees' registry and salary. All the day-to-day work is based on information systems, applications and digital tools: for example, Microsoft Teams is an ultimate messaging application used by the organization as a workspace for real-time collaboration and communication. It is used for meetings, file sharing and joint projects and, seeing as it is accessible to everyone, it allows collaborators to be always connected with each other. Additionally, interviewees have

been asked to set how much technology impacts their tasks on a scale from 1 to 5 and results are displayed in figure 4.3. No respondent selected the lowest values (1 and 2), making it clear how it has become impossible to work without technology. 52.2% of interviewees consider it to have a really high impact on their job, so they selected the top value of the scale (5). 34.8% of respondent chose the score 4, while the remaining 13% opted for the halfway value (3).

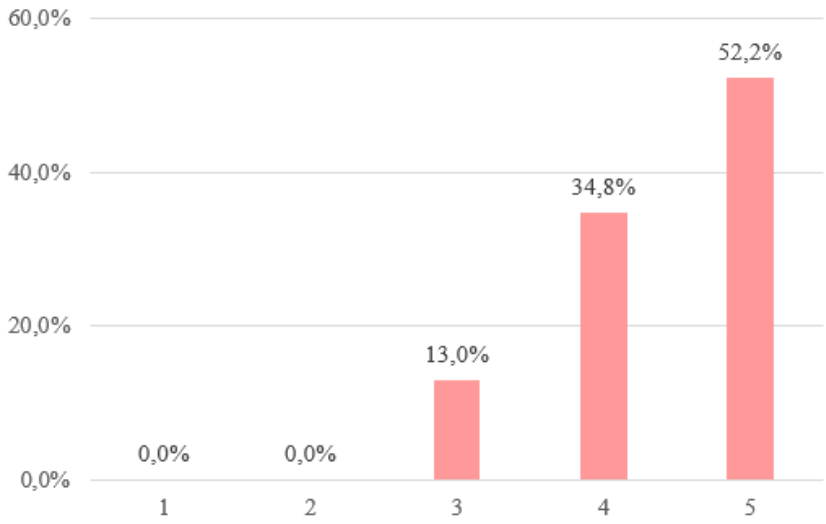

Figure 4.3: Impact of Technology on Interviewees' Tasks

4.3 Changes in the Use of Technology on Workplace

The second topic that has been proposed concerns the changes, both on workplace and in the firm, in the use of technology, such as the employment of advanced software and artificial intelligence tools. By looking at the answers, it is clear that respondents are more confident when replying to the question regarding their workplace rather

than the changes in the company itself. As figure 4.4 shows, most of employees believe that artificial intelligence has not been completely developed on their workplace (52,3%), so it is not employed yet, but, if more time was devoted to it, great advantages could be brought. Others state that changes have been made (34,7%): tools for data analysis have been introduced, software are updated daily and a lot of tasks have been automatized, but it seems like they don't directly impact duties that workers have to carry out. When focusing on the changes in the firm, answers don't seem to differ much from the ones of the previous question: artificial intelligence is not exploited yet according to 43,4% of interviewees and employees don't have a clear vision about if it is used in other sectors, so 30,6% of respondents preferred not to answer. Figure 4.5 displays these values on a graph.

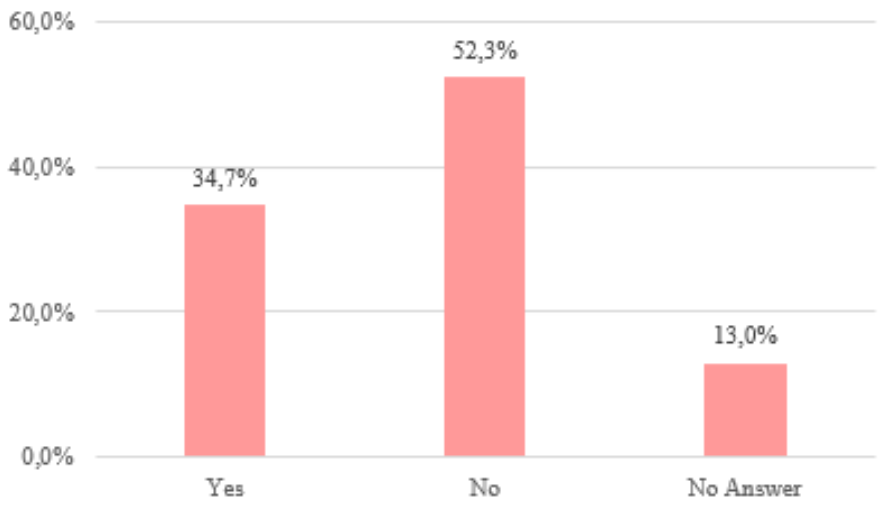

Figure 4.4: Changes in the Use of Technology on Workplace

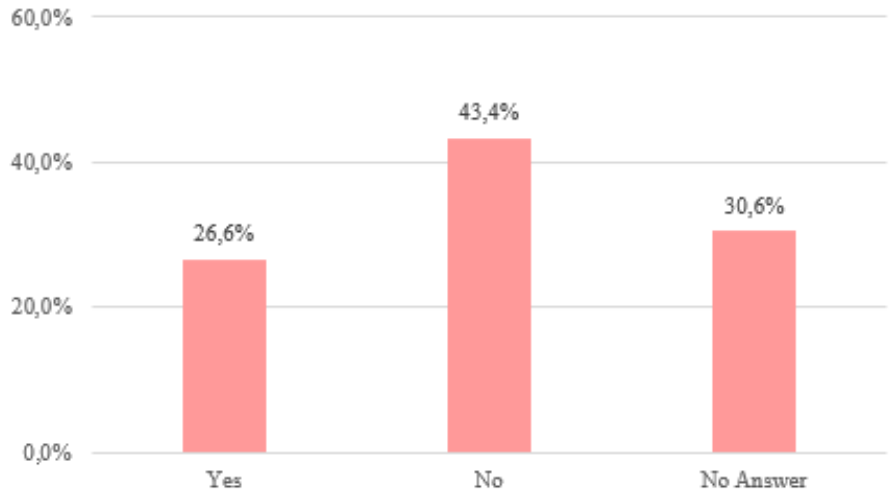

Figure 4.5: Changes in the Use of Technology in the Company

4.4 Influence of Technological Change on Work

Respondents, then, have been asked to explain how changes and developments in technology influence their job. As proved before, digitalization impacts workplaces a lot, so each advancement that takes place has consequences, as well. Everybody believes that technological change influences positively their workplace and no contrary answer has been registered. For example, improvements allow to speed up processes, making them more efficient and reducing time needed to obtain information. The same happens for analysis: digitalization leads to advancements that make it easier to implement, keeping track of the budget and facilitating communication, both during the examination and in the transmission of results. Interviewees have been asked to set how much technological change impacts their job on a scale from 1 to 5 and values obtained can be visualized in figure 4.6. It is clear that digitalization has a big impact on employees, seeing as every respondent selected the top two values of the scale. The peak value has been selected by 64.8% , while the other 35.2% chose the score

4. Nobody believes that changes in technology have no influence on their activities, so the lowest values (from 1 to 3) were not opted for. Additionally, attention is brought on how productivity is influenced. In this case, respondents do not seem to have the same opinion on the topic. Someone thinks that it is not possible to find a correlation between advancements of technology and productivity, while others have a very clear opinion about it and it is possible to define two opposite views. The first one includes all those employees that see clear improvements linked to technological change: effort is reduced, time needed to complete task is shorter and better quality work is obtained, since it relies on advanced systems. On the other hand, the second belief consists of all those people whose main issue is the time required to learn how to use advanced systems: some software and tools are not user-friendly, so effort and time are needed to learn how to use them. Employees who find it difficult to conform to technology, would spend more hours in getting used to it, leading to a decrease of productivity and efficiency. When examining these answers, it possible to find a correlation between the age of the interviewees and the effect that technology has on their productivity: younger users seems to adapt well to changes and do not need a lot of time to learn how to use highly-developed software, while older employees are the most affected ones in productivity terms. In facts, people in the range between 26 and 30 years old and the ones in the group between 31 and 40 years old do not complain about time lost in becoming well-versed with new tools, while respondents between 41 and 60 mainly focus their response on the disadvantages on productivity brought by the long effort needed to familiarize with digitalization.

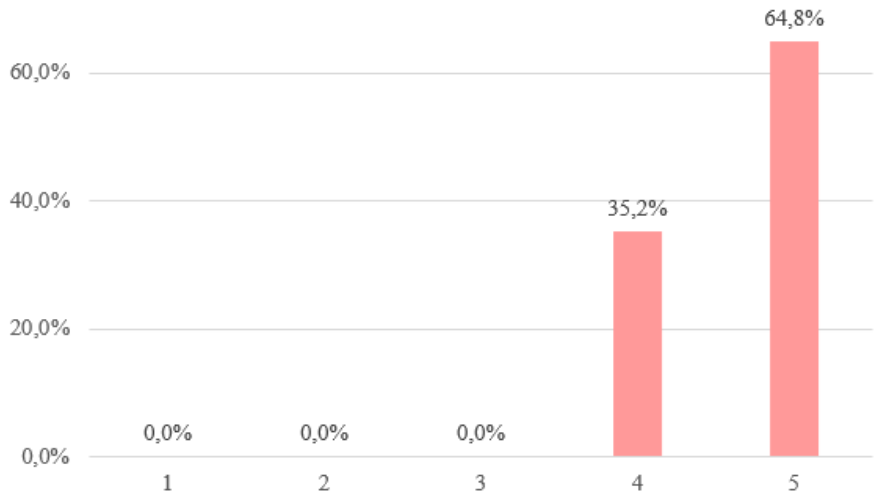

Figure 4.6: Impact of Technological Change on Interviewees' Work

4.5 Effects of Technological Change on Skills

In addition to the analysis of the effects that technological change has on productivity, it is also important to focus on the consequences it has on workers' skills, such as data management, communication or problem-solving. Analyzing the answers of interviewees, it is clear that digitalization offers a lot of improvements to human intelligence, such as advancements in data and information management, which result easier to trace and to share, and more accurate. If employees are trained with technology, its impact is obviously really positive, with upgrades in problem solving, less errors and better results in shorter time. In this way, the effort required in doing some tasks is lower and more working hours could be dedicated to other activities, on wich digitalization has less influence. A lot of respondents want to emphasize the fact that, even if technology plays a big role, human mind is the one that should make the first move: some people noticed that excess of tools makes human capacity lazier, conditioning their abilities

and interactions. Communication is the skill on which technological change has had a negative impact on: relying solely on software and applications removed part of human contact, which has always been necessary and very useful. Even if information sharing is becoming easier and easier, interaction, both among people of the same team and with clients, is suffering from technological change. To make it easier to understand how workers feel about technological, the graph of figure 4.7 can be drawn: 52,2% of respondents firmly believes in a positive outcome, while only 26% has a negative view about it.

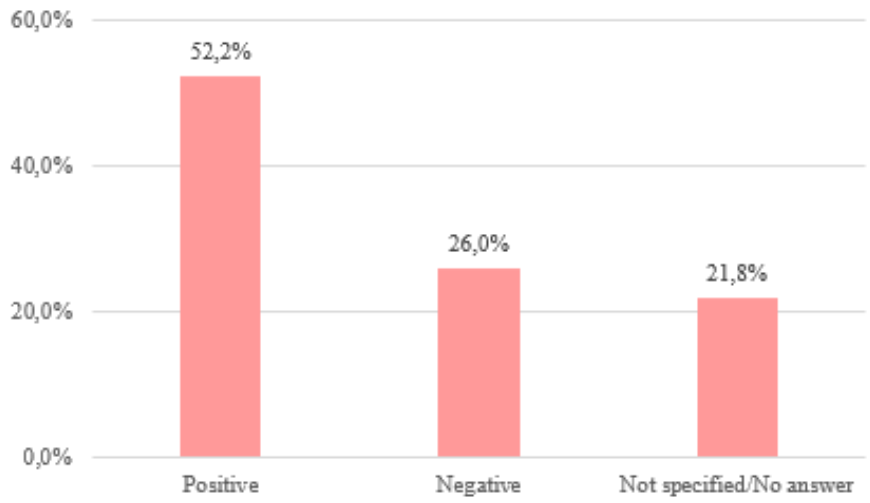

Figure 4.7: Effects of Technological Change on Skills

4.6 Competences of Workers

Employees have been asked if they consider their skills to be adequate enough to keep up with technological change that will happen in the near future, or if they think they need more specific training and results are displayed in figure 4,8. Only few people think that their competences are sufficient to keep the pace of digitalization (21,7%),

but they also admit that they would benefit from more training, seeing as the knowledge of the IT world is necessary. Most of respondents (78,2%) assume that their skills are not adequate enough and that continuous training is required. Training is essential, especially in the framework of technology and automation, but curiosity and dedication are important, as well. It is crucial to follow training courses specific for updated software and tools and education should be done with reference to the different starting level: for example, younger employees will be more flexible and ready to adapt to technological changes, compared to previous generations, that will need more time to develop these competences. Every time new software and tools are introduced or updated, continuing training should be provided to employees, to learn how to interact with them and to obtain reliable data. Workers gave their opinion about the fields in which more education should be provided and Artificial Intelligence seems to be the sector they are more interested in. AI's potential is not exploited completely and, if courses were supplied, its power could be applied in all kinds of activities.

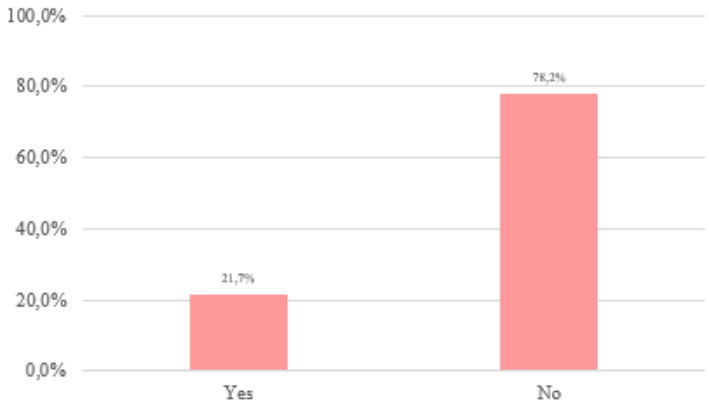

Figure 4.8: Percentage of Workers considering their Competences adequate enough to keep up with Technological Change

4.7 Bosch's Continuing Training

As it was mentioned in chapter 3, Bosch offers employees a lot of courses and training, which encompass different topics. Workers consider that the company lack of profound courses on Artificial Intelligence but, as ascertained in the previous chapter, the firm is working on providing more efficient ones. Respondents of the survey confirm the participation in a lot of training activities, not only class courses, but also lectures held by skilled colleagues that shared their experience. Even if Bosch proposes a large amount of projects to update its employees on digitalization, it seems like education on the topic is never enough: as some interviewees indicated, this could be because courses are not compulsory, so it is for workers to decide wether to attend them or not, and it is not a company's fault. Others answered the question proposing to flank older and less flexible employees with younger and more skilled workers that could help them, providing practical examples and not only theoretical one; as it has already been stated, a big impact on Bosch training is given by on-the-job training based on mentoring. Moreover, the survey asked employees how the company could improve its training in the field of technological change and in the use of new technology, and different solutions have been proposed: training should be focused based on the task conducted, periodically monitoring the needs of each collaborator, as each activity requires the knowledge of different tools and applications. Additionally, compulsory internal courses should be integrated, also with the support of online universities, to force workers to attend them. Apart from tips on the way training is conducted, someone also suggested to reduce the number of new systems introduced, so that, with the intro-

duction of a limited amount, more complete courses could be provided and employees could specifically focus on them.

4.8 Perception of Workers

One question of the survey asked workers if they expected a technological change on their workplace and what effect it brought on their work's perception. Respondents have different opinion about the topic: some of them foresaw this transformation (30,4%), while others did not expect it (52,2%) , or, at least, they did not think it would have happened in such short term. People who were able to anticipate the transformation due to digitalization are less then the other group, as we can see in figure 4.9. They believe that automation of processes is a trend that has existed for at least 20 years and that the topic has already been introduced in people's mind, so they should have foresaw the effects of technological change. Some of them hope that these changes carry on in an always improving way, enhancing workers accomplish 'routine tasks' so that they could focus on more effort-requiring ones, and helping them to adapt to technology in an increasingly easy manner. On the contrary, other interviewees hope that technological transformation slow down: digitalization is speeding up more and more, making it difficult for older generations to keep up with it, while making younger ones lazier. Respondents who didn't expect such technological advancements do not have nothing in contrary about them: they hope it progresses more, because it reduces the risks of human errors and increases efficiency. Analyzing the answers of the workers, it seems like older generations (group of respondents between 41 and 50 and between 51 and 60) were expect-

ing these changes more compared to younger ones (group of people between 26 and 30 and between 31 and 41): this could be due to the fact that youngsters are more flexible and suited to technology, so a small evolution doesn't impact them a lot, while it has a stronger effect on seniors. Additionally, the survey proposes an open question regarding the turn that employees think digitalization will take in the future. Workers hope technology will help making processes easier and faster, reducing human efforts and increasing quality. People think that always more tasks will be automatized and new control and verification systems introduced, also adopting Artificial Intelligence. AI will become integral part of production systems and it will be accessible by everyone so more training will be essential: it will always move forward, so it is important for the company to understand how to better take advantage of it and wether to limit it or not. It will be necessary to work on interconnected systems, to assure a developed communication mechanism between machines and create a progressive networking of computer systems.

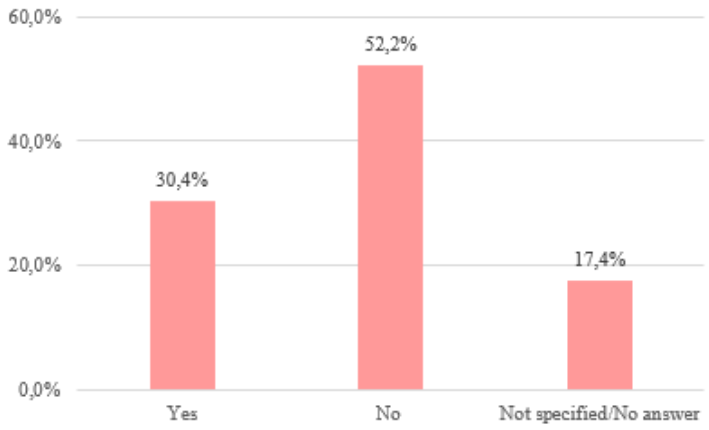

Figure 4.9: Percentage of Workers expecting such Technological Change

Conclusions

This thesis has the goal to examine the relationship between technological change and workers, specifically, how digitalization impacts work and competences of Robert Bosch employees. Based on the survey and the analysis of responses, support was found for both the starting hypothesis. The first hypothesis, which affirms that digitalization and automation influence workplaces positively, is confirmed. Technological change doesn't only speed up processes and makes them less demanding, but it also facilitates communication and leads to advancements of competences. Additionally, last chapter illustrates how repercussions of technology are diverse at different ages: young workers are more flexible and adaptive to technology, they grew up in a world which was already affected by computers so it easier for them to understand how innovative tools and software work. On the contrary, older generations need more time to keep up with this evolution and this also influences their level of productivity. While the age of respondents seems to be an essential feature to ask for, the question concerning the gender is not: as expected, technology impacts men as much as it affects women and no distinction can be identified when analyzing the responses of the questionnaire. Furthermore, the study also confirm the second hypothesis, which states that continuing training is essential, because skills of workers are still not adequate enough

to keep up with technological change. Software and devices are in continuous evolution, so it is important for the company to keep its staff updated. The results of this analysis are important for managers and directors of different teams, willing to understand how technology impacts employees and how their staff reacts to changes. For example, the research shows the type of training activities that laborers are most interested in: they prefer on-the-job training, rather than in-class lessons. Knowing this, leaders can make better decisions regarding the type of education to recommend to their subordinates, in order to be sure they take part in those activities. It is also important to inspect the perception of employees towards these innovations: the thesis studies both wether they expected such an impactful technological change, both their future forecast about it. The analysis of their feeling allows to perceive the attitude they will have and the way they will carry out their profession.

List of Figures

Appendix A

Survey proposed to Employees of Bosch Gmbh Branch in Italy - English Version

- Genre
- Age
- How does technology affect activities you conduct and how much it is used on workplace? Can you give any example?
- Considering a scale from 1 to 5, how much does technology affect activities you conduct?
- Did you notice any change in the use of technology on your workplace in the last period, for example the use of advanced software or Artificial Intelligence tools?
- Did you notice any change in the use of technology in the firm in the last period, for example the use of advanced software or Artificial Intelligence tools?
- How does technological change, as the introduction of digital collaboration platforms, advanced software or digital management systems, affect your job?

- How does technological change, as a higher use of management software or data analysis tools, influence your productivity? Did you notice any improvement or worsening?

- Considering a scale from 1 to 5, how much does technological change affect your job?

- New technologies, such as advanced robotics or process automation, have been introduced in the company. Were you able to foresee it? What effect did their advent have on your job perception?

- Do you think that technological change, as the use of specific software or automated systems, improved or worsened your job skills, such as data management, communication or problem-solving? How?

- Do you think that your actual competences will be adequate to keep up with technological change in the near future, as introduction of artificial intelligence tools or advanced software? Do you think you need continuous training? In which sectors in particular?

- Have you ever taken part in training or business courses for new technologies use? Which ones?

- Do you think that Continuing Training has been enough for use of new technologies, as analysis software automation tools or digital management systems?

- In which ways the company could improve training in the context of technological change and use of new technologies?

- In which directions you think evolution of technological change will carry on in the company? For example, do you expect more process automation, introduction of artificial intelligence technologies or integration of interconnected systems?

Appendix B

Survey proposed to Employees of Bosch Gmbh Branch in Italy - Italian Version

- Genere
- Età
- Quale impatto ha la tecnologia sulle mansioni che devi svolgere e quanto viene utilizzata sul posto di lavoro? Puoi fornire qualche esempio?
- Considerando una scala da 1 a 5, quanto la tecnologia impatta le mansioni che devi svolgere?
- Hai notato un cambiamento nell'utilizzo della tecnologia sul tuo posto di lavoro nell'ultimo periodo, per esempio l'uso di software avanzati o di strumenti di intelligenza artificiale?
- Hai notato un cambiamento nell'utilizzo della tecnologia all'interno dell'azienda, per esempio l'uso di software avanzati o di strumenti di intelligenza artificiale?
- In che modo il cambiamento tecnologico, per esempio l'introduzione di piattaforme collaborative digitali, di software più avanzati o di sistemi di gestione digitali, influenza il tuo lavoro?

- In che modo il cambiamento tecnologico, come il maggiore utilizzo di software gestionali o strumenti di analisi di dati, influenza la tua produttività? Hai riscontrato un miglioramento o un peggioramento?

- Considerando una scala da 1 a 5, quanto il cambiamento tecnologico ha impattato il tuo lavoro?

- Nuove tecnologie, come robotica avanzata o automazione di processi, sono state introdotte all'interno dell'azienda. Lo avevi previsto? Che effetto ha avuto il loro avvento sulla tua percezione del lavoro?

- Ritieni che il cambiamento tecnologico, come l'uso di software specifici o strumenti automatizzati, abbia migliorato o peggiorato le tue capacità lavorative, come la gestione dei dati, la comunicazione o il problem-solving? In che modo?

- Ritieni che le tue competenze attuali saranno adeguate a tenere il passo del cambiamento tecnologico nel futuro prossimo, come l'introduzione di strumenti di intelligenza artificiale o di software più avanzati ? Oppure ritieni di avere bisogno di formazione continua? Se sì, in quali settori in particolare?

- Hai mai partecipato a training o corsi aziendali per l'uso di nuove tecnologie? Se sì, quali?

- Ritieni che la formazione aziendale sia stata sufficiente all'uso di nuove tecnologie, come software di analisi, strumenti di automazione o sistemi di gestione digitale?

- In che modo l'azienda potrebbe migliorare la formazione nell'ambito del cambiamento tecnologico e nell'uso di nuove tecnologie?

- In quali direzioni pensi che evolverà l'evoluzione del cambiamento tecnologico nell'azienda? Per esempio, ti aspetti una maggiore automazione di processi, l'adozione di tecnologie basate su intelligenza artificiale o l'integrazione di sistemi interconnessi?

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