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**Industry 4.0 Implementation and Organizational
Consequences: An Analysis of Organizational Variables
Through a Systematic Literature Review**

Supervisor

Ch. Prof. Andrea Pontiggia

Graduand

Carlotta Moggian Barban

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*Alla mia famiglia,
che mi ha sempre sostenuto.*

*Ai miei genitori,
che mi hanno dato tutto.*

*Alla nonna Billi,
che sarebbe stata fiera di ciò che sono oggi.*

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Introduction

The Fourth Industrial Revolution is no longer a distant theory to which the authors refer, but it is a solid reality, which must not be ignored, but accepted and understood. Unlike previous revolutions, this is characterized by being extremely rapid, in fact in few years it could revolutionize entire production systems. Therefore, it is a topic of substantial importance for companies that want to focus on innovation and increase their competitiveness.

Often, a technological change implies an entire upheaval of the corporate system. In this sense, among the various aspects that need to change, the organizational aspect is a crucial point. Often, it is not easy for companies to make big changes that involve the organizational aspect. This is because the company's organization is a very difficult aspect to change, as it entails a distortion not only of the roles that workers play, but also of the way of working. So, even if organizational changes are necessary, often they are not made, as this is a challenge that many companies would not be able to overcome. In any case, it is very useful for companies to understand what organizational changes are needed for an effective adoption of 4.0 technologies.

This thesis aims to understand the role of the organizational aspect in the process of implementing 4.0 technologies through a systematic literature review thanks to the large number of documents in this regard. Furthermore, it is decided to concentrate the analysis on companies operating in the manufacturing sector, in order to narrow down the research and to understand what kind of organizational changes are proposed within the production centres.

The first chapter is composed of an excursus on the previous industrial revolutions in order to understand the features of them and then to reach considerations regarding the Fourth Revolution. Subsequently, the chapter deals with the description of the main technological innovations that characterize the Fourth Industrial Revolution. Then, a question spontaneously arises: can the Fourth Industrial Revolution be considered as a simple progress of the third one or it is a radical change that must be faced as a real disruptive innovation?

The second chapter focuses on the description of the main modern organizational theories in order to discuss about the most important organizational characteristics that modern companies should have in order to cope with an environment in continuous evolution. For this reason, theories regarding organizational ambidexterity, the concept of agility and other paradigms that are increasingly being researched and tested by companies will be discussed.

In the third chapter, we proceed with the explanation of research design and method to fully describe the characteristics of our systematic literature review. In this work, the method used is the PRISMA methodology, so in this chapter an explanation of it is provided. In addition, the main research questions are outlined which will then be discussed in the last chapter.

Finally, the last chapter deals with providing exhaustive answers to research questions, first by discussing the results obtained individually for each variable and then proceeding to an overall discussion, in order to observe the results as a whole. Finally, on the basis of the obtained results, the organizational aspects that must be taken into greater consideration when making a technological change involving cyber technologies are outlined.

CHAPTER 1 – From the First to the Fourth Industrial Revolution: Industry 4.0 and main technologies

1.1. The economic system before the industrial revolutions

The purpose of this chapter is to introduce the concept of organizational theory, trying to understand the birth of this discipline and its evolution over the past few years. Then we will focus on what is relevant in this thesis, that is to understand the impact of innovation, focusing on Industry 4.0 and on organizational structure.

To understand the meaning and the role of technology 4.0, it is important to revisit all the past technological transformations that influenced the economic and social fabric worldwide. At the same time, it is fundamental to put evidence on the structure of organizations and the main theories behind these.

Organizational theory can be considered a modern discipline, which started to be called a real subject only since the 60s. Certainly, it is possible to observe some previously elaborated theories which nevertheless contributed to the birth of this discipline. These are considered as the prehistory of organizational theory since they were a starting point and source of inspiration for scholars of the following centuries.

Prehistory of the organizational theory was only retrospectively reconsidered and divided into three defined tendencies: classical organization theory, neoclassical organization theory and post-modern organization theory.

The real push towards the creation of an organizational theory began with the advent of the First Industrial Revolution, precisely because of the need to be able to manage larger companies, which entailed organizational problems that had never occurred before. The 18th century is considered the starting point of this economic and organizational upturning, when technological transformations such as steam-engine, set up the first input to the English economic environment.

Before this time, the worldwide economy was characterized by the presence of artisans and family enterprises. Regarding the manufacturing industry, there were three different kinds of firms.

The most popular one was the putting-out-system, which consisted of a master, the owner of raw materials, who coordinated several workers. Usually, workers made some activities of the

production process in their home. This kind of organization was extremely flexible, but at the same time, it was very complex to manage, because the master cannot control the quality of the final product or the efficiency of their labourers (Amatori & Colli, 2011).

The second type of organization was the Craft-production which was often located in the countryside, near to raw materials and cheap energy. The main difference between the first type of organisation was the presence of all the working-force under the same roof. Also here, there was a master, who was a skilled artisan, and several skilled workers under his control. Usually, craft-production belonged to a guild, which was a group of firms, united by the product created. This guild established some standards of quality and quantity of products. On the one hand, the guild allowed firms to organize labour, to monitor skills and to protect firms to the market flows, on the other hand, it effectively was a monopoly, regulated by strict rules, consequently, innovations were nip in the bud.

In any case, the part of population employed in the manufacturing industry was extremely low: the biggest part of the population worked in the agriculture industry, which was the main source of health for most of the countries (Amatori & Colli, 2011).

1.2. The First Industrial Revolution: Adam Smith and Karl Marx thoughts

The First Industrial Revolution (FIR) caused a progressive shift of workforce from the agriculture industry to manufacturing one. The first country which experimented the impact of FIR was Great Britain becoming the leader in manufacture exports in textile and mechanic industry. The rapid evolution of the British economy was facilitated due to the presence of a strong commercial sector and a great network of sales in other countries. In this way, Great Britain developed strong export channels for textile and mechanic industries. Later on, also other European countries were influenced by the FIR: France, Germany, Japan and the United States.

Furthermore, during the First Industrial Revolution, English economic fabric was characterized by the presence of new technologies and faced a continuous enlargement of markets. This, in turn, implied that firms had to satisfy the large needs of markets, causing the need for a fast standardization process inside firms. On one side, this standardization was facilitated by the presence of new technologies, on the other side, it caused an evolution inside firms, which started reaching larger dimensions than before.

So, in the middle of the 19th century only in 50 years, the economic situation of Great Britain and Europe was completely changed. Factories were characterized by significant structural

homogeneities: there was a consistent number of labourers which worked in the same place, inside the factory, everyone had specific labour to perform, and all factories were characterized by the presence of machines in particular stages of the production process. At the same time, the presence and the need for a great number of machines implied big costs, so investment in fixed assets began to be an important constraint.

From a historical point of view, the FIR clearly defined the shift from market-like to capitalistic system, one of the pillars of the classical management theory.

Precisely, classical theory adopts this type of purely rational concept: *organization has defined tools designed to achieve established goals*. In turn, we can distinguish in this first phase two types of different currents: the first school of thought is labelled as sociological because it focuses on roles and relationship of organizations with the company, analysing issues such as the impact of industrialization on job and workers. The second school of thought is the classical management theory. Its central focus regards practical problems that managers face in managing industrial organizations and therefore obvious need to attribute definitions and characteristics that can be defined for each type of organization. The main exponents of Classical Management theory started to elaborate on their theories during the end of the 18th century, so their thoughts are influenced mainly by the Second Industrial Revolution (1870-1970).

Certainly, the starting point of both currents of thought are theories developed by Adam Smith in the second half of the 1700s on the division of labour. According to him, a division of labour boosted productivity and improved it in terms of efficiency. In other words, the division of tasks and activities within a company, especially if large, led to an increase in productivity. Being in a rather particular historical period, namely that of the advent of industrialization, Smith believed that the latter would also lead to social progress.

This is the starting point for developing the two currents of thought mentioned above. The sociological current has as its main exponent Marx. In this historical period, his thought turned out to be a “voice out of the chorus”, but surely his contribution was of invaluable importance for posterity. Marx's Theory of Capital needs no introduction, what is concretized in a reference to future organizational theory concerns particular reasoning that involves what he defines as the economic order and the need for the human being. Marx believes that the human being in response to the risks of nature that he has to face, needs to work with others and thus favour the construction of structures and social roles. This way of working generates a surplus of time and raw materials.

After this brief explanation of the FIR, it is fundamental to understand what caused the step from the First to the Second Industrial Revolution.

The big changeset in the production process led the market to expand their borders, so also communication channels needed a rapid expansion. For this reason, around the second half of the 19th century, countries began the construction of a genuine international communication system. The firsts innovations in this context are the telegraph (1844), the telephone (1877) and the railroad (Amatori & Colli, 2011). In Great Britain, railroads were one of the most attractive business because it was the first large dimension enterprise, in this sense, a real paradigm of what characterized the Second Industrial Revolution. Moreover, the railroad system was able to develop other businesses around it, such as the metallurgy and machinery industries, and it was the fundamental instrument for large scale production and distribution: there were no other instruments which guaranteed its speed, reliability and regularity. At the same, it was the first example of a big business. To manage a big organization like that, new rules such as a salary system, control procedures, sanctions, ongoing worker recruitment and, especially, a hierarchy structure are established. This was the first time in which the figure of manager was separated to the one of owner. To the creation of the manager figure, also the classical organization theory born. In fact, the aim of the classical organization theory was based on the manager figure and the practical problems that managers face in managing industrial organizations and therefore the obvious need to attribute definitions and characteristics that can be defined for each type of organization.

1.3. The Second Industrial Revolution and the Classical Organization Theory

The Second Industrial Revolution is commonly ascribed to the period between 1870 and 1970. As described in the previous paragraph, the real instrument which brought the need for a new Industrial Revolution, was the new transportation and communication system. These were able to provide a real transformation of several industries. Surely, the industry which was more positively influenced by the development of communication and transportation systems were the manufacturing one. Countries which benefited most by the Second Industrial Revolution were Germany and the United States, but, unlike the first one, this second revolution expanded in different countries even influencing all European economies.

Even if several countries are influenced, the industries which grew more, are different in all countries. For instance, in Germany the most relevant industry was chemical one, instead of in the United States, the most important was the oil industry. Generally, sectors in which

technology was used as a support to workers, remained highly labour intensive also during the 20th century and maintained efficiency and effectiveness at a low level. Conversely, industries in which technologies substituted labourers, had a real transformation in terms of quantity, speed and dimensions. It is precisely in this kind of businesses that large companies established their roots.

Moreover, large companies had to build an integrated system which allowed them to survive autonomously. First of all, they found their advantage of reaching a high level of manufacturing production and exploiting scale and diversification economies.

Another fundamental aspect of the second industrial revolution was the rapid downhill of the distribution system. Before the arrival of large companies, the distribution system was composed of several intermediaries who bought different products from several manufacturers, their competitive advantage was very high. The advent of large scale production cancelled their advantage because products started to be diversified and at the same time, large companies developed different strategies to commercialize them. For these reasons, usually, large companies internalized distribution activities.

The internalization of all the value chain brought firms to face on managerial problems that had never risen before. These large companies are the firsts to introduce and govern an extensive managerial hierarchy. These organizations presented a quite simple managerial structure: there was a top manager who supervised the whole organization, several middle managers who oversaw the various departments, and then managers of the lower levels who are responsible for the operating units. (Amatori & Colli, 2011).

During the Second Industrial Revolution, the Classical Management Theory took place thanks to three main figures: Frederick Taylor, Henri Fayol and Karl Maximilian Weber.

The Classical Organization theory is the best known and the most important because it is precisely that which established the pillars of organizational theory, upon which all other theories are based.

The Classical organization theory has its roots in three main modules: *scientific management*, *administrative management* and *bureaucratic management*.

Taylor is considered the father of scientific management, which is the crucial concept of classical management theory. The *scientific management theory* is based on the application of purely scientific methods to work processes. Taylor believed the need for a work schedule which allowed to reach a higher level of efficiency, standardization, specialization and simplification (Ferdous, 2016). It is precisely for this reason that scientific management is so important because it is an extremely organized and scientific way of managing organizations,

with absolutely standardized methods. Taylor identified four fundamental principles of scientific management:

- 1) Replace the old rule-of-thumb method through the development of a scientific method as the right way to legitimate operations-
- 2) Raise the efficiency of production process through the improvement of workers and plants and reorganization process
- 3) Centralization of authority within organization, in order to have a control improvement of production process. (Bonazzi, 1995, p.29)

Around the mid-1800s, scientific management was considered the only winning solution to maximize the benefits that the company could provide to society. The scientific management had much success at the time, it was adopted by several factories which in turn obtained excellent results from the application of this program elaborated by Taylor.

This kind of management was given *ad hoc* for a specific historical era, for organizations of the Second Industrial Revolution, where factories were becoming larger and more complex. The number of workers and machines increased and therefore there was a very strong need for control and order. Managers of the time had a real problem in this sense, managing these big companies was something never done before. The systematize management became the perfect solution to meet the immense need of control, that focused on cost management, control of production and labour (Nelson, 1974). This management school brought several consequences in workers' job conditions. To encourage greater control of costs and production, workers had to assiduously provide information on their work, on their activities and their results.

Moreover, the need for extreme cost reduction also provoked a considerable process of standardization of procedures which ended up becoming simple automatism that staff had to perform repeatedly, all day long. In this way, the human component of labourers went in the background throughout the working period.

Many authors took Taylor's theories as an example, someone to follow his thought, others to oppose it. On the one hand, some authors considered scientific management as dangerous and subversive, since it included labour measures too heavy for workers, leading them to a rapid process of alienation.

This means that labourers' activities were too repetitive, their contribution to the production was the same given by a machine; they ended up completely losing the humanity that identified them as men. On the other hand, other authors considered scientific management as a starting point, continuing and expanding the classical school of management.

The second fundamental theory of classical theory was Henri Fayol's Administrative management (1841-1925). In this case, it is very important to understand what the author's career path was, as it was decisive for the discoveries and the development of his theory.

Despite others, Fayol had the privilege of having both technical and academic training he worked as an engineer in a coal fires company and then became its general manager, at the age of 25 years.

This dual experience, both as a technician and then as a general manager, allowed him to view the situation from two different perspectives. For him, the activities carried out by a manager had to be those of producing, distributing and selling products. So, a manager had to be able to formulate plans, to organize plant and equipment, to deal with people and so on. Therefore, he was a multifaceted figure who had to be able to carry out all those activities that the organization required. Although, the training from which he came was one of an engineer, so he decided to develop his thoughts on company management.

Fayol's thought focused on the idea that effective administration was the key to success for a company: *"a leader who is a good administrator but technically middling is generally much more useful to the enterprise than if he were a brilliant technician but a middling administrator"* (Wren & Bedeian, 1994, p. 214). So, the company's performance was much more influenced by administrative rather than productive power, precisely for this reason he identified what he considered the list of commandments that make the management of the company optimal. He was the first to realize the importance of corporate management, and to consider management as the real challenge for business success and to achieve competitive advantage.

This list included current concepts, not taken for granted or obsolescent. Some of these will be crucial for the discussion of our thesis.

- 1) Unity of command
- 2) Hierarchical transmission of orders
- 3) Separation of powers among distinct departments
- 4) Centralization / decentralization

(Wren & Bedeian, 1994, p. 218)

Another credit attributed to Fayol was being the first to notice the importance of organizational theory, of a real discipline that could define, explain and teach the fundamentals of management. For this reason, he decided to make his contribution to this discipline by establishing the main features that a manager must have to be successful: physical qualities,

mental qualities, moral qualities, general education, special knowledge and experience (Wren & Bedeian, 1994, p. 215).

In summary, in Fayol's words *"the responsibility of general management is to conduct the enterprise toward its objective by making optimum use of available resources. It is the executive authority, it draws up the plan of action, selects personnel, determines performance, ensures and controls the execution of all activities"*. (Fayol, General and Industrial Management, pp. 61-62 and Wren Bedeian, 1994).

It seems clear that the vision of Fayol is timely and not taken for granted even today. Precisely for this reason, he is recognized by all posterity as the father of modern management.

The last representative of classical management school is Weber. He was the first to outline the concept of leadership and bureaucracy. Contemporary of Fayol and Taylor, he experimented the German context and then compared it with the American one, observing two completely different realities at the time. On the one side, the US economy, constantly growing in the manufacturing sector, characterized by huge companies with a peculiar kind of business management, already advanced. On the other side, the German economy characterized by private cartels, without any government control, which threatened competition and innovation for private interests. In this climate of injustice, Max Weber thought as a solution to rising corruption a bureaucratic system, which could cope with the private and corrupt power of few big companies.

Nowadays, the term *bureaucracy* is always interpreted with a negative meaning, for this reason, it is important to describe what Weber meant by this term.

One of the terms most associated with bureaucracy, is the one of inefficiency, this because bureaucracy today is seen as something that slows down business in all its forms.

It is important to remember that in Weber's time there was the opposite need compared to what we need now: there was the need for order and discipline within organizations, so in Weber's time, greater bureaucracy also meant greater efficiency.

Precisely, the aim of introducing bureaucracy in companies was to mitigate corruption and nepotism that characterized companies of the time. At the time, it was normal that the role within the company was handed down from father to son, this however generated an evident problem of social disparity, nepotism and corruption. Furthermore, even for the company, it did not consist of an efficient mechanism since people belonging to the same family did not always have the same skills. For this reason, Weber's bureaucracy is closely connected to the need for

meritocracy within the company, especially for those complex figures and with great responsibility such as the one of a manager.

According to Weber, managers had the authority to interpret and reinforce rules and controls, due to the importance of their position. In this sense, the concept of "obedience" gained another meaning. Obedience, which in the companies of the time was something attributed to the boss, according to Weber became obedience to an impersonal authority of an office. Hence, the leader was not a successor by family law or other social issues, but he was the one who had the charismatic power to guide others. Moreover, being a leader did not mean having the power to command or full control, this task fell to an entity which was impersonal and incorruptible as a bureaucratic structure could be. He believed that bureaucratic structures were the binding-rational power that every society needs since it defeated nepotism and allowed the affirmation of meritocratic criteria in the attribution of authority.

Although classical organization theory is still an important foundation for all the other theories, it had limitations, which precisely led to the emergence of new organizational theories.

The first criticism of the classical organization theory derived precisely from the unrelated rationality and rigidity that it entailed. In its application, the classical theory entailed an extremely mechanical model of organization which in turn caused problems in the internal communication of the organization: workers often ended up not understanding each other, causing an increasing presence of conflicts. It was precisely from the need to overcome these tensions, that neoclassical theory developed around the early decades of the 1900s. The goal of this school consists of paying more attention to people who gave their service within the company and created more careful management to human aspects.

1.4. The first half of the 20th century

Even if the Second Industrial Revolution started at the end of the 19th century, the firsts decades of the 20th century were fundamental for the development of some organizations. At the end of the First World War, American firms consisted of a mixture of mergers and internal growth. The only known organizational structure at that time was the unitary form (U-form) which was the simple functional structure based on activities like production, administration, marketing and so on. All these functions were controlled by a centralized power which often was not sufficient to govern the whole organization.

In 1920, organizations started to implement a new organizational form: the multi-divisional form (M-form). This kind of organization was implemented in several companies because of different reasons. The most relevant one was surely the diversification process which began in the same period. In the classic U-form, diversification process created a lot of problems and tensions inside firms and at the same time, managers had big difficulties in controlling the production process of diversified goods and strategic decisions passed on the background. Thanks to the introduction of M-form, the production process was followed by different managers who worked independently from others. Usually, divisions were based on geographical or production concerns, furthermore, this kind of division allowed firms to develop a better level of flexibility.

The development of this new multidivisional structure was an important step toward the development of organization: for the first time, organizations realized that a different organizational form was able to make the difference in business activities.

Unfortunately, this awareness was developed only in American organizations. In this period, the European economy was not focused on business development, it was facing the First World War, so companies suffered a setback. Moreover, the huge economic crisis and the autarchic regimes worsened the situation even more. So, European companies in the first half of the 20th century were characterized by a smaller dimension than American ones. Moreover, the diversification practice was very difficult to implement in this kind of businesses because European organizations were elementary and less structured. So, without diversification, the M-form was not a good solution; the organizational structure which started to be diffused in this period was the holding company (H-form). The holding company consisted of the presence of a central company which finance and control all the other small companies which were linked to the central but not each other. This kind of structure allowed a great level of flexibility and adaptability which were fundamental qualities in the precarious environment of the time.

At the end of the first half of the 20th century, those authors we define neoclassical started to affirm the importance of human value within organizations, opposing to the classical organization theory.

The most important authors of the neoclassical period are Maslow and Herzberg. What these authors had in common was the continuous reference to the classical idea of a man-machine relationship, they outline the limits of this relationship and the real issues from its flow. For this reason, the neoclassical theory also incorporated many other disciplines, explaining what the

problem of the man-machine relationship was, such as elements of sociology, psychology and philosophy.

Starting from Maslow, he developed the so-called *hierarchy of needs* which consisted of a ranking of theories that satisfy certain workers' needs. The aim of his work consisted of the enlightenment of guidelines to understand what were the reasons that bring a worker to be motivated. The pyramid created by Maslow had physiological needs as its basis, that is, the whole set of primary needs of the individual, those that he needed to survive, such as food, air, hours of sleep. Then there are the safety needs or those needs that allow the worker to remain calm in the workplace, such as safety, stability and freedom from fear. Immediately afterwards, there are the social needs, that is, those of being within a social paradigm, for example having a family, friends or romantic relationships. Another men's need was that of self-esteem, therefore having respect for others and independence. Finally, there is self-actualization, or the need to express potentialities, to achieve personal growth and to have captivating experiences.

Self-actualization is one or more complex aspects for a person to achieve, still in our day, as it includes a series of aspects that not all jobs can guarantee. In 1970, Maslow estimated that only 2% of people achieved self-actualization, and for this reason, he tried to understand what the different levels of this goal were, outlining 15 characteristics of a self-actualized person. Some of the characteristics he defined are still considered valid and they could be a good starting point for reflections. For example, a self-actualized man "*efficiently perceive reality and he's able to tolerate uncertainty*", and also "*accept himself and others for what they are*" (Maslow, 1970, pp. 153-155), are creative people, with a sense of humour, have the attitude to democracy and strong moral and ethical standards. All features that are still mentioned in textbooks and increasingly requested in the workplace.

On Maslow's pyramid of needs, Herzberg develops his theory on dual factors, Motivator-Hygiene Theory (1959,1966,1968). According to this theory, organizations must find and, if necessary, implement those factors that motivate employees to do their job better.

Thanks to research, which began in 1959 and lasted twelve years later, Herzberg came to draw very significant conclusions, which marked the relationship between employees' satisfaction and dissatisfaction. In a nutshell, according to Herzberg's research, satisfaction and dissatisfaction were not two complementary conditions but are two paradigms that coexisted.

1.5. The Third Industrial Revolution

From 1945 to 1970 developed countries started to grow exponentially, the worldwide production tripled its value. There were different factors which allowed this development, such as the stability of the international monetary system, the rapid diffusion of technological innovations and a further step on the transportation system with the development of car sector and civil aviation. Moreover, the low cost of raw materials and energy sources, such as oil, favoured companies to produce always more. Another boost to the economy was brought by consumers: people started to come out from the economic crisis which characterized the war period, and consumed and worked more than before.

Focusing on companies of the time, the Second World War had brought awareness about the importance of technological innovations. This awareness becomes the main pillar of the Third Industrial Revolution: firms started to recognize the leading role of technical innovations and to invest in the development of them. So, Research & Development activities became fundamental and so the partnerships between big companies and institutions such as universities. Several companies decided to internalize this kind of activities, to guarantee their independence and to protect their patents. For this reason, the central science during the Third Industrial Revolution was physics, a science which had an invaluable potential, and which was able to open new market possibilities. The most relevant sectors which developed in this period were: telecommunication industry, transportation and physical materials ones.

With the advent of the Third Industrial Revolution from the middle of 20th century, the industry is once again facing a radical change on organizational level, as the technical revolution tremendously influenced economic progress and therefore the environment. For this reason, theories expressed by classical and neoclassical doctrine were no longer exhaustive as they could not explain organizational changes in such dynamic circumstances. Therefore, it is precisely on this concept of dynamism and environment that modern organization theories are concentrated. The organization is no longer seen, as an autonomous entity, separated from the economic, political, and social context. Instead, it is seen an open system, influenced both by the environment, internal and external and by complexity science. Regarding the relationship between organization and environment, a theory widely discussed around the twenty years 1950-70, with a fulcrum in Great Britain, is the theory of contingencies. The goal of this theory was to be able to find connections between the internal structures of organizations and the external environment.

The assumptions on which the theory of contingencies is based are mainly two: on the one hand, there is the belief that organizational structures are mere human constructions. Consequently, once imposed, they become objective and limiting conditions, which in turn affect human decisions. On the other hand, there are also internal sub-components in organizations that are in communication with the external environment, therefore influences must also be considered in this sense. From these assumptions, the currents of thought that were developed were two. On one side, there were those scholars who were concerned with studying the connections between organizational structures and internal variables (technology and size), on the other, there are those who care to study connection between organizational structures and external variables (predictability and unpredictability).

The firsts to analyse the connection between organization and environment were Burns and Stalker (1961) and Paul Lawrence and Jay Lorsch. The Burns and Stalker study focuses on the analysis of numerous English and Scottish companies operating in different sectors, some characterized by a more stable environment (as this study regards to market and technology), others less so. Results showed the presence of two different ways of reacting: companies that had to face unstable environments, adopted increasingly flexible organizational forms, the others instead, maintained a more mechanistic organization, consistent with classical theories. (Donaldson, 2001, pp. 37-38)

Burns and Stalker's study will then be the starting point for Lawrence and Lorsch's theory (1967). Their research took into consideration three organizational units (research and development, production and sales), in companies belonging to different sectors (food sector, plastics and packaging). Results of such research, enlightened different behaviours depending on the sub - reference environments: in fact, every business were considered three organizational units, each of these units has a different *sub-estate* (for example the R&D sub - the estate is scientific, instead the production sub-estate is technological). Consequently, an organizational differentiation appears, since different organizational units imply different objectives, different planning time horizons, and different organizational structures. Instead, a wide organizational differentiation implies the need for different integration moves. In fact, in stable environments, integration mechanisms remain the traditional ones, such as hierarchy, programs and procedures. But in unstable environments, the integration mechanisms adopted become cross-functional groups and people completely dedicated to integration and solution of conflicts. In other words, Lawrence and Lorsch's study is concretized in the idea that the greater the differentiation of the various organizational units, the higher is the number of integrative

mechanisms. At the same time, the more unpredictable the environment, the lower the need for formalization of internal organization. Conversely, when organizations face with a predictable environment, organizations tend to be very formalized. Despite this principle seems somewhat rigid, Lawrence and Lorsch attribute to it a certain degree of flexibility and variety, thanks to predictability levels: each level of predictability is connected to a different organizational structure. So, in organizations, there is not only an organizational model, but multiple models coexist, since the external variables, with which the company interacts, are different (Donaldson, 2001, pp. 43-44).

As for the studies of the connections between organizational structures and internal variables, the most important ones are certainly the study of Joan Woodward and one of the Aston group. Certainly, Woodward's study had the merit of being a pioneering, modern and avant-garde study compared to the others of that time. Woodward's research arose from a question about the classical school: given the optimal models prescribed by the classical school in theory, how far does reality deviate from the theory? In particular, Woodward wanted to verify the presence of connections between structural aspects and other factors such as the size of the company, style of leadership, type of ownership, and so on. The study was conducted on a sample of one hundred British companies from South Essex. Initially, results were very disappointing and disconcerting: in addition to be an immense variety of organizational structures, also seemed impossible to determine a trend, everything seemed random and devoid of logic (Bonazzi, 1995, p.364-365). Only when Woodward began to group companies according to the technology used, a trend began to emerge. In this way, the study allowed to divide the companies into three categories:

- 1) Companies involved in the production of single units or small series: that is, those companies that we can define as artisanal (production of luxury accessories, production of prototypes, etc).
- 2) Companies involved in mass production or large series: that is, companies that produce products in series and in which an important workforce is needed (household appliances, production of massive clothing, standard furniture, etc).
- 3) Companies involved in continuous production processes, i.e. the "process industries": where the processes are automated (foundries, oil refineries, chemical production etc).

What emerged from the study was that: a higher degree of technological complexity implied a higher degree of predetermination of processes. In other words, in companies defined as "process industries", manufacturing processes are carried out entirely by machines.

Consequently times, procedures and quality are pre-established, and the labour required in these types of production is extremely low and composed of a large number of technicians and an extremely low percentage of workers. On the other hand, there are different results in mass production or large series companies. In this case, the predetermination of production is sought, but difficult to predict in a precise way. In this type of production there are considerable organizational problems, since the work performed is mainly carried out by workers. In this case, the workforce is very large and mainly composed of workers, who still need intermediate workers to supervise them. Finally, in the companies involved in the production of single units, predetermination is not possible due to the great variability of processes. In this case, organizations took into account were small companies, where hierarchical control is reduced to a minimum and the workforce is purely artisanal, therefore workers must independently be faced and solved possible problems that occurred during the production process. (Bonazzi, 1995, p.366-368)

After Woodward's study, other scholars began to take an interest in this subject, one of the most famous is certainly the Aston Group. The group intended to give a more precise definition of technology, making distinctions that were not foreseen in Woodward's study. For this reason, two types of different technologies were highlighted: the integration of workflow and the continuity of production. The first alluded to the level of interdependence given by the presence of automated mechanisms within the phases of the production process; the second, instead, concerned those technologies that allowed the transformation of the raw material within the process.

This distinction allowed a reduction in the result achieved by Woodward. In his study, the prevalence of companies was small, and the internal structures of SMEs were much more influenced by the internal needs of production than large companies. Consequently, the advent of technology in small companies influenced the entire organizational structure, but this did not happen in large companies. In these organizations, what increased was the autonomy of offices from the technological constraints of production. The Aston group came to determine that the main variable to explain the organizational structure of companies was not technology, but the size of companies: the more the company was characterized by important dimensions, the more it tended to be specialized, standardized in procedures and formalized in internal communications.

In this long excursus, we tried to provide a complete vision of the evolution that industrial revolutions brought. Alternating the historical vision with that linked to organizational literature was a means of better understanding how revolutions led to a change within companies. Furthermore, understanding how the technological innovations brought about by industrial revolutions have influenced companies of the past can be very important in defining how they will influence the future of organizations. In the same way, the overview of organizational theory allows to frame modern organizational theories in a broader and more complete perspective.

1.6. From the Third Industrial Revolution to our days

Concluding, these three Industrial Revolution were fundamental for the developing of the worldwide economy. In figure 1.1, all the most important contribution of the industrial revolutions are summarized. As explained before, the Third Industrial Revolution boosted the investments on Research & Development activities, but these investments did not stop during the next decades, indeed they continued to grow even more. This continuous improvement of innovation processes brought to an important phenomenon: the First and the Second Industrial Revolution endured respectively ten and seven decades, instead of the Third Industrial Revolution only three. This decrease of time could be interpreted as an increase of innovation rate, but also as a consequence of the appearance of a new world to investigate, the digital one, which was not known before the middle of the 20th century. As explained before, the Third Industrial Revolution gave a real boost to the economic system, especially of industrial processes, thanks to the Integrated circuit (microchip) (Pereira & Romero, 2017). At the same time, this revolution is defined as the digital revolution, which implies the use of electronic automation systems and the use of electronic applications and automated production processes. The Fourth Industrial Revolution consists of the introduction of the cyber world. It means that the evolution regards in an improvement of innovation introduced in the Third Industrial Revolution.

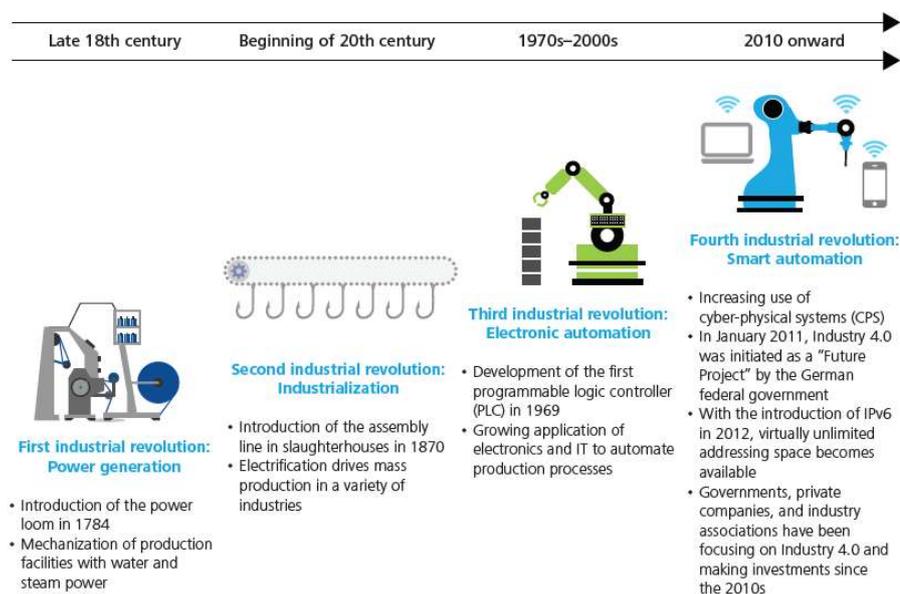
One of the best definitions of the Fourth Industrial Revolution was given by Germany Trade and Invest (GTAI):

“[...] Smart industry or “INDUSTRIE 4.0” refers to the technological evolution from embedded systems to cyber-physical systems. INDUSTRIE 4.0 represents the coming fourth

industrial revolution on the way to an Internet of Things, Data and Services. [...] INDUSTRIE 4.0 connects embedded system production technologies and smart production processes to pave the way to a new technological age which will radically transform industry and production value chains and business models [...]” (Germany Trade & Invest, 2014).

To understand the real impact of the last industrial revolution, it is important to understand what kind of innovations are included.

Figure 1.1. The history of industrial revolutions and key innovations



Source: Sniderman, B., Mahto, M., & Cotteleer, M. (2016, February 23). *Industry 4.0 and manufacturing ecosystems: Exploring the world of connected enterprises*. Retrieved from [www2.deloitte.com](https://www2.deloitte.com/us/en/insights/focus/industry-4-0/manufacturing-ecosystems-exploring-world-connected-enterprises.html): <https://www2.deloitte.com/us/en/insights/focus/industry-4-0/manufacturing-ecosystems-exploring-world-connected-enterprises.html>

1.7. Advanced Manufacturing Solutions

The term Advanced Manufacturing Solutions refers to the set of interconnected collaborative robots that offer to be quickly programmable. (Calenda Plan, 2016).

This is the short definition that is identified in the Calenda plan. The concept of Advanced Manufacturing Solutions could be explored much more. Starting from the definition, it is easy to understand that the concept of interconnected and quickly programmable robots is closely

related to that of artificial intelligence (AI). Although the concept of artificial intelligence has been in vogue for several years, it is still complex to give a single definition, it is a matter for which scholars still express themselves differently. Trying to give as a scientific definition as possible of the topic: "*Artificial intelligence is an aggregate of technologies - from machine learning to Natural Language Processing - that allow machines to perceive, understand and learn*" (Accenture, 2018).

In other words, AI allows a machine to act through behaviours increasingly associated with the behaviour of a human being. Accenture 2018, in its report on artificial intelligence, provides a series of capabilities that AI allows a machine to perform:

- 1) Listen: AI allows the machine to come in contact with the surrounding world, acquiring all kinds of information from the external world.
- 2) Understanding: after having received the information, AI allows the machine to process such information, analysing them.
- 3) Act: after understanding the problem, machine equipped with AI can act to solve the problem.
- 4) Learning: AI, finally, enables machines to constantly optimize their performance, allowing it to learn from its mistakes.

Today, artificial intelligence is declined in the most various ways, thanks to its versatility. Many experts speak of artificial intelligence, as a *multipurpose* technology, and for the same reason, it is defined as a disruptive innovation that will mark an epochal technological change. Indeed, it is a technology that can be declined in infinite ways, as electricity and the combustion engine were in the past. Today, anyone takes it for granted that these two inventions have given rise to the whole world of telecommunications and that of transport.

1.8. Additive Manufacturing

Additive manufacturing is commonly called 3D Printed and consists of creating a layer-by-layer object. This type of technology began to spread around the 80s, but only in recent years has it gained the success it deserves. In fact, over the years, its use has been extended and expanded both from the materials used and as regards the type of activity carried out. In this sense, additive manufacturing finds application in various areas such as rapid prototyping, rapid manufacturing, rapid maintenance and repair, rapid tooling.

The operation of this activity consists in the realization of a product through a particular software installed on a computer. Subsequently, using the same software, the image is sent to the 3D printer which interprets the coordinates of the software and creates the physical product. This unique is able to exponentially improve many production activities, from different points of view.

For designers, it is a very useful tool as it allows to get a prototype quickly enough. This allows understanding more easily if the product is usable and suitable for market and consumers. Besides, advanced 3D printers allow not only plastic printing, but also complex components such as those of planes or cars. Ford, BMW and Audi are just some of the companies that have already implemented additive manufacturing. Moreover, some companies can make the entire car through only one operator who coordinates a set of machines, especially 3D printers. In the same way, the use of the 3D printer also seemed an excellent tool to be used in the healthcare sector. 3D printers are already used for the creation of prosthetics and medical components, but various companies are dealing with the creation of 3D printers for skin or even to be able to print entire human organs in the future. (Gilchrist, 2016, pp. 61-62)

1.9. Augmented Reality

The term augmented reality (AR) refers to the integration of human perception with technological perception, through data or information that through human perception would not be possible.

An example of augmented reality can be the various smartphone applications that allow to point the camera of a smartphone on a work of art or a monument and know the information of that place, simply reading it from the smartphone. This is one of the simplest augmented reality

applications, but this technology is often adopted by various companies for marketing or sales purposes. This happens because augmented reality allows providing a totalizing experience to the consumer. There are several examples of how fashion houses are cautious to this kind of technology and try to exploit it. For example, ASOS, the famous leading brand in fashion e-commerce, launched an AR feature last year in collaboration with HoloMe. The application called Virtual Catwalk allows viewing some products from the ASOS collection worn by a "cyber model". The experiment in question was successful, and now ASOS is working on another project where augmented reality is still the protagonist. The new project consists of an application that allows comparing different sizes on the cyber model to understand the perfect size for your physical conformation.¹

But AR is not only extremely useful in marketing and sales, but it is also of fundamental importance in other sectors. In construction sector, for example, it can act as a simulator during the construction process, so that errors are minimized.

At the same time, AR can be a fundamentally important tool in the field of emergency management. For instance, during an emergency managed by the firefighters, these could be equipped with a helmet with a display that allows them to have more information on the situation, such as the temperature, any dangers in progress and so on. (Gilchrist, 2016, p. 60)

Finally, further reading of AR is that of *virtual training*, which some companies have already implemented. This consists of the integration of both theoretical and practical educational systems. Often the practical part can be considered problematic because it is difficult to implement, but through the AR the obstacle is bypassed through a virtual representation so that the application in real life is simpler.

¹ Gilliland, N. (2019, December 10). *Econsultancy*. Retrieved from [www.econsultancy.com: https://econsultancy.com/14-examples-augmented-reality-brand-marketing-experiences/](https://econsultancy.com/14-examples-augmented-reality-brand-marketing-experiences/)

1.10. Simulation

The simulation consists of a process that allows to visualise a specific subject or object in virtual reality through the creation of a "*twin*".

The concept of virtual twin is based on the presence of three components:

- 1) The presence of a physical product in the real world
- 2) The presence of a virtual product in the digital world
- 3) The presence of a connection between real and virtual product thanks to the presence of data which express the same information but in two different languages (Bouchard, 2017).

Virtual Twins is a very useful tool in the industrial field, as it allows to create, experiment and design virtually. Therefore, simulation allows companies to save a significant amount of time, both because errors on physical world are avoided and because it allows to immediately understand limits of some designs or implementations. The creation of a "*virtual twin*" allows technicians and engineers, which usually work on physical products, to work through simulation and not to interfere in any way with production process. Also, simulation allows everyone to experience many more conditions than would have been possible based exclusively on reality.

There are companies in which real-world experiments are very problematic for various reasons. For example, Boeing designs its planes in a completely virtual way, then it sends all its suppliers the specifications of the necessary components, always through a "*virtual twin*". Likewise, suppliers also respond through a virtual project. Boeing proceeds with the verification of the virtual component by applying it virtually to the initial project and through various simulations tests the component. Only at the end, when Boeing has verified the suitability of the component, production is carried out from a physical point of view².

2

Saracco, R. (2018, February 13). Network Digital 360. Retrieved from [www.agendadigitale.eu: https://www.agendadigitale.eu/industry-4-0/industry-4-0-modello-digital-twin-migliora-sviluppo-prodotti/](https://www.agendadigitale.eu/industry-4-0/industry-4-0-modello-digital-twin-migliora-sviluppo-prodotti/)

In this case, the contribution provided by simulation technology has enormous value. Without simulation, Boeing would have necessarily had to test the component in the physical world, with a consequent exponential increase in costs related to transporting, time spent and risk of such experimentation.

1.11. Horizontal and Vertical Integration

In the Calenda plan, horizontal and vertical integration is considered one of the enabling technologies. Actually, it concerns a certain type of objective that implementation of 4.0 technology allows to achieve, rather than an enabling technology.

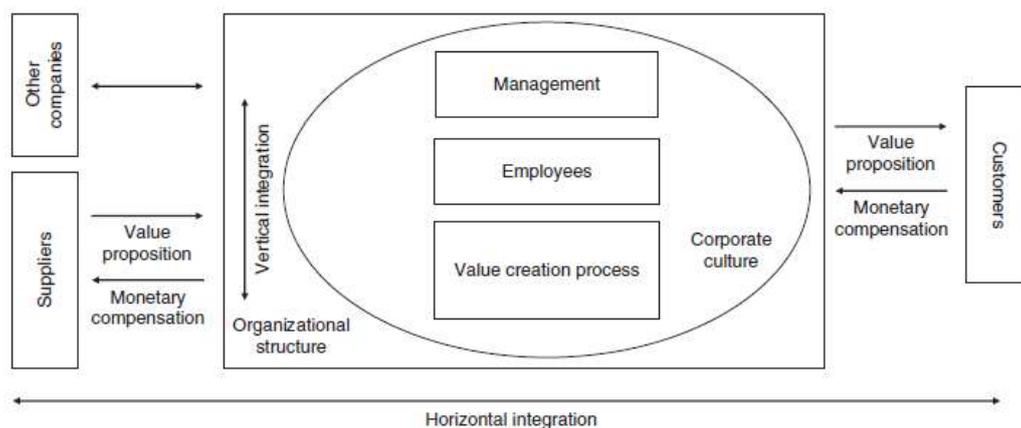
Although, we are not talking about a kind of technology, it is still an important feature that Industry 4.0 intends to promote. First of all, it is important to understand the meaning of vertical integration and horizontal integration and the benefits that this type of change can bring to a company, and then, it is important to define how 4.0 technologies can allow this kind of implementation.

Starting from the concept of integration, both when referring to vertical integration and when referring to horizontal integration, it means an implementation that takes place in the value chain, the only difference lies in the type of implementation to which it refers. Referring to a horizontal implementation of the value chain, it means being able to integrate some units in production process, or, if you are not in a production environment, the integration of units that, from a hierarchical point of view, are on the same level. Instead, referring to a vertical implementation of the value chain, it is an integration between organizational units which have a different hierarchical level in the corporate structure. In other words, the level of vertical integration can be measured based on the speed with which information passes from one hierarchical level to another. Instead, the level of horizontal integration can be measured taking into account the speed with which information passes from a production plant of an organization to another one.

The concept of integration can be applied at different levels: at the production process, at the production plant level or the supply chain level. For example, when it comes to horizontal integration:

- Production process: means a connection between machines and production units that constantly communicate their performance, maintenance problems, and autonomously respond to the needs of production dynamics.
- Production plant: if the company owns several factories located throughout the territory, a horizontal integration process allows the production data to be shared with the whole company and the production objectives to be shifted from one plant to another to respond effectively to production needs.
- Supply chain: in this case, it is possible to create a link between all the components of the production chain. This guarantees great transparency in information and data sharing³.

Figure 1.2. Graphical explanation of areas of applications of horizontal and vertical implementation



Source: Veile, J., Kiel, D., Muller, J., & Voigt, K.-I. (2019). Lessons learned from Industry 4.0 implementation of the German manufacturing industry. *Journal of Manufacturing Technology Management*.

Therefore, integration is a very important tool for companies, since they can promote communication and information sharing both inside and outside companies. For example, small-medium enterprises through a horizontal integration process involving other companies of the same size can create strategically indispensable networks. Networks, especially for small companies, allow them to balance risks, expand market opportunities, and ensure higher

³ ARGO System. (2019, November 20). *Industry Platform 4 FVG*. Retrieved from www.ip4fvg.it: <http://www.ip4fvg.it/focus-tecnologie-abilitanti-integrazione-orizzontale-e-verticale/>

strategic agility for small companies that otherwise would not have been able to afford (Brettel, Friederichsen, Keller, Rosemberg, p. 39, 2014).

Technologies 4.0 seem to be fundamental to guarantee companies both vertical and horizontal integration. New technologies allow to expand and speed up communication in ways that were not previously possible, for this reason, it is possible to guarantee a much more accentuated vertical and horizontal integration than before.

For example, the consulting firm Zenon is promoting the Microsoft Dynamics ERP system. This system allows to receive the information coming from the production and to send it to the management in such a way that there is a much closer relationship between management and production process. Furthermore, this transfer of information to management takes place in real-time, this allows great advantages because the exchange of data allows systems, previously separated, to become a single system that controls everything. The system promoted by Zenon, through a particular data connector, enable to view data in three different languages, so that they can be viewed directly on HMI (human-machine interface), SCADA production management control program and software ERP⁴.

1.12. Industrial Internet of things

Internet of Things (IoT) is a term coined by the company that made its use famous, General Electric. This term indicates the presence of very sophisticated machinery that interact with each other to create a fully integrated system of standard technologies. This connection not only allows the interaction between devices themselves, but also the interaction between various devices and individuals who use these devices.

As in other situations, defining IoT is a difficult task, since it is a very broad concept. The most appropriate definition seems to be Gilchrist's:

⁴ Copadata. (s.d.). *copadata*. Retrieved from www.copadata.com:
<https://www.copadata.com/it/industrie/integrazione-orizzontale-verticale/smart-factory-23/>

"[...] The Industrial Internet provides a way to get better visibility and insight into the company's operations and assets through integration of machine sensors, middleware, software, and backend cloud compute and storage systems [...]" (Gilchrist, 2016, p.3).

So, IoT allows to create a fully integrated system that involves all the components of a human-machine relationship and every kind of interaction, such as the constant monitoring by an individual on machine activity or the tracking of goods during travel.

Today, IoT turns out to be a fundamental tool within some companies, which usually have such a complex system that they are no longer able to manage it without the use of IoT devices. For example, modern industrial systems are a combination of IoT tools. All this set of technologies are part of many industrial activities. Investments in this type of technology continue to grow exponentially as they provide companies with great advantages in terms of operational efficiency and productivity. In other words, IoT is an integrated system that allows communication between some of 4.0 technologies.

The most important technologies for IoT systems are usually sensors, big data and cloud computing. In recent years, sensors have reached exponential levels of development, thanks to their multiple utilities and their relatively low cost compared to the utility that derives from them. Many sensors can guarantee almost total autonomy to machines since they can collect very precise data of current situation, but they are also designed to be able to make predictions on future situation and to act on these predictions. Big data are also an important tool since they allow to enable an IoT system, providing information on the present, past and future of a process or a machine. This provides an unparalleled advantage since it allows to observe and understand production process or a machine in a very detailed way. Finally, cloud computing allows supporting the presence of such a large amount of data. (Gilchrist, 2016, pp. 4-5)

1.13. Cloud

As just mentioned, cloud computing technology is an essential tool for managing a large amount of data collected by firms. The technologies described in previous pages emphasize how their operation is linked to the acquisition and the analysis of data that these technologies collect. Usually, data are not analysed instantly by companies, but are first archived and then analysed later. For this reason, cloud computing is an essential tool, because it is the virtual place where all this information is kept.

The amount of data that companies need to store is so huge that it requires the intervention of external companies that sell this type of service. The first company to make this service available was Amazon in 2005, with a project called Amazon Web Services (AWS). To date, AWS “[...] is the most complete and used cloud platform in the world, offering more than 175 comprehensive data centre services at a global level. Millions of customers, including fastest-growing startups, largest companies and industry-leading government agencies, use AWS to decrease costs, become more agile and innovate faster [...]”⁵

In practice, the AWS service and other similar services, "rent" the virtual space for data collection in exchange for a fee that the company has to pay. The advantage is in the *pay-as-you-use* formula that allows companies to reduce costs and pay only for what is used. This is a great advantage, especially for those small businesses or for those who are still developing and therefore do not have a budget that can afford wastes.

The services offered by cloud computing can be very different, Gilchrist divides them into three groups:

1) Infrastructure as a Service (IaaS): with this type of service, the company that provides it receives rent from another company that uses it. In return makes available its infrastructures, such as a server room or data centre, and companies paid the rent based on how much they consume thanks to the *pay-as-you-use* formula. (Gilchrist, 2016, p. 48)

2) Platform as a Service (PaaS): service created by Microsoft for those companies that do not only need the hardware component but also need to access the development of languages, libraries, microservices to manage Windows-based applications. (Gilchrist, 2016, p. 48)

3) Software as a Service (SaaS): this is a service that allows access to the software via the web browser instead of using a copy of the application to a local private server. Initially, this service was slow, but when broadband Internet access accelerated, the performances became satisfactory. (Gilchrist, 2016, p. 49)

⁵ Amazon. (2018, June 29). *AWS*. Retrieved from [aws.amazon.com:https://aws.amazon.com/it/what-is-aws/](https://aws.amazon.com/it/what-is-aws/)

1.14. Big Data and Analytics

As already explained above, all the technologies described so far, act through the collection and the analysis of a huge amount of data. Each technology described, perceives data of a different nature: videos, photos, web blogs, comments, GPS coordinates, text, the list is endless (Gilchrist, 2016, p.52). The problem exists when the company not only has to store this set of data but must also be able to analyse it. It becomes immensely complex due to the presence of data from such different sources. Although the challenge of analysing these data is difficult, the advantage that managers and analysts can perceive from them is immensely greater. Precisely for this reason, these data are called "Big data", both for the amount of data and for the complexity of analysis that characterizes them, so their analysis requires different solutions.

Gilchrist describes Big Data considering the four characteristics: volume, speed, variety and value. Volume because, as already specified, the amount of this data grows exponentially. As a result, even with the right analysis tools, a normal laptop or processor is unable to process them. Speed refers to the speed with which this data is generated. The high generation speed also involves the need to speed up processing. This is still a current challenge facing companies. The term variety means the presence of data of a very different type, which is the real motivation for which data are considered "big" because it is impossible to categorize them. Generally, three types of data are highlighted: structured, semi-structured and unstructured⁶.

Finally, the last characteristic of Big Data is truthfulness. There is an absolute need for the data that is analysed to have correct content, this turns out to be a big problem in evaluating the data because analysts usually assume that the data is correct, in practice, this is not always true.

1.15 Cyber-security

Nowadays, many companies are using Big Data to acquire more information. The presence of such a large amount of sensitive data often becomes a target for hackers: companies are increasingly facing cyber-attacks. Consequently, because of the need to protect themselves

⁶ Big Data Framework. (2019, March 12). *Enterprise Big Data Framework*. Retrieved from [www.bigdataframework.org: https://www.bigdataframework.org/four-vs-of-big-data/](https://www.bigdataframework.org/four-vs-of-big-data/)

from cyber-attacks, that can undermine the results of organizations, the concept of cybersecurity was developed.

In recent years, the security of personal data has become a key problem to be solved. People, whether they are employees or customers, are increasingly aware of the risk to which they are exposed when they provide their data. For this reason, every company feels the need to have tools that can protect their data. Furthermore, the protection of data belonging to the company has become a real competitive advantage for companies themselves.

The CISCO 2020 Report shows the significant advantages of a company in owning cybersecurity tools. As can be seen from Figure X, cybersecurity tools produce benefits in every direction: they improve the quality of sales service, improve business management that becomes more agile and encourages innovation, contribute to improving efficiency and analysis some data⁷.

Figure 1.3. Percentage of business impact of privacy in each area



Source: CISCO Cybersecurity Series. (2020, January). CISCO. Retrieved from [www.cisco.com: https://www.cisco.com/c/dam/en/us/products/collateral/security/2020-data-privacy-cybersecurity-series-jan-2020.pdf](https://www.cisco.com/c/dam/en/us/products/collateral/security/2020-data-privacy-cybersecurity-series-jan-2020.pdf)

Moreover, companies that suffer from hacker attacks, are companies that face negative impacts not only on the financial side but especially on the reputational side. The idea is that a company that is unable to defend its data and resources, is not reliable. This is a really important threat,

⁷ CISCO Cybersecurity Series. (2020, January). CISCO. Retrieved from [www.cisco.com: https://www.cisco.com/c/dam/en/us/products/collateral/security/2020-data-privacy-cybersecurity-series-jan-2020.pdf](https://www.cisco.com/c/dam/en/us/products/collateral/security/2020-data-privacy-cybersecurity-series-jan-2020.pdf)

especially considering that in recent years cyber-attacks increased exponentially, the tools with which it is easier to receive attacks are email and cloud. Especially the latter can become a dangerous tool when its proper functioning is not well known.

To face this threat, the European Union has established a general data protection regulation, which came into force on 25th May 2018. This regulation provides a series of actions that companies should take to prevent possible cyber-attacks. It is a 200 pages document, so it is difficult to summarize in few words. It deals with going to protect the portability of personal data, so companies are forced to pay more attention from this point of view. Second, when a data breach is reported, it must be notified to the individual within 72 hours. Besides, the GDPR established the Data Protection Impact Assessments (DPIA), which allows identifying high risks of personal data, and companies are required to face these emergencies. Finally, the GDPR also provides a detailed list of penalties to which companies have to face if the rules passed by the GDPR are not respected⁸.

Although the GDPR establishes rather severe measures, European companies seem to realize the real advantage that this type of regulation can guarantee. According to CISCO Report, built on data received from over 2900 interviews with experts on the subject, 59% of companies meet most of the requirements set by the GDPR, 29% do not yet meet most of the requirements but expect to meet them within a year, and only 9% expect to do so in over a year. In any case, the report shows that the percentage of companies that have met the requirements and that have undergone cyber-attacks (74%) is much lower than the percentage of companies that have undergone cyber-attacks that do not meet these requirements (89%).

1.16. Industry 4.0: disruptive or incremental innovation?

After this excursus on what the Italian Ministry of Development considers to be the enabling technologies of industry 4.0, it is time to analyse the kind of consequences that this phenomenon could have. The previous industrial revolutions caused radical changes from an economic and evolutionary point of view. The First Industrial Revolution, through the invention of the steam engine and electricity, completely revolutionized the world of transport and communications. The Second Industrial Revolution led to the development of the telephone, revolutionizing the

⁸ Deloitte. (2016, May). Deloitte. Retrieved from [www.2deloitte.com](https://www2.deloitte.com/it/it/pages/risk/articles/gx-general-data-protection-regulation.html):
<https://www2.deloitte.com/it/it/pages/risk/articles/gx-general-data-protection-regulation.html>

telecommunications world. The Third Industrial Revolution led the digital revolution, the world of automation broke forcefully into factories. Internet revolutionized the way of working, not only within companies but also outside of them, conditioning the whole society in everyday life. As in any revolution, it is complex to define at the beginning of their development what directions it will take. For example, no one would have imagined that from the "simple" invention of the light bulb the whole world of communications, household appliances and modern society would be built.

In this sense, the Fourth Industrial Revolution is a controversial topic. Scholars have conflicting opinions on the type of changes that this revolution will bring. Some have a positive outlook on the future, while others do not share the same beliefs. What can be assumed from the past is that an industrial revolution does not only entail the implementation of new inventions but implies a radical change in the whole economic and industrial context. For this reason, it is difficult to define the main changes that the latter industrial revolution could entail.

Another point of discussion concerns the meaning that is attributed to this revolution: lots of people misunderstand the real contribution that the Fourth Industrial Revolution can provide, and others underestimate its impact. The technologies of the Fourth Industrial Revolution could be a mere technological advancement of the digital technologies that characterized the Third Industrial Revolution. Hence, it is difficult to understand why it has only been in the last five years that it talks about a "new revolution". What often passes unnoticed, are not the enabling technologies in themselves, but the interconnection system that these technologies can create with each other and with the systems already implemented. Professor Bartezzaghi of Politecnico di Milano affirms *"The ability to develop adequate solutions, using 4.0 technologies, allows to radically innovate processes, products, relationships with the market and the supply chain, up to the radical modification of the business model or the creation of new business [...]"* (Bartezzaghi et al., 2019). This is the real competitive advantage that companies should invest in, an advantage that in medium and long term could become essential to compete in the market. On the other hand, the real challenge for companies is to create an internal system that allows for implementing these technologies. In other words, a company is not only made up of technology, but it is an ecosystem that includes many coherently connected components. The technological implementation, if not implemented with the right attention, can be an obstacle rather than an advantage. This should not be an excuse for companies to stay in their comfort zone but must be a starting point and a stimulus in considering all aspects of their business and not just innovation itself.

To understand the impact that 4.0 technologies have on companies, it is essential to rely on empirical evidence, observing how companies implement these technologies and how they adapt internal systems to manage these innovations.

According to the article by Ana C. Pereira and Fernando Romero (2017), the internal elements on which companies must focus are business model, work environment and skills development (Pereira, Romero, 2017). The first element affected is the business model or the tool that allows defining the logic through which the company operates. Recently, business models have changed, because the needs of companies are different. Industry 4.0 influences the way companies sell and provide their products, the way they manufacture them, so the business model also has to adapt to these changes. Certainly, one of the main pillars that must not be missing in new business models is *integration*, which has already been discussed previously. Another feature that modern business models must meet is being useful in managing the complexity that modern technologies can cause. Complexity management is a constraint that concerns the second point on which Industry 4.0 impacts, or the development of skills. A big contribution must be provided by companies in this area, since Industry 4.0 causes a strong advancement and technological complexity that must be understood and managed by people who have to work with these tools.

So, it will be the companies themselves that require specialized personnel with specific skills. Finally, a strong change will come immediately from the work environment, both for man-machine relationship and for what concerns work management, organization and planning. In this sense, changes related to the corporate organizational aspect are fundamental, since they allow to create the appropriate corporate structure that enables companies to introduce and manage 4.0 technologies. Very often, the organizational component is underestimated, since it is not easily analysable, but this behaviour only brings more confusion and further management complexity. Instead, a correct approach is given by a synergy of several aspects put together, and the organizational component is certainly not the one to be overlooked.

For this reason, it is important to understand what the main organizational variables are being tested by 4.0 technologies because it is through their analysis that an important contribution can be made for those companies that are close in making this kind of change. In this sense, it is useful to go and observe what organizational theory and experts show as being the best solution to manage this kind of innovation.

CHAPTER 2 – Literature review: Industry 4.0 from an organizational point of view

2.1. Features of the Fourth Industrial Revolution

The previous chapter ended by manifesting the importance of the organizational aspect for those companies which implement 4.0 technology. It is fundamental to analyse those situations in which companies have tried personally the organizational implications brought by this technology, but it is perhaps even more important to understand what experts in this discipline manifest to be essential.

The Fourth Industrial Revolution, unlike the others, is a revolution that starts in a different way. It starts from the market, which pioneers consumers, and which only afterwards arrives within companies and, in particular, in factories. This means that also its adoption and its rise takes place in a different way and it is companies that first had to learn from the market the possible uses of these new technologies. Obviously, this is a revolution in which the use of the internet by people is the main driver. Until a few decades ago, the Internet was an asset reserved for a few, those who understood its use, and, at the same time, who could afford it. Today, anyone owns a smartphone, and anyone use internet daily. The younger generations see internet as a commodity, which is an essential asset to be able to live, they use it for several hours during the day and certainly could not do without it. Adult generations, on the other hand, are often called "digital immigrants" to allude to the fact that they are people who learned to use technology but have not grown up with it. Despite this, the simplicity of use of many devices allowed adults to become confident rather quickly. From a business point of view, there are many realities that try to bring some 4.0 technology applications within their company, this kind of change occurs in every kind of reality, from the smallest to the most imposing ones, clearly in different ways.

So how to justify the effort by many companies to introduce these new technologies into their businesses? The advantage acquired by companies through the use and interpretation of these new technologies in different forms, can be the winning strategy to compete in today's market. There are several examples of companies that thanks to internet created business empires, including: Uber, Airbnb.

Uber is an American company founded eleven years ago. In few years, it put a strain on the empire of US taxi drivers. The service promoted by Uber allows you to create a connection between people who want a ride and people who give it. In this way, people are able to move comfortably from one place to another by taking advantage of a ride by another person. In this way, it is easy to understand that the service provided by taxis proves useless and completely replaced by Uber: more ecological, faster and above all cheaper. In fact, Uber's turnover has increased exponentially in recent years, from 1,995 billion in 2015 to 14,147 billion in 2019 and an extremely high Wall Street rating (Uber Annual Report, 2019).

Also, Airbnb has a similar history. Airbnb was founded in 2008, the year in which the website was created. Today, it operates in more than 81,000 cities and 191 countries worldwide. Already in its early years, Airbnb was very successful because, like Uber, the service offered by Airbnb was also new. Airbnb allowed people to interact through a platform and to offer beds and rooms to stay a certain number of nights. As with Uber, the advantage for Airbnb was the very affordable price compared to hotels: a traveller can manage to get a bed for \$ 14. To date, Airbnb users amount to 150 million and the 2017 profit was 93 million with 2.6 billion in revenue⁹.

Similar stories are shared by many other companies that have now become iconic such as Apple, Google, Microsoft, Amazon, Facebook. They are all multinationals known by anyone but at the same time united by a variable. They are all modern companies, which have been able to find the winning strategy and the right technological declination that has allowed them to become what they are. All these companies made sense of their business because they had the readiness to notice before competitors the changes required by the market and by people and find the right declination to meet these needs.

Surely, the competitive advantage of all these realities is given by the presence of the right innovative idea that would allow to offer a unique product or service. But experience teaches that this is not everything, or at least, it is not enough. Many managerial studies have the objective of ascertaining the reasons behind the great gap between competitive advantages, in order to discover the reasons for these differences. Among the most accredited there is the theory according to which a large contribution to the competitive advantage is guaranteed by the ability of companies to continually reorganize their business, so that even the competitive advantage is continuously renewed. This is commonly referred to as Organizational Capability

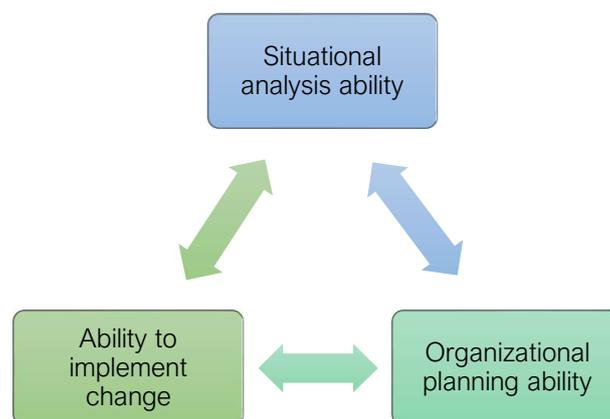
⁹ <https://muchneeded.com/airbnb-statistics/>

(Venier, 2017). Organizational capability can be defined as "[...] that ability that distinguishes a certain way of organizing from others, the originality of an organization or, in other words, the way in which it interprets the competitive context, uses the design rules in an original way to design processes suitable for this context and is able to transform these designs into action [...]" (Venier, 2017 p.24).

This means that organizational capacity is the ability that companies develop thanks to learnings related to the competitive context and to the common design rules that anyone can access through managerial or organizational literature. At the same time, however, the organizational choice is influenced by that note of diversity that characterizes the organization itself, making it unique, it is the social dimension of the organization. In this way, different companies present different organizational choices, because they contain the social and cultural influences characteristic of each company.

Furthermore, the organizational capacity reserves the possibility of managing and combining organizational resources, such as human resources, technological resources, coordination rules. It is the combination of all these elements that creates a real advantage. To better understand which are the macro areas that the organizational capacity proposes to manage, Turati (1998) divides them into: *situational analysis ability*, *ability to implement change* and *organizational planning ability*.

Figure 2.2. Three organizational skills proposed by Turati (1998)



Source: Turati C. , "L'organizzazione semplice: la sfida alla complessità inutile", 1998, Egea

Starting from the situational analysis ability, we intend to emphasize how important it is to understand the circumstances in which the company is, then trying to understand which market it is intended to operate in, understand who the main competitors of the company are, understand the technological level of that particular sector and what skills are needed to enter that type of business. All this information is useful for carrying out the situational analysis of the company. Over the years, numerous models that allow the situational analysis of companies to be performed with some precision were created, the most famous was the Porter model of five forces. The problem with these models is that they often do not provide a sufficient amount of information or, on the contrary, they risk leading to an analysis that is too formal and not adaptable to the real case.

As far as organizational planning capacity is concerned, this also presents a vast organizational literature which can be a valid guideline for a company. Certainly, the models in question are not sufficient to possess an exhaustive competitive advantage but the lack of such knowledge also constitutes an obstacle for achieving this advantage. Consequently, organizational models can be interpreted as a sine qua non condition, the achievement of the design capacity becomes impossible, but it is not a sufficient condition. To develop the design capacity as a whole, it is necessary to be able to combine theoretical and practical models using the right dose of creativity. Venier himself states "*[...] the design capacity is the engine of organizational innovation, and is here understood as the ability to grasp the performance gap of the organization and imagine and draw the "ideal state" of the organizational system [..]*" (Venier 2017, p. 26).

Finally, the ability to implement. This consists in the company's ability to converge the first two skills, namely organizational situation and configuration. This very often does not turn out to be a simple process, because it consists precisely in the transition from "theory" to "practice", when the company must be able to put into practice what it has established in the two previous theoretical phases, otherwise all of this which was conceived is impracticable.

Obviously, this process of creating the right strategy was much easier when evaluating the environment and the organization according to a static vision. This type of considerations allowed to focus exclusively on situational and planning analysis without having to go and analyse and consider possible internal and external changes to the organization. This is the same concept expressed by Burns and Stalker, in Chapter 1: companies change organizational aspects when they face on different external environments.

The main critical issues that must be considered when it comes to organization concern precariousness, risk and uncertainty that comes from market, competitors and unpredictable circumstances. For this reason, it is essential to take this type of factor into consideration when a company chooses to take a certain path. Clearly, it is very far-fetched to understand how to consider factors such as risk, uncertainty, evolution and so on. This is because they are all variables that cannot be calculated and whose scope is unknown. Burns and Stalker in their study highlighted how companies changed their structure, making it more or less flexible, depending on the external environment and the idea remained the same. Flexibility is still the best weapon against uncertainty.

2.2. The end of competitive advantage

The change in today's economic fabric does not only impact organization, implementation, the world of work, but also the business model, strategy, and method of acquiring a certain competitive advantage. The competitive advantage is one of those iconic terms found in every business course. In short, it can be defined as *"The ability of one company to outperform another because its managers are able to create more value from the resources at their disposal"* (Jones, 2013, p.12). So, the competitive advantage of a company comes from the core competences of the company itself that manages to overcome competitors and maintain the competitive advantage thanks to a winning strategy, which can lead to a better product, a better production cost or other factors which can make company an advantage over competitors. However, the concept of competitive advantage can be considered a somewhat dated concept. The first to talk about it was Michael Porter in 1985 in his article "Competitive Advantage: creating and sustaining superior performance" New York, free press. This means that it dates back more than 30 years, and many believe it to be dated and obsolete. The same considerations remain valid for Porter's value chain. These concepts have proven to be fundamental and extremely useful for companies of another era, but as the market changes, its laws also change (McGrath, 2013). According to McGrath, what really matters in a company is to seize those essential opportunities that create a "transient competitive advantage", that is, a competitive advantage with great potential but for a short period of time. Only companies that can benefit from this kind of advantage will have a chance to survive.

In this way, one of the main requirements of the old "competitive advantage", ie durability, is broken. Unfortunately, in a modern perspective, maintaining a competitive advantage that has

a medium-long duration seems very complex given the constant speed with which the market and its dynamics change. Today, keywords and themes that describe modern organizations have changed from twenty years ago. The paradigms change, because it is organizations that are different and have different characteristics. The concept of competitive advantage is based on Porter's concept of value chain, according to which value develops through a sequential process through which a certain number of inputs leads to a specific output. The value chain is made up of primary activities and support activities. All these activities contribute together to the creation of value. Instead, what is manifested today is the need to speak no longer of a chain, but of an ecosystem.

2.3. New business model forms

In recent years, new forms of business emerge. They are based on new ideas, new concepts, new needs of companies. The new forms of business models are based on the presence of interconnection between companies, on the presence of a framework based on collaboration rather than on competition. According to the study conducted by Westerlund et al. 2014, *"The pillars of the tool build on the different aspects of creating and capturing value in the ecosystem. They consist of the drivers, nodes, exchanges and extracts of value. The pillars are interconnected, and, in contrast to existing business model frameworks, they aim to explain the flows and action of a business model rather than components of the model"* (Westerlund et al., 2014).

This means that it is the same business model concept that has to change. Previously, the business model had multiple nuances, many definitions, but basically it consisted of the description of how a company was able to create value.

Today, instead, the concept of business model must necessarily change. The creation of value does not concern only a company, but value is created thanks to the entire ecosystem and therefore also the business model must be understood in this broader perspective. The ecosystem leads companies to consider and take advantage of all opportunities that this system can provide, but also any problems emphasized by it. On the one hand, the ecosystem allows for numerous important interactions between a group of companies that have a strong interest in cooperating to create value all together. On the other hand, the ecosystem can be a high entry barrier for some incumbents that they have to cooperate with logics they do not know.

Similarly, even large companies face numerous difficulties when they operate according to traditional logic. The difficulties are mainly given by the clash between traditional and innovative logics. Usually, traditional companies fail to recreate completely different internal logics than those previously owned. This happens for various reasons: because the company's human resources may be adverse to change, because innovative logics entail a change strictly linked to cultural aspects, to that set of socially accepted rules and norms and because change also entails changes in organizational structures and, consequently, decision making variations. Other difficulties concern the need for some companies to create a different focus than the starting one in order to be able to enter the ecosystem. Or, for incumbents, to be able to provide a certain kind of information to companies in the ecosystem so that the latter can create products in line with the company's needs.

For these and other reasons, the strategy adopted by many companies is that of ambidexterity. The concept of organizational ambidexterity is one of those concepts that have always aroused great interest in many scholars, in fact, the literature in this regard is immensely vast. The first scholars to introduce this concept were Tuschman and O'Reilly in 1996 describing it as *"The ability to simultaneously pursue both incremental and discontinuous innovation [...] from hosting multiple contradictory structures, processes, and cultures within the same firm"* (Tuschmann & O'Reilly, 1996).

Already from this first definition it is possible to grasp the paradoxical note of this structure, given by the coexistence of different structures, cultures and ideas within it. Its implementation becomes very complex in various situations in which the team is not sufficiently cohesive or otherwise inclined to change. Certainly, the concept of ambidexterity has undergone further analysis and specifications and has developed in more detailed and varied ways. The most recent articles give a similar but, at the same time, more specific definition. The organizational ambidexterity consists in the simultaneous pursuit of exploitation and exploration process so that companies can face sudden environmental changes at any time. The pursuit of both processes allows, on the one hand to meet the business objectives related to efficiency, and on the other to always be ready to face a rapid change in business logic given by a change in environment in which the company operates.

To better understand the meaning of organizational ambidexterity, it is certainly essential to understand the meaning of the two key concepts, namely exploration and exploitation. According to the ambidexterity theory, these opposing elements must coexist within the

company. Exploitation consists of that process that ensures the company to efficiently exploit existing resources, through well-known activities (Venier 2017). Exploration, consists of the process that allows you to discover and learn potential combinations of new resources, in order to search for new capabilities and opportunities (Venier 2017). It is evident that these two concepts represent the opposite of the other. Exploitation guarantees production efficiency, therefore profit, but at the same time causes a certain level of rigidity, caused by the need for high efficiency. On the contrary, exploration allows the organization to be flexible, thanks to the constant acquisition of new knowledge, but does not guarantee the efficiency necessary for the company to be sustainable. It is for this reason that the two realities must coexist, since one helps the other to fill their deficiencies and vice versa. At the same time, it is clear that the co-existence of both processes can cause obvious problems related to lack of harmony and presence of clashes due to the obvious differences in terms of ideas, points of view and needs of your area.

The paradox that exists in the adoption of both exploration and exploitation systems is evident, there are several authors who have tried to provide a solution to these paradoxes. One of the most relevant studies in this regard is the one of Raisch, Birkinshaw, Probst, Tushman, 2009. In this study they try to provide answers to the main questions concerning ambidexterity: Is ambidexterity obtained through integration or through differentiation? Should ambidexterity be sought at an individual or organizational level? Should ambidexterity be understood in a static or dynamic sense? (Raish et al., 2009).

So, on the one hand, there is a disagreement between differentiation and integration: studies on ambidexterity differ from those that show the importance of differentiation, that is, the division of tasks into distinct organizational units, in which there are smaller organizational units that pursue exploration activities and there are larger organizational units that pursue exploitation. This type of distinction helps organizations maintain different skills, useful for pursuing different purposes. On the other hand, a part of scholars has dealt with the opposite concept or that of integration, that is, being able to perform both exploration and exploitation functions within the same organizational unit.

However, in the second question, we attempt to understand whether ambidexterity is to be sought in the individual or if it should instead be sought at an organizational level. The ideas about it are the most disparate. Those who believe that they should be sought at an organizational level, which is the largest part, and those who believe that they should be sought

at an individual level. Those who believe that ambidexterity should be sought at an individual level only at top management levels, those who believe that there cannot be individuals who are good both in exploration and exploitation. (Raisch et al., 2009). All this discussion serves to understand that the concept of ambidexterity is still in continuous and constant evolution and the facets it acquires.

Over the years, various types of organizational ambidextrous have been observed, the most classic and well-known are: *sequential ambidextrous*, *structural ambidextrous* and *contextual ambidextrous*.

The term sequential ambidextrous means the ability of a company to vary its structure according to the strategy adopted. This means that depending on the need of the company at that particular moment, the company will be able to change its organizational structure by pursuing the logic of exploitation or exploration depending on utility. On this kind of ambidextrous, many express doubts since it is a kind of mechanism that does not allow the exploitative and explorative character to coexist simultaneously, so some authors wonder if it can be called "ambidextrous".

To solve this dilemma, the second type of ambidexterity is the structural one. In this case the dilemma is solved thanks to the simultaneous presence of both frameworks but dedicated to different organizational units. This means that the company in some areas maintains the exploitative character, instead in other areas it adopts the explorative behaviour. Usually, the most implemented division involves the adoption of an exploitative attitude in the core business and all those activities that must guarantee production efficiency. Instead, the explorative attitude is left to those units that deal with research and development. But this distinction is not the rule. There are companies that, operating in different markets, prefer to adopt different behaviours depending on whether they operate in a more or less stable environment.

Finally, the last type of ambidexterity is called contextual ambidexterity and is used when the company requires that each employee has to be able to use both exploration and exploitation. So, while in structurally ambidextrous companies exploration and exploitation frameworks are divided by production units, in contextually ambidextrous companies all individuals working in the organization must manage their time between exploration and exploitation activities.

After defining these three types of organizational ambidexterity, it is time to analyse how ambidexterity is analysed and applied when it comes to collide with technological application 4.0. It is clear that the ultimate goal of companies is to adopt an organizational form that is as functional as possible and that allows to achieve high performance. As already mentioned,

companies increasingly face the need to cope with the constant and sudden changes in the market or the environment in which they find themselves. This principle according to which a company must develop a continuous ability to adapt to external conditions is now called *organizational agility*.

Unlike traditional change management models, organizational agility allows companies to insert itself in an always dynamic context, always in constant change and not in a model that foresees the passage from one static situation to another. In this sense, 4.0 technology is configured as an enabling element to guarantee organizational agility, through the use of ambidextrous model. In this regard, experts refer to IT ambidexterity. Venier, defines IT ambidexterity as a particular case of organizational ambidexterity and is defined as the company's ability to simultaneously follow exploration and exploitation in the management of IT resources and in practices that could be an antecedent of organizational agility "(Venier, 2016, p.173).

Consequently, the concepts of exploration and exploitation also take on a more specific meaning. IT exploitation refers to the ability of a company to make the best use of its IT resources, to increase its business, making the resources in question fully efficient. The term IT exploration refers to the experimentation of innovative information technologies in order to understand the potential applications of these resources (Venier, 2016, p.174).

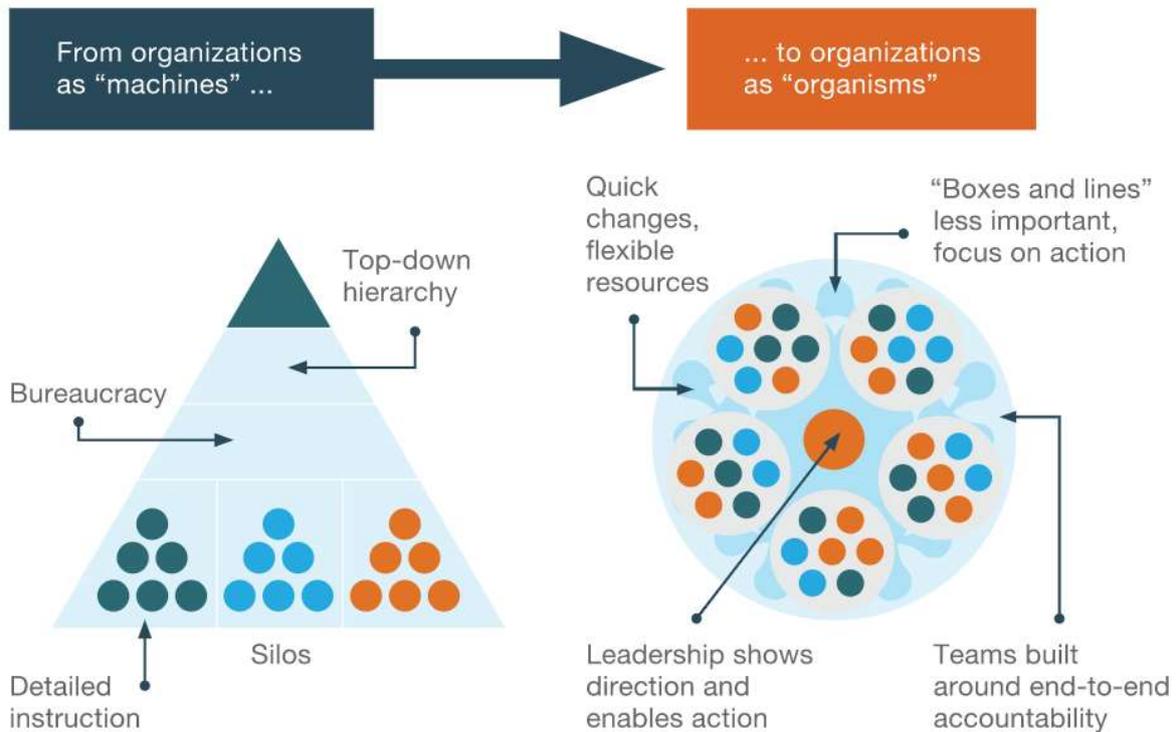
2.4. The agile organization and others organizational forms

As previously mentioned, one of the fundamental characteristics sought by today's organizations is certainly agility. This feature is defined as that "magic word" that allows companies to survive current market changes, and that provides companies with all the tools necessary to become sustainable over time. Indeed, there are many studies that confirm the success of agile companies, compared to those with a less flexible and more traditional structure. So, agility is now a well-known and widely used term in business, but what is the real meaning of this term? According to Accenture 2017, the concept of agile transformation is not completely clear and defined in all its facets. Often, companies that want to achieve the concept of agility deal with a particular aspect of the business, which can be production, human, technological and so on. Instead, what makes an organization truly agile is the involvement of all aspects of the organization towards this paradigm (Accenture, 2017). In this sense, the

paradigm of the agile organization must involve all aspects of the organization: strategic planning, operations, production, and last but not least, people who work in organizations.

Figure 3.2. Difference between organization conceptions

Rather than organization as machine, the agile organization is a living organism



McKinsey&Company

Source: Aghina, A. D. (2018, January 22). McKinsey & Company. From [www.mckinsey.com](https://www.mckinsey.com/business-functions/organization/our-insights/the-five-trademarks-of-agile-organizations): <https://www.mckinsey.com/business-functions/organization/our-insights/the-five-trademarks-of-agile-organizations>

The development of a clear strategy is a fundamental step to guide the company in a process of implementing agile products and services. When coordination is missing at this stage, the whole process of change risks not working. Together with strategy, also organizational aspects are fundamental for the success of a right development plan. Certainly, this is a problematic point, as changing the organization of the company means going to impact a large number of factors.

The first factor to be involved is the organizational conception in itself. As can be seen in Figure 2.2, the concept of traditional organization is very different from that of modern organization. Therefore, the first thing that needs to be highlighted is the difference between conceptions: in traditional organizations the company is perceived as a machine, composed of many gears that are able to all work together thanks to a particular order and combination. Traditional

organizations are composed of a well-defined hierarchical structure, a series of instructions that must be carefully followed, and usually a high degree of formalization. All these characteristics do not belong to the idea of agile organization, which instead appears to have a completely different organization. Usually, agile organizations lack a high pyramidal hierarchical structure. On the contrary, they consist of a flat hierarchy, where the leadership does not have the task of giving precise information, but it has the task of showing a common direction towards which the company must go. In addition, workers are not distributed in rigid silos, but are arranged in teamwork, so that each team is the same and it has components with different backgrounds, skills and school education, so as to be able to better mix the skills. In this vision, the organization is no longer perceived as a machine, on the contrary, it is identified as an organism. This type of perception is well aligned with the holistic concept of organization.

2.5. The holistic concept of organization

The holistic term derives from the Greek *Olos* which refers to the meanings of everything, whole, integral, and was used for the first time by the South African philosopher Jan Christian Smuts in the 1920s. This philosophical theory extendable to different disciplines saw the whole, the integrity, the collective, the global. Precisely on these terms is the holistic vision that wants to consider man as a whole of body, mind and spirit completely interconnected with each other identifying the exact opposite in individualism. But how can holistic theory be considered in the vision of Smart factory, object of the present paper? The intelligent factory becomes the application of holistic theory in all its parts.

Body, mind and corporate spirit become one, the company becomes a single entity, which brings the importance of people and the human relationship back to the focus. A brief look at the traditional organizational models reveals how they based the division: from function models to divisional models and processes, from matrix models to those by geographic area or project. The holistic company overturns these structures in favour of a mono-function, mono-division and mono-process entity.

Moreover, traditional organizational models are beginning to be obsolete since the evolution and complexity of market has synergized with the speed of connection between markets. The speed with which new technologies overwhelmingly enter company's production cycle, force it to re-evaluate the internal organizational structure in favour of a new vision. In this vision, there

is no divergence of objectives or conflicts that could characterize traditional structures. The strength of holistic company becomes the collaboration paradigm, in the most harmonious and synergistic sense of the term that leaves no room for unnecessary individual competitiveness.

As pointed out by Carlo Alberto Carnevale Maffè, Professor of Strategy and Entrepreneurship at the SDA Bocconi School of Management: *“Today's technologies no longer develop in a vertical, surveillance logic, but in a horizontal logic of collaboration and sharing [...] these technologies do not have a "center" of command, they do not communicate as much with the "top" of the organization and the company, but with those who work alongside us, and with the outside world. They allow us to "flatten" hierarchies, to develop and work through horizontal links. They enhance workers' autonomy, collaboration, not hierarchy neither control”*¹⁰

The importance of convergence of the "vision" becomes a crucial problem. Each collaborator has to give his best in a group vision, of a strategic work team that knows how to go beyond the obstacles for the success of a common project. Surely, the well-being and the personal enhancement is part of the holistic project. The physical well-being of worker draws strength in spaces of the holistic factory which must be large, bright, free of noise, with a controlled temperature microclimate. His mental well-being is in the hands of the manager. He has to personally know their collaborators, identifying their aspirations and attitudes, as well as personal and family needs to push them towards the most suitable placement for their enhancement.

A question mark concerns the role of trade union. The holistic factory seems to eliminate the need for a trade union fight precisely in its conception: the motivation of the worker is rewarded and there is no longer need to protect him from company mechanisms, since it is the main goal of the company to protect him¹¹.

¹⁰ Source: Casini, S. (2018, August 16). Industria Italiana. Retrieved from [www.industriaitaliana.it: https://www.industriaitaliana.it/il-lavoro-4-0-rendera-liberisi-se-sapremo-usare-le-nuove-tecnologie/](https://www.industriaitaliana.it/il-lavoro-4-0-rendera-liberisi-se-sapremo-usare-le-nuove-tecnologie/)

¹¹ Source: Emidi, G. (2018, December 2018). GIANNI EMIDI. Retrieved from [www.gianniemidi.com: https://gianniemidi.com/lazienda-olistica-segnera-la-fine-dei-modelli-organizzativi-tradizionali/](https://gianniemidi.com/lazienda-olistica-segnera-la-fine-dei-modelli-organizzativi-tradizionali/)

2.6. Others organizational forms

The search for agility has become a fixed target for many companies. Lots of them are aware of the potential of this concept, and many want to implement it. For most companies, this challenge becomes absolutely inapplicable or very difficult. What is certainly clear is that traditional structural models are outdated and obsolete and that if you want to remain competitive, change is essential. Another concept that appears clear is that surely the concept of agility is very broad and therefore also very varied. This means that the possible applications are infinite, but also the possible solutions are infinite. The phrase "no one fits all" in this case is perfect: each company needs to find a precise variation of agility, because what may be valid for some companies, could not necessarily be an optimal choice for all the others. As a result, each company proposes different attempts to achieve organizational agility. This means that variations achieved are many and it is interesting to understand the functioning of some.

2.7. The helix organization

According to the McKinsey 2019 study, the CEOs of many companies complain about the need for more agile structures but at the same time they make it very difficult to implement this type of structure in their companies, often giving up and returning to a rigid matrix structure. This kind of attitude is created to make up for an increasingly complex and interconnected corporate environment. This means that there is a tendency to bring this complexity also to the structural aspect, through complex matrix structures, which instead of facilitating, complicate the mechanisms even more.

At the same time, it is illogical to think that organizational tools that turned out to be the best in recent years can be effective even now that the market, complexity and environment are changing continuously. The helix organization is a type of structure present in many companies for several years, and which embraces the paradigm of agility. In short, companies that adopt it, implement a division of traditional management hierarchy, to create two parallel lines, equal in power and authority but at the same time very different¹². *"One of the two lines has the task*

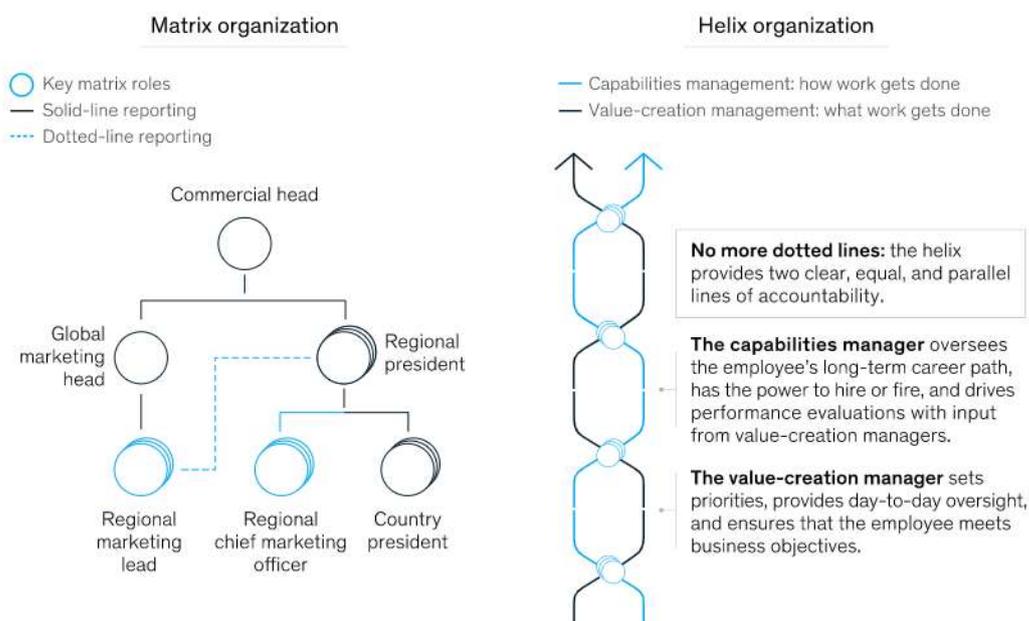
¹² Source: De Smet Aaron, K. S. (2019, October 3). McKinsey & Company. Retrieved from [www.mckinsey.com: https://www.mckinsey.com/business-functions/organization/our-insights/the-helix-organization](https://www.mckinsey.com/business-functions/organization/our-insights/the-helix-organization)

of developing people and skills, setting standards and promoting functional excellence. The other line instead focuses people and skills on company's priorities (including supervising their daily work), creates value and helps to offer a complete and satisfying experience " (McKinsey, 2019).

This vision brings many benefits to companies from many points of view: it creates a stable command unit, allows employees to have to submit to a single boss who deals with hiring and layoffs, promotions and assessments, so workers are less subjected to stress, tend to be more efficient and more flexible. Usually, organizations of significant size have a matrix structure, which provides for the presence of two leaders one primary and one secondary. Obviously, the primary boss has the main role over the second one. The helix organization reconciles this disparity by assigning leadership tasks (usually entrusted only to the primary manager) to two distinct managers with equal powers, but with different tasks.

Figure 2.4. Difference between traditional and helix organization

The helix organization provides a balance between flexibility and stability that is the hallmark of a truly agile approach.



McKinsey & Company

Source: De Smet Aaron, K. S. (2019, October 3). McKinsey & Company. Retrieved from [www.mckinsey.com](https://www.mckinsey.com/business-functions/organization/our-insights/the-helix-organization): <https://www.mckinsey.com/business-functions/organization/our-insights/the-helix-organization>

Even if it is demonstrated that helix organization works, its implementation is still a complex issue. This happens because an organizational change involves a change in the logic of power.

Especially in the helix organization, these changes concern top management and it is always difficult for a manager to give up some of his managerial powers to share them with someone. However, managers should be aware that a division of their decision-making powers can be a great advantage for their organization.

2.8. The Fractal organization

The fractal organization is another kind of organization that allows a good level of organizational agility. The concept of fractal organization can be summarized in six key points: emergency, co-evolution, sub-optimal, requisite variety, shared purpose and information sharing. All this set of factors generates what is called a fractal organization.

- 1) Emergence: alludes to the way systems and agents interact; interactions occur quickly and in a random way and this is how interaction models are created.
- 2) Co-evolution: it occurs because systems are also part of a larger system and therefore when the environment changes, the large system changes and brings change even in the smallest system.
- 3) Sub-optimal: perfection is not a necessary requirement, it is important just being better than competitors. Further energy put into a project where we are already the best, is wasted energy.
- 4) Requisite variety: indicates how variety is a very important requirement within organizations and a factor to be promoted.
- 5) Shared purpose: because it is important to create a sense of community and integrity also at a participatory level, so that everyone tends towards a single common purpose.
- 6) Information sharing: unlike the hierarchical organizational structures that often cause information gaps, in fractal organizations everyone shares the same information in maximum transparency.

Fractal organization is therefore seen as a system made up of autonomous actors that cooperate in a system governed by simple rules that all actors share. This model is often promoted as it promotes a creative, innovation-oriented and agile work environment¹³.

2.9. Scrum Organization

The organization proposed by Ken Schwaber and Jeff Sutherland does not consist of a real structure, but more of a paradigm that companies can adopt and that has many different functions. Starting out, the founders define Scrum with three terms: lightweight, simple to understand, difficult to master.

This model is made up of very flexible and adaptable small teams. These small teams operate on many networks to manage and support the work and products of thousands of people. The Scrum framework is based on three pillars: transparency, inspection, and adaptation. Transparency means that significant aspects of the process must be shared with everyone so that understanding is complete. Inspection because it is important that tools and skills of teams advance, and this occurs through the inspection of those who use the service.

Finally, teams must be adaptable because if a particular service or aspect of the process is not adequate or does not meet the required standards, the team must be able to change it as soon as possible¹⁴.

¹³ Source: Coleman, D. (2016, September 8). MEDIUM. Tratto da [www.medium.com: https://medium.com/@dcoleman100/collaboration-and-the-fractal-organization-ad7224183e8](https://www.medium.com/@dcoleman100/collaboration-and-the-fractal-organization-ad7224183e8)

¹⁴ Schwaber K., Sutherland J. (2017, November 16). Scrum Guides. Tratto da [www.scrumguides.org: https://www.scrumguides.org/scrum-guide.html](https://www.scrumguides.org)

2.10. Organizational variables

After this long excursus on the new organizational forms that are found more and more frequently in the modern business landscape, it is time to try to define those organizational variables that allow to compare organizations with each other. This allows to get a fair comparison between multiple companies and recognize characteristics of each.

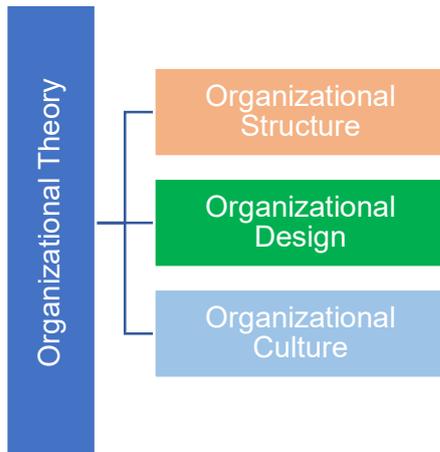
Although, these new paradigms are sought after by most companies, they are still very difficult to implement, and most companies still have a traditional model. Very often, however, studies require to be able to compare every kind of organization, and for this reason there is the need to create a common metric capable of comparing most of the organizational aspects, between organizations of all kinds.

To make this kind of distinction, it is necessary to define variables that can be "calculable" on any kind of organization. Before this, it is necessary to figure out a more technical terminology in order to better understand the references to variables.

The discussion about these variables is faced by experts from various points of view, in particular it is considered important to compare the definitions introduced by Daft and those of Jones. According to Daft, to measure the organization it is necessary to first make a distinction between contextual variables and structural variables (Daft, 2007, p. 17). Instead, according to Jones, it is preferable to start from the concept of Organizational Theory, in turn composed of three parts: organizational structure, organizational culture and organizational design and change.

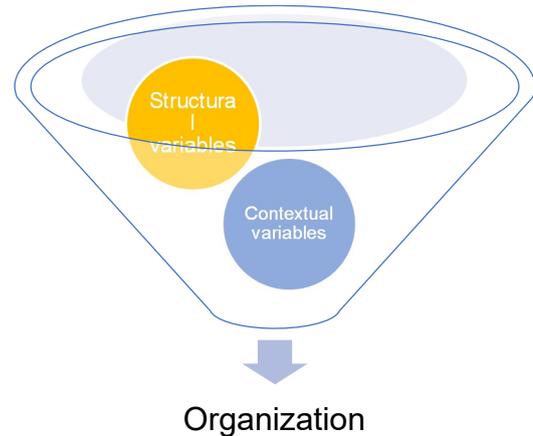
The organizational theory can be divided into 3 parts: organizational structure, organizational culture and organizational design and change. The relations between these three parts only explained by the Figure 4 according to Jones's view. The Figure 5 represents Daft's vision of organization.

Figure 2.6. Composition of Organizational Theory



Source: personal elaboration

Figure 2.5. Structural and Contextual variables



Source: personal elaboration

Although the starting points are different, the variables that are then analysed by both Daft and Jones are the same. This also testifies to their reliability. For this reason, it is important to understand both approaches, which cannot be called right or wrong, but only two different points of view.

Starting from the model of Jones, it is important to understand the meaning of Organizational Theory. The Organizational Theory is defined as *"the study of how organizations function and how they affect and are affected by the environment in which they operate"* (Jones, 2013, p. 8). So, Organizational Theory is that discipline that deals with understanding the functioning of the organizational logics present in an organization and how the functioning of these logics is influenced by the external environment. The Organizational Theory has various subgroups, Jones mainly identifies three: Organizational Structure, Organizational Culture, Organizational Design and Change.

Starting from the organizational structure, this can be defined as *"the formal system of task and authority relationships that controls how people are to cooperate and use resources to achieve the organization's goals"* (Jones, 2013, p. 8). In other words, the organizational structure includes all that set of functions and relationships between people who belong to an organization and makes explicit the type of cooperation. The main purpose of the organizational structure is the control of all the aspects that concern people within the organization, such as behaviour, motivation, coordination and so on. So, the purpose of the organizational structure is to facilitate and solve people's coordination and motivation problems.

Other authors give different definitions of organizational structure. Zahidul et al (2014), brings several definitions that are given of this concept. According to Robbins (1996) and Ghani et al. (2000), the organizational structure consists of the division, classification and formal coordination of tasks of each of people who work in the organization. The organizational structure can be classified using different methods, for this reason there are several models of organizational structures. Among the various classifications, the best known are the classification between mechanistic and organic structures, and the traditional organizational forms among which the main ones are functional structure, divisional structure, matrix structure and hybrid structure.

The organizational structure of a company is not something that is fixed and unchanging in time, in fact, it varies depending on business needs that may arise for the most varied causes, such as the change of environment, technological and cultural change.

The organizational culture instead, *"is the set of shared values and norms that controls organizational members' interactions with each other and with suppliers, customers, and other people outside the organization"* (Jones, 2013, p. 9). That is, all that set of rules through which people interact with each other and with stakeholders of the organization. Organizational culture, like the structure, can also be subject to frequent changes, depending on the needs of the organization. Furthermore, we often find cases where similar companies instead adopt profoundly different organizational cultures. Exemplary is the case of Coca-Cola and Pepsi: the former extremely loyal and fond of its employees, the latter, extremely competitive and with a high turnover even for the highest positions.

Although an organization can always change its organizational culture, this process is not easy at all, because it does not consist of a mere "structural" or "organizational" change. Very often it influences the mentality of people who work within organizations. People within organizations are rarely willing to change their way of working and their mentality. Furthermore, this aspect is influenced by people's social culture. For example, in multinational organizations it is much easier to get in touch with people who have different ways of speaking, thinking and working. On the other side, this is more complex in SMEs that work in a single location, and therefore will have people who belong to the same social culture and who supposedly work in a rather similar way. The fact of working in the same way may initially seem an advantage and it is a short-term facilitator. However, this is not a long-term advantage; different cultures provide a great cognitive contribution in organizations, which learn to accept,

work and learn with different people and this allows to create a precious organizational dynamism.

Both the organizational structure and organizational design can be changed through organizational design and change.

Organizational design *"is the process by which managers select and manage aspects of structure and culture, so an organization can control the activities necessary to achieve its goals. Organizational structure and culture are the means the organization uses to achieve its goals; organizational design is about how and why means are chosen "* (Jones, 2013, p.9). This means that organizational design is precisely the tool through which managers of an organization can change its organizational structure or organizational culture. Describing the design of an organization means being able to capture those aspects of the organization that distinguish it from the others, that characterize it.

For what concerns the model elaborated by Daft, he highlights two types of variables to describe an organization: structural variables and contextual variables. The structural variables are those that allow to describe the organization within it, therefore they give a view of the skeleton of organization. Within the structural variables, you can find many of the variables that Jones identifies in Organizational Structure, namely: Formalization, Specialization, Hierarchy of authority, Centralization, Professionalism, Personnel ratios.

Instead, contextual variables are variables that describe both organization and environment in which the organization is located. Daft identifies in these variables: Size, Environment, Goals-Strategy, Technology and Culture.

It is important to monitor these variables, as it is a very effective system for comparing companies with each other and at the same time allows to understand if the dimensions are in line with the expectations of the organization or if some are needed changes.

Now that the approaches adopted by two different authors have been defined, it is important to go into variables that will be crucial in research.

2.11. Daft's structural dimensions

With **formalization** it alludes to the level of formalization of the organization, that is to the set of all those written procedures and rules that allow standardizing some operations. Each company has written documents of regulations and procedures that must be respected, for example regulations, policy manuals, procedures, and job descriptions. Consequently, an organization with a high level of formalization is an organization in which there are a large number of rules and rules to follow, however, an organization with a low level of formalization is an organization in which the rules and rules written are relatively minor. Usually, large companies have a high level of formalization, while small companies do not have a large level of formalization. Despite this, we will see that there are still exceptions to the rule. In fact, the level of formalization of the company also depends on the needs of the company itself, as formalization, like all other variables, has positive and negative aspects. On the one hand, a high degree of formalization allows a higher level of standardization, which in turn favours the achievement of a higher level of efficiency, on the other hand, however, it can prove to be deleterious as regards corporate flexibility and the management of particular cases. The method of calculating this variable is somewhat complex, since it is not possible to find a parameterization that is the same for all companies; usually what can be considered is the amount of written documentation within the organization.

The second structural variable that will be taken into consideration in this thesis is **specialization**, one of the main cornerstones of capitalist society, which consists in the degree with which the organization divides specific tasks into different jobs. In other words, it is the level of specialization of the job within the organization. If in the organization we find a situation in which each worker has a specific and precise task, then specialization is configured as high, if in the organization we find a situation in which each worker performs multiple tasks, which can also overlap with each other, then in specialization level it is low. Often the concept of specialization is linked to that of division of labour: in a company with high specialization, we will certainly also find a high level of division of labour. The more a company needs highly specialized personnel, the more it is forced to divide the various tasks of the staff. What is usually observed in organizations is that smaller companies there is a lower level of specialization. However, in most companies, large level of specialization appears to be generally higher. Thinking, for example, to an engineer: working in a small company, his job could be to deal with a particular machinery as a whole, so activities could include both

maintenance and design of a machine. Instead, in a large company, the engineer is unlikely to take care of a machine as a whole, but usually it could only deal with the design of this. Consequently, by only dealing with an activity, his job becomes more specific and consequently more detailed on that particular type of activity.

This simple example can make us understand how the division of labor can be profoundly different from small companies to large companies. In fact, it is no coincidence that the degree of innovation is usually more present in large companies rather than in small ones: a greater specialization allows to focus on specific problems or issues and to solve them more quickly. Another positive aspect of specialization is also the increase in efficiency and effectiveness: a production worker who carries out a single activity, such as the equipment of a machine, will be -on average- more efficient on that job rather than a worker of equal skills which performs both the tooling and the control activity on the product made by the machine. However, excessive specialization also has negative aspects. First of all, a high specialization also leads to a high level of rigidity since each person has a specific and efficient task, but only one task. So, when the production process undergoes changes, the person may be required for another task that he initially cannot do. If we think that this problem could involve an entire factory, it is easy to guess that the problem may be significant and troubled.

The third structural variable which has to be taken into consideration is the **hierarchy of authority**. It is defined the degree of hierarchization of an organization. In a nutshell, it indicates in an organization to whom the various employees are subordinated. There are organizations where hierarchy is considered as a mere organization of work and resources without particular constraints, but other organizations make it a pillar. Usually, companies do not start with a complex structure. Hierarchy often arises from a need for better coordination and management of company resources and activities by managers. To demonstrate this, it is precisely the large companies that are the ones with the highest hierarchy, since the innumerable activities to be managed and a large amount of staff require a greater number of managers to deal with them. Despite the presence of a greater hierarchy in larger companies, it is possible to note that there are companies of the same size (with dimensions alluding to the same number of employees) which, however, have different hierarchical levels. For example, an organization of 1000 employees has four hierarchical levels on average: CEO, function or department heads, department supervisors and employees. However, there are companies of equal size that have five or six hierarchical levels, and instead companies which have three or two levels. In this

case we have hierarchies of different levels, the first is certainly more structured, and therefore higher, and the second is lower, therefore the technical jargon it is called flat.

Hierarchy is a very important dimension for companies: very often it is one of determinants that can cause major problems within an organization, both in the case of a tall hierarchy, and in the case of a flat hierarchy, both have weaknesses points.

a) Tall hierarchy problems:

- Communication problems: a hierarchy composed of a large number of levels requires a slower type of communication, because it must pass through all levels. For example, if the CEO of a company decides to increase the production of a certain amount due to an urgent market demand, if the hierarchical levels are few, news quickly reach production. Instead, if the hierarchical levels are many, news take longer to get to production. As a result, if decisions come slower, the whole organization becomes slower.

- Motivation problems: companies with a strong hierarchy often have low motivated workers. This is mainly because workers find it very difficult to understand the reasons for their work. It often happens that a high hierarchy also implies a lower number of responsibilities entrusted to each person, and this also means giving less stimulus to workers.

- Bureaucratic costs: obviously, a consistent hierarchy also implies a more complex bureaucracy and a higher number of managers. All of this has a substantial cost because managers usually do not have the same salary as a normal employee.

b) Flat hierarchy problems:

- Problems of coordination: compared to tall hierarchy, the flat can give rise to big coordination problems due to the fact that for a single manager it is difficult to coordinate a large number of people. Often a climate of general chaos is created, this causes great limitations to efficiency.

- Lack of role clarity: the fact that an organization is flat, can cause problems of clarity on who should make decisions. Very often in these organizations it is not clear who is in charge since there is no prevalent figure over others, they are all on the same level. At the same time, there is usually no clear definition of roles of each person: everyone can do any type of profession. Consequently, it is complex to establish who the merit of a particular job goes to.

- Difficult to grow for employees: at the same time, the possibilities for professional advancement is less frequent than in companies characterized by tall hierarchy and it can cause a sharp discontent and strong motivational problems among staff.

So, it is clear that strengths and weaknesses of flat and tall organizations are complementary, therefore the challenge for each organization lies in finding the right balance between them.

An extremely correlated concept to that of the hierarchy is what is called span of control. This concept alludes to the number of people over whom the manager exercises direct control. This measure is very different between organizations and depends fundamentally on variables such as the type of activity that an organization deals with and also on the type of manager that a company has available, and on the function of a manager. For instance, a company that deals with nuclear energy (nuclear power plant are usually characterized by a tall hierarchy) or span of control down , this is because the manager needs to observe and to manage his staff personally given the high-risk nature of activity in question. We can easily guess that the relationship between hierarchy and span of control is inverse: companies with a tall hierarchy usually have a low span of control, in the sense that each manager controls very few subordinates and does it directly. On the other hand, companies with a flat hierarchy usually have a high span of control, in fact the manager must manage several subordinates.

The fourth variable analysed is **centralization**. This concept is extremely tied to that of hierarchy and span of control, in fact it alludes to understand what are hierarchical levels that have the power to make decisions. If most of the decisions are made by top management, the organization will be defined as centralized, if instead the decisions are also delegated to middle management, then we are talking about a decentralized organization. The decisions referred to include, for example, establishing goals, choosing suppliers, setting prices, hiring employees, deciding marketing territories and so on.

Centralization also has negative aspects and others that can be considered positive. When we are in a situation that requires high centralization, employees tend to refer to their boss for any kind of problem even when the issue could be resolved independently. This is because they are not incentivized to take responsibility for a certain activity, and when nobody takes responsibility, the company slows down, because decision making activity is delayed for too long. The solution to this problem is decentralization of authority, which means allowing employees of lower levels in hierarchy to have the authority to make decisions about certain problems or issues that need to be resolved. Decisions about how to decentralize are still one

of the most challenging constraints facing companies today. This is because excessive decentralization also has negative aspects. First of all, the fact that excessive decentralization can lead to major coordination problems between the parties as well as problems in maintaining a common line of strategy. What is believed to be the ideal situation is a middle ground between centralization and decentralization of decisions, in this way middle and lower managers would make short, medium-term decisions, and instead the top manager takes on the task of making decisions medium-long term. In this way, on the one hand, the top management ensures continuity through a common line, on the other hand, the middle management manages to ensure the necessary flexibility to respond quickly to problems and possible changes of environment.

The last two variables are less important for the aim of this research, so they were discussed briefly.

Professionalism consists in the type of education that an employee needs to carry out a certain activity. This means that there are some jobs where the person is asked for a long period of training before they can do that kind of job. Instead, there are other jobs where the job requires a much less demanding training period.

As for Personnel Ratios, this is the measure that allows you to understand how staff are distributed according to the various areas such as marketing, sales, administration etc. This measure allows to understand a lot of information about the efficiency and performance of the teams.

2.12. Other relevant organizational variables

The variables analysed so far are important structural variables to consider when trying to understand how an organization is structured. Among the variables presented in the research, those just described are also the most known but also the oldest ones. This is mainly because the drafting of Daft's book dates back to a few decades ago when some of the knowledge we possess today had not yet been well understood, or at least went into the background.

For this reason, the research will also contain other variables that have already been briefly discussed, which are important for defining organizational agility. For this reason, we will try to make some considerations on these too.

The first fundamental variable to be analysed is **flexibility**, already mentioned in previous paragraphs. The concept of flexibility cannot be called a modern concept, but it is certainly a paradigm that currently enjoys great fame for defining those companies that today have satisfactory performances. The real problem with this concept is that it is used so frequently that the real meaning is often lost sight of. The University of Cambridge defines flexibility as *"the ability to change or be changed easily according to the situation"*¹⁵. It is a simple but effective definition, because it expresses in simple words the meaning of flexibility, that is, a quick and simple response to change. Precisely because its meaning is so simple, its application is optimal in a variety of innumerable cases. From an organizational point of view, we will try to define the various areas in which the term is involved.

From an organizational point of view, flexibility can be understood at the micro and macro level. The micro point of view alludes to a vision of flexibility understood as a characteristic that belongs to the individual worker. For the individual worker, being flexible means having the right dynamic capabilities that allow him to vary his activities during his work, without having any problems. At the same time, worker flexibility can also be understood as hourly flexibility. To date, more and more workers are subject to smart working contracts, or flexible working hours according to their needs. Furthermore, flexibility can also allude to a certain kind of behaviour in decision making operations, which leads the worker to know how to evaluate the right decision to make based on the situation.

At the same time, the term flexibility is also adopted for issues related to the organization in the macro sense. This means that we focus on the organizational structure. In this case, the term flexibility takes on different connotations because it alludes not exactly to the type of behaviour adopted by an individual, but rather to the characteristics of a team of people or to the characteristics of an organizational structure. As for the team, a flexible team is usually a heterogeneous team, that is, made up of people who have different lives, academic paths and experiences from each other. At the same time, a flexible team is able to pursue different objectives and to find the most suitable solutions according to the situation. As for the flexibility of the organizational structure, it is evident that there are more flexible organizational structures than others, and flexibility occurs in those organizations that have a weak structure and that are able to adapt quickly to any kind of change, internal or external, which is necessary.

¹⁵ <https://dictionary.cambridge.org/en/diction/english/flexibility>

In addition to flexibility, there are also other variables that are important when dealing with corporate organization. Another key variable, which has become especially important in recent years is **collaboration**. Many could identify it as trivial, actually, very often it is a fundamental criterion for understanding how an organization acts and works. Collaboration is also a feature that can be analysed by following certain levels. On a micro level, it can allude to the collaboration that must be present between employees. The work that involves creating many small teams is increasingly widespread and at the same time sought after. This is because small teams favour a much more flexible work environment. Very often, collaboration makes it difficult to implement, especially when the corporate organizational culture does not foresee it. In fact, many companies have to deal with employees who are not used to a collaborative climate, but rather to a competitive climate. Actually, collaborate is demonstrated to be fundamental in order to achieve results, and how the work of a united and cohesive team is crucial in this perspective.

From a macro point of view, cooperation is a paradigm that is becoming increasingly important in the relationship between companies. In fact, companies often find it much more advantageous to cooperate with other companies than to develop a purely competitive attitude. The term that was coined for this type of relationship that is created between companies is called coopetition. Coopetition is that relationship of interdependence that is created between companies, given by the simultaneous presence of competition and cooperation and which gives rise to a structure of partially convergent interests and objectives (Dagnino, Padula, 2002). So, the relationship between companies is an interdependence that must pay double attention, on the one hand to competition within the market, and on the other hand, to the common objectives that can be manifested in these relationships. Often, in fact, these are relationships that are created between a large number of companies, therefore there is also the great risk of being trapped in these coopetition relationships, which require a lot of attention for this reason.

CHAPTER 3 – Research Design and Methods

The purpose of this chapter is to give as clear a definition as possible of the method used to carry out the research object of the thesis. The aim of this work is to investigate the impact that new technologies can have on companies' organization. To understand this impact, various research methods could have been used, for example using an empirical analysis, observing the results reported by each company that has adopted these technologies, but surely the sample under analysis would have been quite limited. Another option was to carry out a specific investigation within a single company, but even this could have provided limited feedback to a single company. Another method could be a simple literature review in which to observe the most relevant research and draw conclusions on the basis of few available data, but in this case the scientific nature of the research would have been lost. For all these reasons, the only method that seemed suitable for the type of research is to perform a systematic literature review, thanks also to the large number of articles on the subject.

The studies that affirm the importance of the organizational theme within the logic of implementing 4.0 technologies are certainly significative. Consequently, the topic is particularly interesting also to help companies understand what types of changes can be requested and incentivized, thanks to 4.0 technologies. In particular, the introduction of new technologies has strongly impacted the manufacturing sector, that is one of the pillars of cyber technology, which allows the factory to be completely autonomous and managed only by technology. This is still a utopian idea thinking of today's factories, but it is still important to consider these new technologies and encourage their implementation because in few years they could become the key to an essential competitive advantage.

Lots of people make the mistake of underestimating and debasing the organizational theme, essentially due to a lack of understanding of its relevance. Consequently, companies always tend to invest large amounts of capital in the technological sphere, without then investing equally in the organizational aspect, which is equally important.

Precisely because the organizational theme covers various aspects within the company, it is right to implement a generic division regarding these aspects, in order to observe if there is a connection between the organizational sphere and the influence suffered. This can be a starting point for companies that want to implement these technologies, to understand what kind of

organizational aspect they should pay more attention to during the implementation process. Often it is not only difficult to achieve, but even with often worsening outcomes.

To introduce all the organizational aspects in the review, we divided the variables into three macro-sections, consistently with the analysis of the literature carried out in the previous chapter. In this sense, the macro-sections identified in the analysis were three: organizational structure, organizational culture and technological integration. Consequently, the following research questions have been outlined:

RQ1: Comprehension of the 4.0 technologies' impact on organizational variables belonging to the organizational structure in companies operating in a manufacturing sector.

RQ2: Comprehension of the 4.0 technologies' impact on organizational variables belonging to the organizational culture in companies operating in a manufacturing sector.

RQ3: Comprehension of the 4.0 technologies' impact on organizational variables belonging to the technological integration in companies operating in a manufacturing sector.

3.1. The Systematic Review in Managerial studies

The systematic literature review consists of a systematic review of a sample, usually vast of articles or other material under analysis, in order to obtain a correct interpretation of the collected results. Scholars give several specific definitions of the purpose of this method of analysis. The most relevant definitions are those given by the authors who first spoke of this method of analysis, such as Cook, Mulrow, Fink and many others. Cook and Mulrow 1997, define the systematic review as *"a scientific investigations in themselves, with pre-planned methods and an assembly of original studies as their subjects. They synthesize the results of multiple primary investigations by using strategies that limit bias and random error"* (Cook, Mulrow, Haynes, 1997). According to Fink 2005, he defines the systematic review as *"systematic, explicit, and reproducible method for identifying, evaluating, and synthesising the existing body of completed and recorded work produced by researchers, scholars, and practitioners"*.

Actually, the systematic literature review does not have very modern origins, the first to conduct a study with this methodology was James Lind in 1753, a doctor who studied scurvy. Only in the late 70s, systematic review was recognized as a real method of analysis. The motivation for the resumption of this method is given by the simple need for collecting and organizing the pre-existing knowledge, which begins to have a very consistent size (Poklevic, Tanveer, 2019).

It is around the 70s that a rigorous and reliable format was created. It allowed to locate, select, understand and transfer the synthesized knowledge so that it could be accessible and known not only by researchers, but also by practitioners (Denyer, Tranfield, 2009, pp. 673-674). The first subject in which the Systematic Review was used were health care sciences, since this tool adapted very well to the systemic collection of results of medical research. Clearly, being a new and long-processing tool, there was a need to carry out checks on the research in question, since the amount of data collected could cause errors in the processing of such data. In this regard, in 1992 the Cochrane Collaboration was formed. It was a group of researchers and scientists that aimed to establish rules, procedures and guidelines in order to guide the review process. Subsequently, this also became the method of control of these medical researches, made up of a group of researchers whose aim was to control the literature review studies, eliminating any errors present in the reviews (Denyer, Tranfield, 2009, p.674) .

Then gradually the tool also extended to biological, educational studies up to management and economics. Denyer and Tranfield were the firsts to define how to adapt this tool to economic-

managerial studies. Obviously, different subjects often need tools with different characteristics. In this adaptation process, some key concepts with which the systematic literature review tool was defined, have been removed to replace them with others that better adapt to the needs of managerial and economic subjects.

The traditional key features with which the systematic review is described are: replicable, exclusive, aggregative and algorithmic. The term replicable refers to the need for systematic review to be reproducible. In the medical field, this is not a problem, as a protocol is established on how to conduct research before it starts. The fact is that often there is a need to change these protocols during the research process. The second characteristic is exclusivity. The systematic review must include the best possible documentation on a certain behavior. In medical studies, the hierarchy of evidence is usually used, which classifies research designs, based on the purpose of their analysis. The third characteristic is aggregative, in fact very often medical studies choose to carry out a meta-analysis, or a tool capable of aggregating data from different studies to draw conclusions from the multitude of these data. In many subjects, however, data are not homogeneous, therefore they do not allow this kind of aggregation. The last traditional feature is algorithmic. In medical studies it is almost always possible to give a numerical-scientific value to the review, through the development of an algorithm. However, this is not always possible when different areas are touched. To replace these variables, Tranfield et al 2003 introduces other variables that better adapt to a systematic review model for management. According to Tranfield 2003, the change in these variables is a necessity given by the need to adapt the traditional model established by Cochrane to the needs of a new material, replacing some elements with others. The elements proposed by Denyer and Tranfield 2009 as key features are transparency, inclusivity, explanatory and heuristic.

Instead of replicability, transparency is considered as the first key feature, as the main objective when systematic reviews are documented. Transparency is a fundamental requirement in many aspects of creating a systematic review. For example, it is essential to ensure adequate transparency by explaining the methods used in the review. In addition, transparency also concerns the consistency between the conclusions reached by the author and the evidence reported in documents. In fact, it is also required that the reviewer approaches the results and their own beliefs *a priori*, so that the review is not affected by results.

Instead, to replace the requirement of exclusivity, Tranfield et al 2009 introduces the concept of inclusivity. In management articles, collection and classification of the data used in the

analysis are often not deeply described, even in the most respectable dedicated newspapers. Furthermore, the methods used by authors to receive and analyze data are also very variable and therefore grouping them also becomes a complex operation. Unlike the traditional method, which provided for a hierarchy of evidence, for managerial systematic review, this is not very effective. What is being promoted is a *"fit for purpose"* attitude which involves hierarchization based on the objective of the research and at the discretion of the author.

The aggregability requirement is far-fetched if adapted to management, because, as mentioned in some previous paragraphs, it is often complex to find data that are homogeneous in different studies, and therefore the possibility of performing meta-analysis often becomes utopian. Instead, what seems more likely is to carry out a review that is explicative, and which consequently can provide the analysis method with the right note of creativity and explanation of the theory (Pawson 2006). In this way, the review will not only consist of a mere aggregation of parts but will provide a personal contribution to the research.

Finally, the last replaced feature is algorithmic with heuristic. This is to allude to the presence of a research that is not exact but rather indicative in results. In other words, the systematic reviews in the managerial and organizational context provide an overview of theory and a suggestion on the direction of the latter, rather than an exact and detailed solution to a specific problem (Denyer & Tranfield 2009).

In conclusion, the systematic review in managerial and economic contexts assumes different connotations, given by the presence of different facets precisely in the subject under analysis. For this reason, many of the rigidities that are built up in the reviews of medicine and biology are not considered appropriate in the subjects of management.

3.2. Different kinds of Systematic Review

Obviously, there are various types of systematic reviews that depend on various considerations such as the type of question defined at the beginning of the research, the subject matter, the type of documents that must be analyzed, and so on. For this reason, there are several types of systematic reviews, which depend on all these factors listed above.

Basically, three macro-types of revisions are identified: meta-analysis, narrative reviews and meta-syntheses (Siddaway, Hedges, 2019). Meta-analyses consist of a systematic review that

can be carried out under certain specific conditions. Usually, it is the tool that we always try to adopt as it has a more scientific value than the other two types, and is based on the presence of quantitative scientific data, on the need of the auditor to collect a large number of studies and on the presence of documents very homogeneous. The meta-analysis therefore provides a very scientific representation of the literature, consequently also the documentation in question requires great rigor. Instead, when this rigor cannot be guaranteed due to the presence of qualitative data or non-homogeneous documentation, other types of systematic reviews are used, that is, narrative review and meta synthesis. These methods, unlike the previous one, do not necessarily make use of demanding statistical tools as happens for meta-analysis, but only guarantee the synthesis of the selected documentation (Siddaway, Hedges, 2019).

The narrative revision is used when there is documentation that provides quantitative data, but which have used different conceptualizations, that is, they are not homogeneous studies. The meta-synthesis, on the other hand, provides for an opposite study, that is, the presence of qualitative but homogeneous studies, in order to create a synthesis of the theory, identifying key concepts and more specific theoretical results. (Siddaway, Hedges, 2019).

Although the types of revisions do not end with these three options, these can be considered as the most relevant. However, the choice to be stuck in one of the following typologies, does not always turn out to be a winning strategy, for the simple fact that each discipline requires particular attention to some particular aspects that can be taken into consideration for a large number of studies, considering a certain type of data, or not having the opportunity to access a certain level of quality, due to lack of literature about it or other limitations. As a result, experts very often advise taking as examples some literature review methodology used in important and recognized systematic reviews of the same subject matter of the study to be carried out (Siddaway, Hedges, 2019).

Following this approach, Fish and Block 2018, defines six important tips for a correct systematic review in managerial and organizational settings.

- 1) First of all, it is important to outline and make explicit what the research question is, so that the reason for the revision is made clear to the readers (Fish & Block, 2018).
- 2) The second step to follow is to find the literature that is suitable for our purpose in a systematic way. This means that the process by which the documents were collected must be completely explicit, so that anyone can reproduce the search. Therefore, the databases that have

been used, the keywords that have been used, the criteria with which the articles have been read and the criteria through which they have been eliminated (Fish & Block, 2018).

3) Very often, one of the fundamental problems encountered by many authors is having difficulties in asking a correct research question that is balanced between the breadth of the studies that are evaluated and the depth with which the most relevant studies are deepened. For this reason it is important to find a middle ground so that the search is not unclear or rambling. So, it is important to use graphs and tables to describe the results found effectively (Fish & Block, 2018).

4) Another advice given is to read the documents in a comprehensive way, but to focus mainly on the concepts of the review and not on the objective of the individual studies, to avoid the risk of losing the focus of the research (Fish & Block, 2018).

5) Linked to the previous concept, it is important to underline that systematic reviews do not consist of a trivial summary of literature, but are created to give something more, drawing conclusions through a careful analysis of literature. For this reason, it is very important that the literature review work draws significant conclusions (Fish & Block, 2018).

6) Finally, the best literature reviews are recognized through the structure of the article in which they are proposed. For this reason, it is important that the structure of the paper is coherent and functional for the purpose of maximum understanding of its research (Fish & Block, 2018).

3.3. Research methodology

After making a brief excursus on the meaning and use of the systematic review, it is time to start describing the work done for this study. As already mentioned, in the systematic reviews a protocol is usually used that serves as an orientation tool. The best known and most used protocol when it comes to systematic reviews that aim to collect both qualitative and quantitative data, is called PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses). This method was created in 2005 by a group of 29 authors considered to be experts in systematic reviews and to date it is the most complete method to carry out a review.

This tool consists of a list of operations that must be done to carry out the revision in the correct way. In fact, the basis of a good systematic review is a precise planning of the procedures to be carried out (Liberati et al 2015). The checklist consists of 27 items and a 4-step flow chart.

The PRISMA method provides the exact procedure for writing a meta-analysis article completely. The points of the check list from the first to the fourth concern the drafting of the title, abstract and introduction. The points from the fifth to the sixteenth, however, specifically deal with the planning of the methodology used to carry out the research. Points seventeenth to twenty-third report the construction of the results of the review and their analysis. Finally, the points from the twenty-fourth to the twenty-sixth concern the discussion of results and the signing of the right conclusions drawn from the review. Any funding sources are indicated with the twenty-seventh.

Obviously, being the PRISMA built for medical-clinical research, it has facets that meet needs typically inherent in that discipline. Consequently, some points of the checklist do not present any managerial answer or relevance (yellow highlighted lines).

Table 3.1. Checklist Item according to PRISMA methodology

Section	Checklist item
TITLE	
1) Title	Identify the report as a systematic review, meta-analysis, or both.
ABSTRACT	
2) Abstract	Provide a structured summary including, as applicable; background; objectives; data sources; study eligibility criteria, participants and interventions, study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.
INTRODUCTION	
3) Rationale	Describe the rationale for the review in the context of what is already known.
4) Objectives	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).
METHODS	
5) Protocol and registration	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.
6) Eligibility criteria	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.
7) Information sources	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.
8) Search	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.
9) Study selection	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).
10) Data collection process	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.
11) Data items	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.
12) Risk of bias in individual studies	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.
13) Summary measures	State the principal summary measures (e.g., risk ratio, difference in means).
14) Synthesis of results	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.
15) Risk of bias across studies	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).
16) Additional analyses	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.
RESULTS	
17) Study selection	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.

18) Study characteristics	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.
19) Results of individual studies	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).
20) Results of individual studies	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.
21) Synthesis of results	Present results of each meta-analysis done, including confidence intervals and measures of consistency.
22) Risk of bias across studies	Present results of any assessment of risk of bias across studies (see Item 15).
23) Additional analysis	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).
DISCUSSION	
24) Summary of evidence	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).
25) Limitations	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).
26) Conclusions	Provide a general interpretation of the results in the context of other evidence, and implications for future research.
FUNDING	
27) Funding	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.

Source: PRISMA Statement. (2015). PRISMA. Tratto da [prisma-statement.org](http://prisma-statement.org/PRISMAStatement/Checklist): <http://prisma-statement.org/PRISMAStatement/Checklist>

Chapter 3 concerns the methodology used to carry out this systematic review, consequently, the points of the PRISMA checklist that are analyzed are those from the sixth to the fifteenth. These steps concern the method by which the revision was carried out, starting from the criteria used to scour the chosen databases and motivating this choice, continuing with the process of data collection and the characteristics of the latter, ending with a first mention of the method of building the results.

3.3.1. Eligibility Criteria

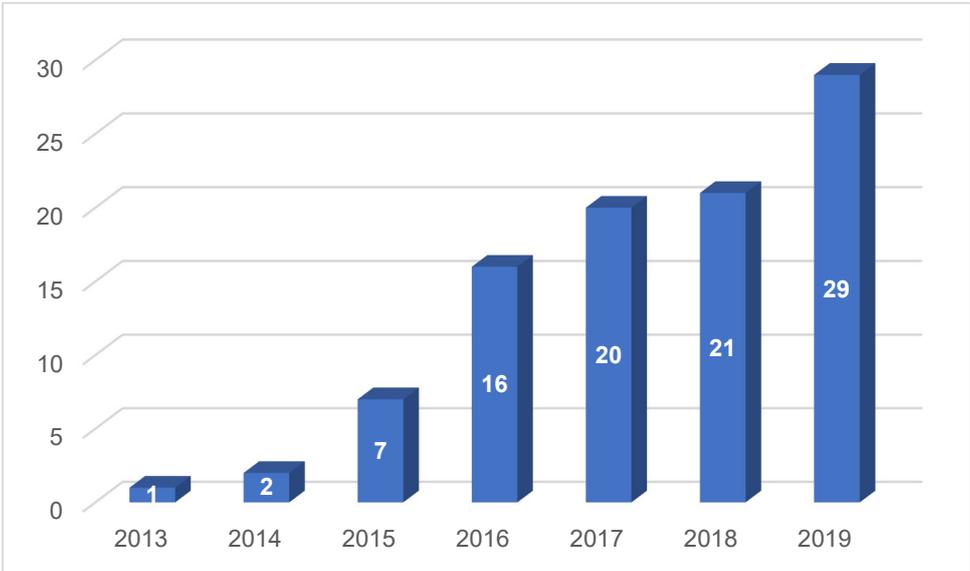
The eligibility criteria consist in identifying all those characteristics established for the identification of articles or studies useful for the review. This means outlining general but at the same time selective characteristics, so that all the documents subsequently chosen have to meet these requirements *a priori*. An example of these characteristics may be the year of publication, the place of publication, the type of document, the language used and so on. The function of this operation is to perform a first skimming between the documents which are certain that they are not suitable for revision.

In the case of this study, the eligibility criteria concern the year of publication, which must be between 2013 and 2020. This criterion was established for reasons inherent to the study subject

since the concept of Industry 4.0 dates back to 2013, so there is no reason for relevant papers prior to this date to exist.

Another criterion of eligibility was the language. For obvious reasons of comprehension problems, the documents taken into consideration had been written or translated into English and Italian. In any case, the language used in the documents does not imply that empirical research is carried out in the reference country.

Graphic 3.1. Records per year of publication



Source: personal elaboration

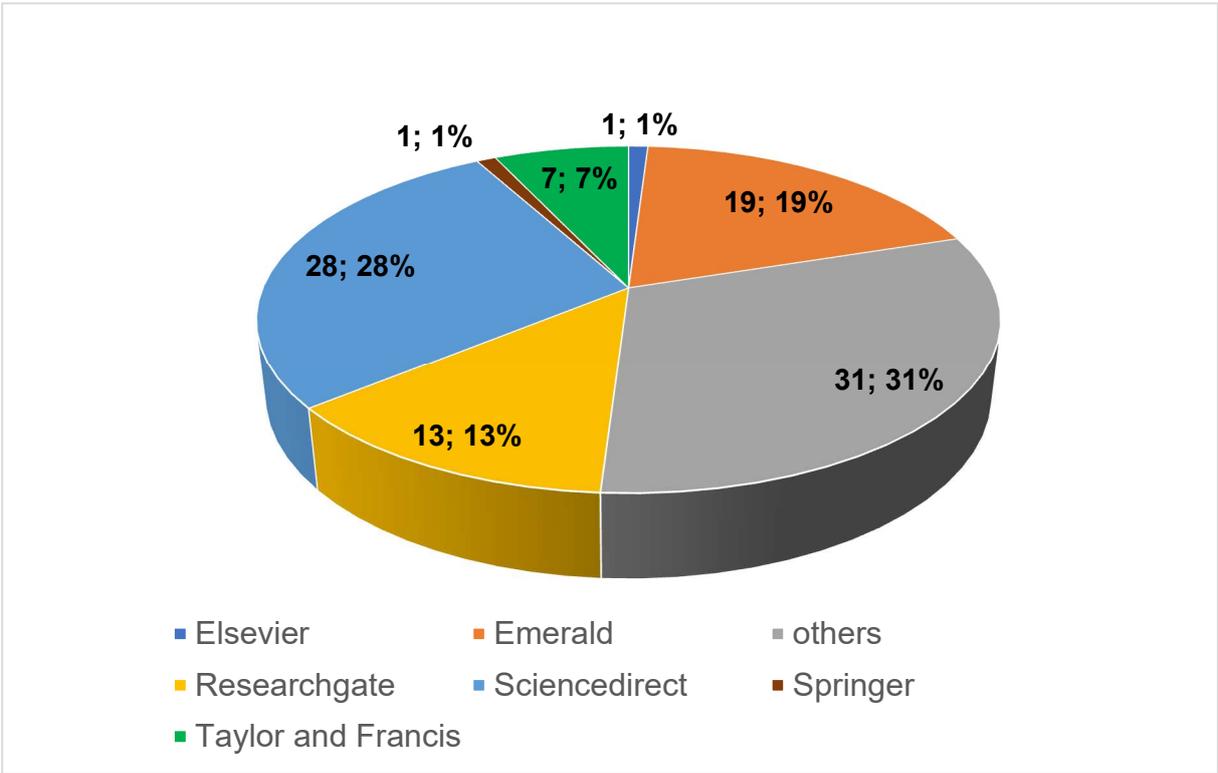
As can be seen from Graphic 3.1., the documents found are in increasing order with the passing of the years. This also shows a growth of interest in the topics covered. Obviously, the result reported in the year 2020 is not reliable as the search for the articles ended at the end of April 2020.

The rush of articles from 2015 to 2016 can be interpreted as an awareness of the importance of the organizational theme. Probably, the interest grew around 2016 as the presence of companies that introduced 4.0 technologies has increased, revealing organizational questions. This clearly led the literature to treat the topic more carefully.

3.3.2. Information Sources

The term *information sources* alludes to the resources that were used to search for the documents belonging to the revision. This data is usually used to ascertain whether the documents in question have been detected through a search using instruments considered reliable or not. Usually for each study subject, there are different research tools, and databases that deal with more or less specific topics for each subject. In the review discussed here, the main tool used to search for documents was the database. Those consulted to receive the data were: ResearchGate, Emerald Insight, Taylor and Francis, Springer, ScienceDirect, Elsevier and others.

Graphic 3.2. Databases consulted



Source: personal elaboration

As can be seen in Figure 3.2., not all the documents detected have been found into the databases. This is justified by the presence of numerous articles and reports from consultancy agencies, ministerial documents, the European Commission, therefore they can still be evaluated as valid scientific documents. In addition, the topic in exam appears to be very consultative, consequently articles and reports provided by the consultancy companies are relevant.

3.3.3. Search strategy

The search strategy consists of the criteria that have been used in the bibliographic research. This means that it is necessary to outline which filters and terms are used in the search for documents subsequently used in the review. This section is very important to understand how they were found in documents belonging to the revision and therefore it is necessary to analyze it in a specific way.

First, in this research, many keywords have been used to find the necessary documents. The searches carried out included two groups of keywords combined. The first group of keywords aimed to select those documents that dealt with the theme of Industry 4.0 and new technologies, instead the second group of keywords wanted to select those articles that deal with organizational issues. From the combination of these two groups, documents were obtained that presented both characteristics.

Table 3.2. List of keywords

Keywords Group 1	Keywords Group 2
Technology 4.0	Organizational structure
Smart Manufacturing	Organizational design
Smart Factory	Organizational performance
Smart Industry	Organizational aspects
Smart Technology	Organizational variables

Source: personal elaboration

Subsequently, when a paper was considered very valid for research purposes, either we continued to search for related articles using the appropriate button, if any, or we continued with the search in the reference bibliography, to find related articles.

Another feature that was assessed was the names of authors and journals they belong to, in order to view other articles by the same authors or other articles that belonged to a specific magazine.

Table 3.3. Main authors in the sample

Author	Paper number	Percentage
Bartezzaghi Emilio	4	3,2%
Muller Julian Marius	4	3,2%
Voight Kai-Ingo	3	2,4%
Wang Honghui	3	2,4%

Source: personal elaboration

3.3.4. Study Records

In this phase, the goal is to understand how documents are used and analyzed, in order to understand what kind of analysis was carried out to review them. This is important to realise what type of screening of the documents was carried out, in this way it is possible to understand at what level of specificity the review was conducted.

In this review, the documents found were articles or reports. For each article, the title and the abstract were initially read, to assess the presence of signals that could demonstrate the presence of topics related to Smart manufacturing and at the same time organizational issues in the work. In reports, the title and introduction were read, in order to understand if they could be valid documents for the subject under review.

After verifying from title and abstract that articles addressed the right issues, we moved on to a careful reading of the papers, focusing in particular on the section of the conclusions, since it usually consists of the most significant part of the analysis. As for reports, these were carefully read in their entirety, dwelling on the parts that outlined the concepts sought in this document. For each document, the presence of consistency was also assessed within the document, to avoid contradictions in the same. Often, difficulties were found in understanding the objective of the selected documents. In fact, lots of documents includes scientific descriptions of 4.0 technologies and how they work, and these parts are not easy to understand.

As for the only book *“Welfare Aziendale tra Industry 4.0 e Smart working: leve di wellness, particiative creative per la crescita della produttività cognitive del paese”* by Luciano Pilotti that has been selected to carry out the revision, title, index and introduction of this had been

read, and then to focus carefully on the chapters that dealt with the organizational theme in a specific way, namely Chapter 3, Chapter 6 and Chapter 8.

3.3.5. Data Collection Process

After understanding how the documents have been analyzed, it is time to understand what is the method by which the data from documents are extrapolated and explained on our database. This process is important because it helps to explicate the measurement of the data reported in the revision database and therefore to grasp with the right emphasis the final results achieved by this report.

In the present work, four possible answers have been defined for each variable: unknown, low/flat, medium, high. Each response corresponded to a specific combination within the document.

Table 3.4. Possible values for each variable

Value	Meaning
Unknown	In the document there is no presence of the term relating to the variable, nor is there a sentence that implies its meaning.
Low	In the document, the variable is explicitly described as low impact, or its opposite is defined as high impact.
Medium	In the document, the variable or phrase that alludes to its meaning is cited as important only once.
High	In the document, the variable or a phrase that alludes to its meaning, is cited as important more than once, or the thesis of the paper is centered on that variable, or its opposite is defined as low.

Source: personal elaboration

Also in this phase, difficulties were found concerning the attribution of a certain value, since not all documents express a clear opinion. In many articles, it happened that the opinion provided on some variables seemed discordant. In reality, reading carefully, the opinion in question is not discordant but only expressed from two different points of view. In fact, in some of these documents, the objective to which the implementation of industry 4.0 should aim was

defined, and only later, we talked about the same variable in opposite terms, but alluding to the reality in which the variable was located. In these cases, the ideal goal that Industry 4.0 intends to achieve was reported in the database, but the presence of a double value of the variable in question was recorded separately. This topic will be discussed later in Chapter 4.

3.3.6. Data Items

After describing how variables collected through the review of the analyzed documents were classified, it is important to give as complete a definition as possible of the variables that have been taken into consideration in the analysis. As described at the beginning of this chapter, the variables were divided into three macro-sections so that the organizational theme could be analyzed from different points of view. Basically, we tried to deal with the organizational theme from a structural, cultural and finally technological point of view. The macro sections indicated above therefore refer to these three categories: organizational structure, organizational culture and technological integration. Subsequently, for each of these macro-sections, some variables were identified that could probably have been influenced by the implementation of new technologies or a logic belonging to Industry 4.0.

As already discussed in Chapter 2, the organizational structure is that part of the corporate organization that mainly deals with the relationships that exist between people within the organization, i.e. the kind of relationships that are established within a company. For this reason, the variables that can best describe this macro-section are: hierarchy, centralization and collaboration / team work. As previously discussed, the hierarchy expresses the level of verticalization of a company, and helps to understand the composition of the various internal bodies; centralization, on the other hand, allows to understand which parts of the organization have the ability to make decisions about the fate of the company. Finally, collaboration/ teamwork expresses the way in which the divisions work, whether through a method of sharing or instead a more autonomous method. In this way, we can get a clear view of the organizational structure within a company, since these variables allow to grasp many different facets.

As far as organizational culture is concerned, the variables chosen in this case are: autonomy, specialization and flexibility. As already discussed in chapter 2, organizational culture consists of that set of values and principles in which people who work within the organization believe. Clearly it is difficult to understand what these principles are, because very often they appear as

tacitly known. Instead, it is much more useful to observe the types of behavior that people within an organization adopt. In this sense, characteristics that particularly impact the organizational context have been defined. Autonomy allows you to check the type of conception that the worker has regarding his or her job, if his or her job consists in executing orders or if he also has the task of taking on responsibilities. Specialization, on the other hand, provides an idea of the kind of skills that are required of workers, if more detailed or perhaps more generic. Finally, flexibility allows to define an even more cultural aspect of workers, that is, their predisposition towards change and the attitude to seek it.

Finally, the more technological facet, considering the industrial context, could not be overlooked. For this reason, a third component has also been identified, technological integration, which however is believed to have a great impact on the organizational theme, since it influences the way in which information is exchanged and shared with others and influences the connections between different work units in both vertical and horizontal logic. For this reason, the variables outlined in this case were: vertical integration and horizontal integration. The term vertical integration means the integration between all those units that are united by hierarchical relationships, as can be the various departments within a large company. The term horizontal integration, on the other hand, means the integration between those units that are united by horizontal logics, such as the company's connections with customers and suppliers.

3.3.7. Risk of Bias in Individual Studies

Since the Systematic Review in question is a work of reading and personal understanding, the results are affected and influenced by an essential subjectivity of the individual who lends themselves to perform the analysis. This risk is very difficult to correct, as it would require at least readings carried out by a team of experts who can somehow balance each individual subjectivity. As this type of action was not possible for obvious reasons, the risk of bias was reduced through a double reading of all the papers involved in the review. The first reading focused on identifying the introductory and conclusive paragraphs, since these are usually the most significant and explanatory points of records. In the second reading, we privileged a careful review of the paper in its entirety, so that we could not leave out any useful information for the investigation.

In this way, the risk of bias should have been reduced. The second reading, through a comparison with the first one, allows to remove all the misunderstanding or other errors, so that the results should be more precise.

3.3.8. Summary Measures

The measures taken to analyze the results consist of purely descriptive analyzes. This is due to the nature of the collected variables that do not allow the adoption of different methodologies. For each collected variable, the type of analysis carried out will consist of counts, medians and comparisons between variables on the results found.

Of course, there will always be explanatory graphs of results, so that the reported results can be better understood. The importance of the variables found will not be given by the quantitative analyzes carried out on the data, but rather by the discussion of the results found thanks to the systematic review.

3.3.9. Synthesis of Results

In this section, we highlight what have been the main studies analyzed within the systematic literature review. This allows to understand what the main issues faced by the studies covered by this paper were. In addition, the Table 3.5. is able to suggest which are the most determining studies in this area of analysis.

Table 3.5. Source, keywords, methodology, and main focus of paper under review

Reviewed papers	Source	Key words	Methodology	Focus/Main topic
Cagliano, Canterino, Longoni, Bartezzaghi (2019)	<i>International Journal of Operations & Production Management</i>	Manufacturing technology, Organizational structure, Plant design	Conceptual paper	The purpose of the paper is to provide evidence on how smart manufacturing affects work organization at both micro level and at macro level
Agostini, Filippini (2019)	<i>European Journal of Innovation Management</i>	Manufacturing industry, I4.0 technologies, Italian manufacturing firms	Empirical research	In the context of the Fourth Industrial Revolution, this article aims to examine the relationship between organizational and managerial practices and the adoption of I40

				technologies in the manufacturing industry.
Tortorella, Vergara, Garza-Reyes, Sawhney (2020)	<i>International Journal of Production Economics</i>	Organizational learning, Industry 4.0, Operational performance, Survey	Empirical research	This article aims at examining the mediating role played by Organizational Learning capabilities at different contextualization levels on the association between Industry 4.0 (I4.0) technologies and operational performance.
Schumacher, Selim, Sihn (2016)	<i>Article of sciencedirect</i>	Industry 4.0, Maturity Model, Strategic Management, Change Management	Systematic literature review	In this paper it is propose an empirically grounded novel model and its implementation to assess the industry 4.0 maturity of industrial enterprises in the domain of discrete manufacturing .
Veile, Kiel, Muller, Voigt (2019)	<i>Journal of Manufacturing Technology Management</i>	Industry 4.0, Industrial Internet of Things, Digital transformation, Implementation, Qualitative research, German companies	Empirical research	Industry 4.0 is assumed to yield extensive industry-spanning opportunities. However, exploiting these opportunities require a targeted implementation of Industry 4.0. The purpose of this paper is to generate a deeper understanding of relevant implementation actions.
Kiel, Muller, Arnold, Voigt (2017)	<i>International Journal of Innovation Management</i>	Industrial Internet of Things, Industry 4.0, Triple Bottom Line, sustainability,expert interviews, multiple case study; qualitative study; manufacturing companies, German industry sectors	Empirical research	This paper aims at painting a comprehensive and structured picture of IIoT related economic, ecological, and social benefits and challenges.
Bartezzaghi, Campagna, Colonna, Pero (2019)	Report CISL Ed.Lavoro		Empirical research	Starting from the concreteness of real experiences, this report wants to offer an overview focused on the management of business change in the light of industry 4.0 which, being an ongoing process, must be addressed strategically by the companies themselves and by the union.
Agolla (2018)	<i>Article of IntechOpen</i>	human capital, cyber physical, space, industry 4.0 revolution,	Conceptual paper	The purpose of this chapter is to highlight the important role of human capital management in the

		innovation, management, virtual organisations		Smart Manufacturing and Industry 4.0 revolution.
Kolla, Minufekr, Plapper (2017)	<i>Journal of engineering manufacture</i>	Smart manufacturing, Industrie 4.0, Industry 4.0, cyber-physical systems, smart factory, industrial Internet, advanced manufacturing, digital manufacturing	Systematic literature review	The purpose of this article is to collect and structure the various characteristics, technologies and enabling factors available in the current body of knowledge that are associated with smart manufacturing.
Sivathanu, Pillai (2018)	<i>Human resource management international digest</i>	Emerging technologies, Industry 4.0, Credit Suisse, Employee attrition, People analytics, Smart HR 4.0	Conceptual paper	In the twenty-first century, Industry 4.0 heralds the innovation of both smart business and smart factory. The HR domain is not immune to this phenomenon, and it must join the bandwagon of disruption or be disrupted.
Nosalska, Piątek, Mazurek, Rządca (2019)	<i>Journal of Manufacturing Technology Management</i>	Digitization, Innovation, Technology, Strategy, Organizational change, Industry 4.0	Systematic literature review	The purpose of this paper is to introduce coherent Industry 4.0 definition via a rigorous analysis framework, and provide a holistic view of technological, organizational and other key aspects (variables) of Industry 4.0 along with the identification of interdependencies that co-occur between them.
Flores, Xu, Lu (2019)	<i>Journal of Manufacturing Technology Management</i>	Human capital 4.0, Competences and skills, Typology, Workforce architecture, Industry 4.0-enabled interaction, Industry 4.0	Conceptual paper	The purpose of this paper is twofold: to raise and address an important change for the human capital in the future of Industry 4.0, and to propose a human-focused perspective for companies underneath the new Industrial Revolution.
Ghobakhlooa, Tan Chingc (2019)	<i>Journal of Industrial Information Integration</i>	Industry 4.0 Smart manufacturing Manufacturing digitalization Small and medium-sized enterprises Information Technology	Empirical research	The present study is concerned with identifying the determinants of SMIDT adoption within manufacturing SMEs. The study benefits from a cross-sectional survey to capture the opinions of Malaysian and Iranian participating SMEs.

Source: personal elaboration

CHAPTER 4 – Analysis and Discussion of Results

We have now reached the conclusive chapter of this document. The aim of this chapter is to discuss results of the systematic review covered by this thesis. Consequently, it is a very full-bodied chapter as it is fundamental for summing up what has been defined in previous chapters. For this reason, it is important to make a short preamble where structure and composition of the following chapter is outlined.

First of all, to place the review in the right context, it is important to include as much as possible on the documents it composes. Consequently, the first part of this chapter will be dedicated to a series of analyses that will outline in the most precise and effective way possible, the main characteristics of documents involved in the research. In this way, it will be possible to place the research in the most suitable context.

The second part of this chapter will deal with the analysis and discussion of results received on the main variables under discussion and which are discussed in both chapter 2 and, briefly, in chapter 3. We chose to analyse the variables first individually, this to ensure greater clarity and then to analyse the variables jointly, to verify any connections between the variables present in the research.

The third part of this chapter will make some considerations and discussions of results outlined by the analysis, also introducing additional topics that have been outlined as the main ones when reading the documents. These considerations provide a more detailed and broader view of characteristics and challenges that manufacturing companies have to face during the introduction of cyber physical technologies. It is no longer seen as a futuristic theory but as a solid reality to be accepted and exploited in the best way.

4.1. Study Characteristics

To discuss these results, it is important to understand some characteristics of the research, such as the countries where the research was conducted, the characteristics related to the type of studies that were analysed and so on. This first analysis is useful to understand what the characteristics of the analysed documentation are and to contextualize it in the most appropriate way. Also, this allows to provide greater clarity to the kind of results outlined, and at the same time will allow for a more specific discussion on results and variables resulting from the analysis. For this reason, it is decided to analyse characteristics of documentation that concern the type of research carried out in the document and the type of document analysed. At the same time, it was considered essential to outline the disciplinary area to which the document belongs, if belonging to management or rather if it was an engineering document and so on. In the same way, it is fundamental to understand where studies were carried out, precisely because, the presence of documents belonging only to a specific country could have compromised the analysis by providing an apparently fair but unbalanced analysis.

For all these reasons, this first part of the analysis regarding the characteristics of the research should not be overlooked or taken for granted.

4.1.1. Country research

Country research is the first characteristic analyzed, it is very important to understand the country to which the selected articles refer. In fact, if articles all belonged to a certain country, the search could be misleading or it could not be considered of global significance, but belonging to a certain context. Consequently, it could not be generalizable from a geographical point of view.

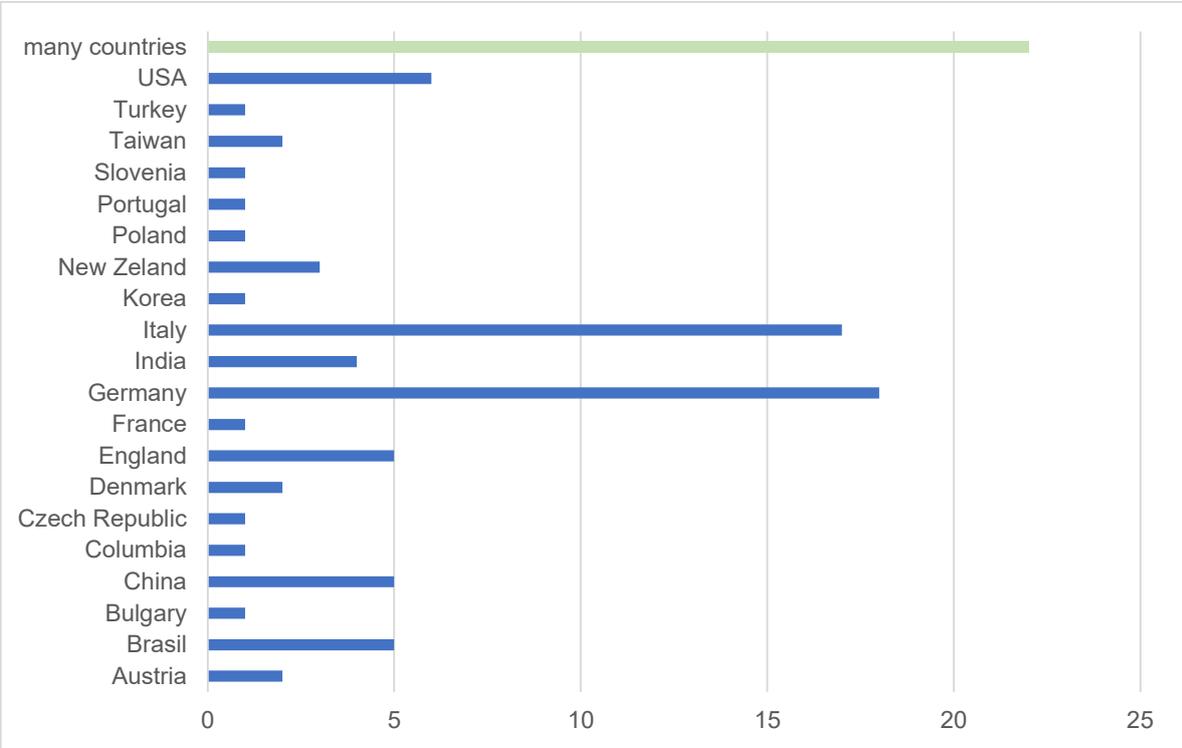
Moreover, collecting this variable is not an easy process, as it has to deal with a multitude of different factors that can be misleading. Usually, the country where the analysis is carried out is the same country where the author carries out his work. But this does not happen everytime, or the author does not always specify where his research is carried out. In this sense, it is decided to opt for a data collection that gives precedence to the words of the author regarding the nationality of companies on which the study is carried out. Instead, if there was no evidence of companies on which the analysis is carried out, it is decided to delineate the variable based on

author's workplace or his nationality, giving priority to the first factor over the second. This choice is motivated by the presence of various non-empirical studies, which are drawn up by authors who work not only in the same state, but also in the same university or institution. Consequently, it is believed that the variable linked to the country in which the study is made, is still relevant.

Furthermore, a large number of documents show a multiple belonging to different countries. Furthermore, it is not always possible to define a single country of belonging of these documents, and they are classified with the term "many countries".

As reported in Graphic 4.1., the documentation analysed in the systematic review shows a clear and justified preponderance of Italian and German documents. This result appears quite obvious, for a linguistic question. In fact, all papers analyzed are in Italian or in English. This explains the large presence of Italian articles. Instead, the presence of a large quantity of German articles is justified by the birth of the Fourth Industrial Ievolution in the German context, which allows the theme to be developed in greater depth.

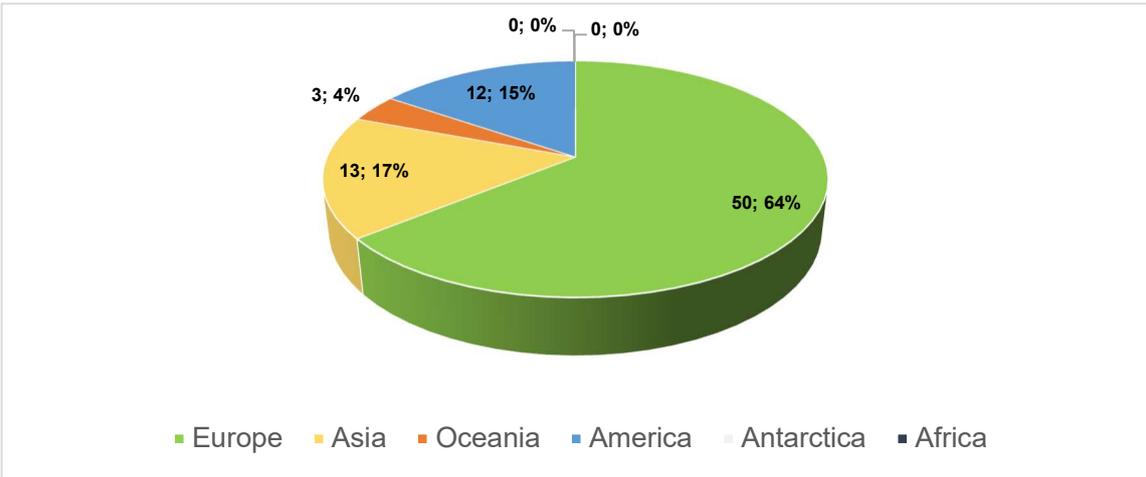
Graphic 4.1. Country Research



As for the other data, from Graphic 4.1. we can see the presence of a fairly large multitude of countries, considering the total presence of 100 records. The majority of the documents belong to the “*many countries*” category, and this shows the international nature of the subject. Subsequently, the other countries involved in research and which have a substantial number of documents are USA (n = 6), England (n = 5), China (n = 5) and Brasil (n= 5).

About documents, it is decided to divide the documentation also by continents, in order to observe whether the trend is homogeneously distributed among the various continents. From this point of view, Graphic 4.2. shows a clear preponderance of articles belonging to the European continent. This is clearly justified by the presence of many articles of Italian and German origins, as previously pointed out. As for the Asian and American continent, the number of articles involved is almost equivalent, instead the number of articles from Oceania is much lower. This is also justified by the presence of significantly lower measures than the other continents, which can be a deterrent to the number of articles published each year. As for Africa and Antarctica, the articles resulting in Graphic 4.2. turn out to be null. Actually, this value must be partially revised, given the presence of articles belonging to the “*many countries*” category. In fact, articles belonging to this category contain authors and studies from countries such as Morocco, South Africa, Namibia and others. However, this shows the presence of a series of articles of an African nature, even if mixed with other nationalities.

Graphic 4.2. Continent Research



Personal elaboration

So, we can conclude by saying that from a country research point of view, among the records analyzed, the majority of these documents come from the European context. In particular, the

Graphic 4.1. shows 50 articles including 17 Italian and 18 German. As for the other documents, these are divided in half between Asian and American documents, respectively 13 and 12. On the other hand, as regards African, Oceanic and Antarctic continent, the values are clearly lower (for all three <5).

4.1.2. Type of Research

In this paragraph we analyse the literature review records observing another kind of characteristic, that is, the one concerning the type of research carried out within each individual study. This helps us understand what kind of information is collected within the review, if information related to an empirically verified reality, or if it is secondary data processing.

Just to analyse this variable, four possible options have been defined, in order to be able to specifically define what type of research is carried out within a given study. In this sense, the possible options are: E1, E2, L3, L4.

1) With the acronym E1, it alludes to those studies that provide quantitative empirical research. This means that all those studies that included a survey submitted to some companies, or a questionnaire submitted to people with considerable roles who work within companies, fall into this category. Usually, this type of research then provides a quantitative synthesis of results obtained, through a statistical analysis.

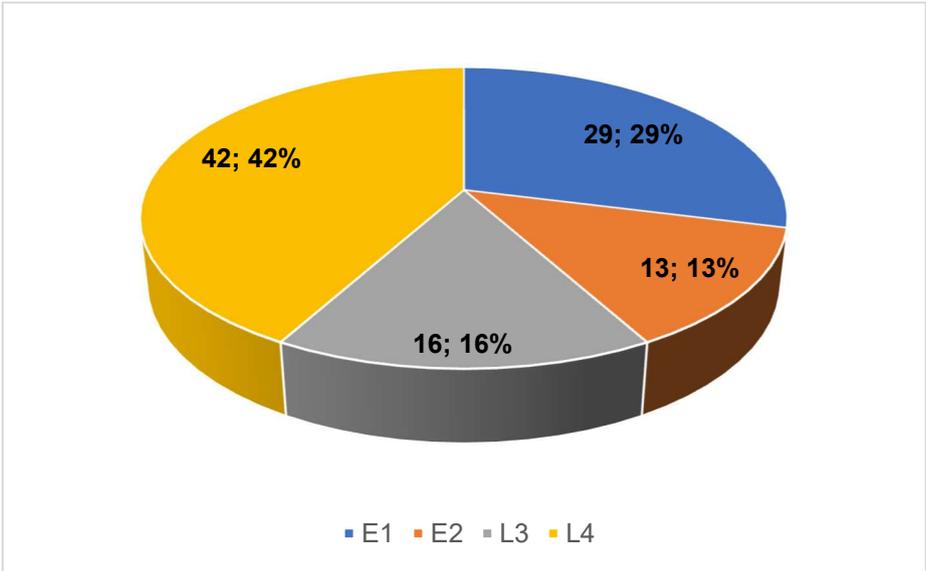
2) With the acronym E2, it alludes to those qualitative empirical studies. This means that the study has an empirical value, however data collection does not take place through a standardized multiple choice survey, but through a series of open questions that allow the candidate to answer freely. Later in studies that carry out this kind of research, the words of the candidates are then reported through direct quotations.

3) As regards the acronym L3, this includes those studies that carry out a systematic search on secondary data. Systematic literature reviews fall into this category, since they systematize secondary data and then derive results from it.

4) Finally, the abbreviation L4 alludes to theoretical documents, which provide for unsystematic research on secondary data. Consequently, this kind of documents focuses on reading and selecting other articles and the general collection of information.

As demonstrated in Graphic 4.3., the records collected in our review are mostly belonging to the L4 category. This result is almost normal, as usually empirical research is not easy to draft, so it is normal that there are less documents of these types.

Graphic 4.3. Type of Research



Personal elaboration

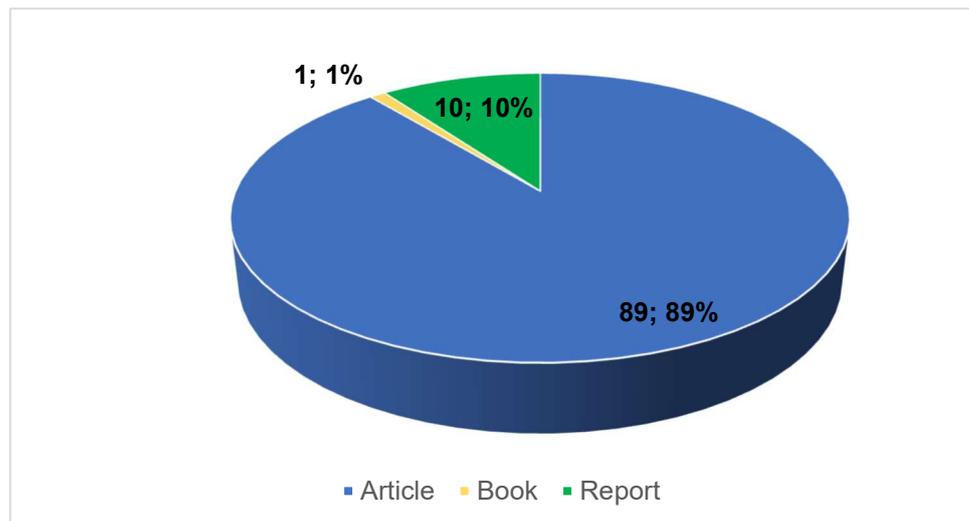
However, the type of research carried out is fairly homogeneous, as there are articles that carry out different searches in good proportion. This allows a double advantage: on the one hand, it allows the introduction of empirical research which is always considered to be of greater scientific value. On the other hand, empirical research can provide misleading results for various reasons such as the presence of a sample that is not very homogeneous or heterogeneous, or the presence of an unclear survey, or even the presence of distortions in the answers. To solve this problem there is the theoretical component that somehow mitigates these distortions, bringing attention to more concrete and precise theoretical results. In conclusion, from a research point of view carried out in the studies, the situation of our work is almost homogeneous.

4.1.3. Type of Records

Another important feature of this work concerns the kind of documents selected in the review. This is important because the selected records may also belong to very different types, such as for example audio or video file and so on. Actually, this is not our case, in fact the great majority of the documents analysed in this research are articles from specialized scientific journals that have been found in valid databases.

As demonstrated in Graphic 4.4., most of the selected records are articles from scientific journals (n = 89), then there are various reports (n = 10), as the theme presented in this work originates from consultancy environment. Finally, there is also a textbook that is introduced in the research because it is particularly relevant to the topic dealt with: *"Corporate welfare between Industry 4.0 and Smart working - wellness levers, creative participations for the growth of cognitive and country productivity"* by Luciano Pilotti. In this book all the analyzed variables are present, this is also justified by the fact that the book appears with a much longer text than articles. Consequently, it is also easier to find evidence of variables.

Graphic 4.4. Type of Records



Personal elaboration

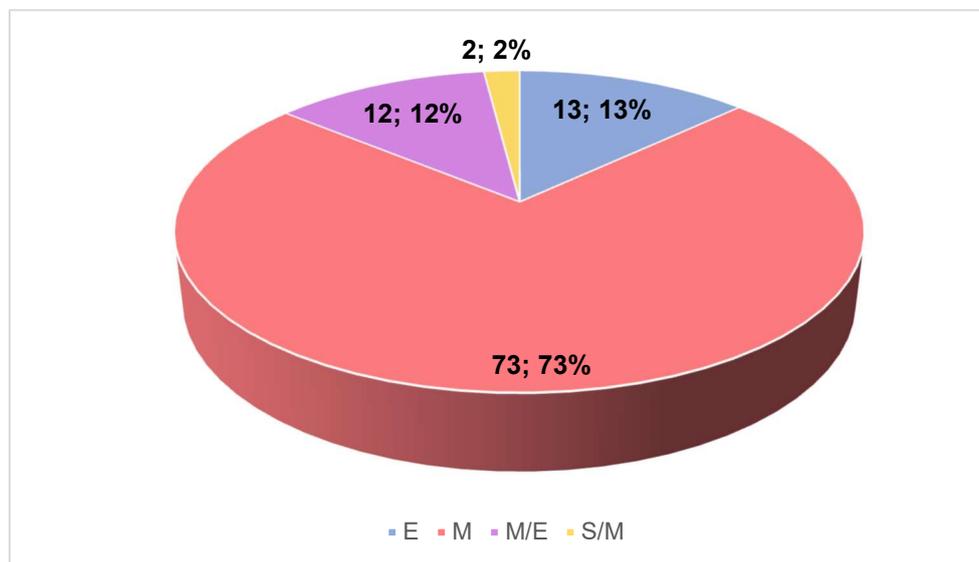
In conclusion, the review is mainly composed of articles from periodicals and magazine articles, a small part of the review also includes reports from certain companies or consultancy companies. Finally, only a textbook is included in the review, since it is particularly relevant to the subject matter.

4.1.4. Research Discipline

This feature is of crucial importance when dealing with the theme of Industry 4.0, which is inherent in the organizational theme. This is because Industry 4.0 is still a cross-cutting theme, as it affects different areas belonging to different disciplines. As already partially addressed in chapter 3, the organizational theme affects various areas, from the social to the engineering one, obviously with different facets. Consequently, as shown in Graphic 4.5., articles belonging to the management discipline are obviously the largest number, since they are inserted in the organizational context. However, the presence of more engineering or more sociological documents is relevant. Also, there are articles that refer to more economic than managerial disciplines, but to simplify the analysis, it is preferred to insert them in the managerial discipline anyway.

In addition, articles of dubious belonging to a specific discipline are also selected. In this case it is decided to create "hybrid" categories, which are placed halfway between one discipline and another.

Graphic 4.5. Research Discipline



Personal elaboration

As we can see, most of documents deal with management (M = 73). Instead, a small part of documents are purely engineering (E = 13). There are no articles that belong exclusively to the sociological category. In fact, various articles were found that deal with the theme of industry

4.0 belonging to the sociological current. However, the problem of these articles, was that many did not refer specifically to the manufacturing industries. Consequently, it was not possible to include them in the review and they were discarded during the screening process. Furthermore, many documents appear that can be defined as hybrid because half of engineering disciplines and managerial disciplines (M/E = 12). Instead, there is only one hybrid document halfway between sociological and managerial disciplines, for the reasons previously explained (S/M=1).

4.1.5. Study Selection

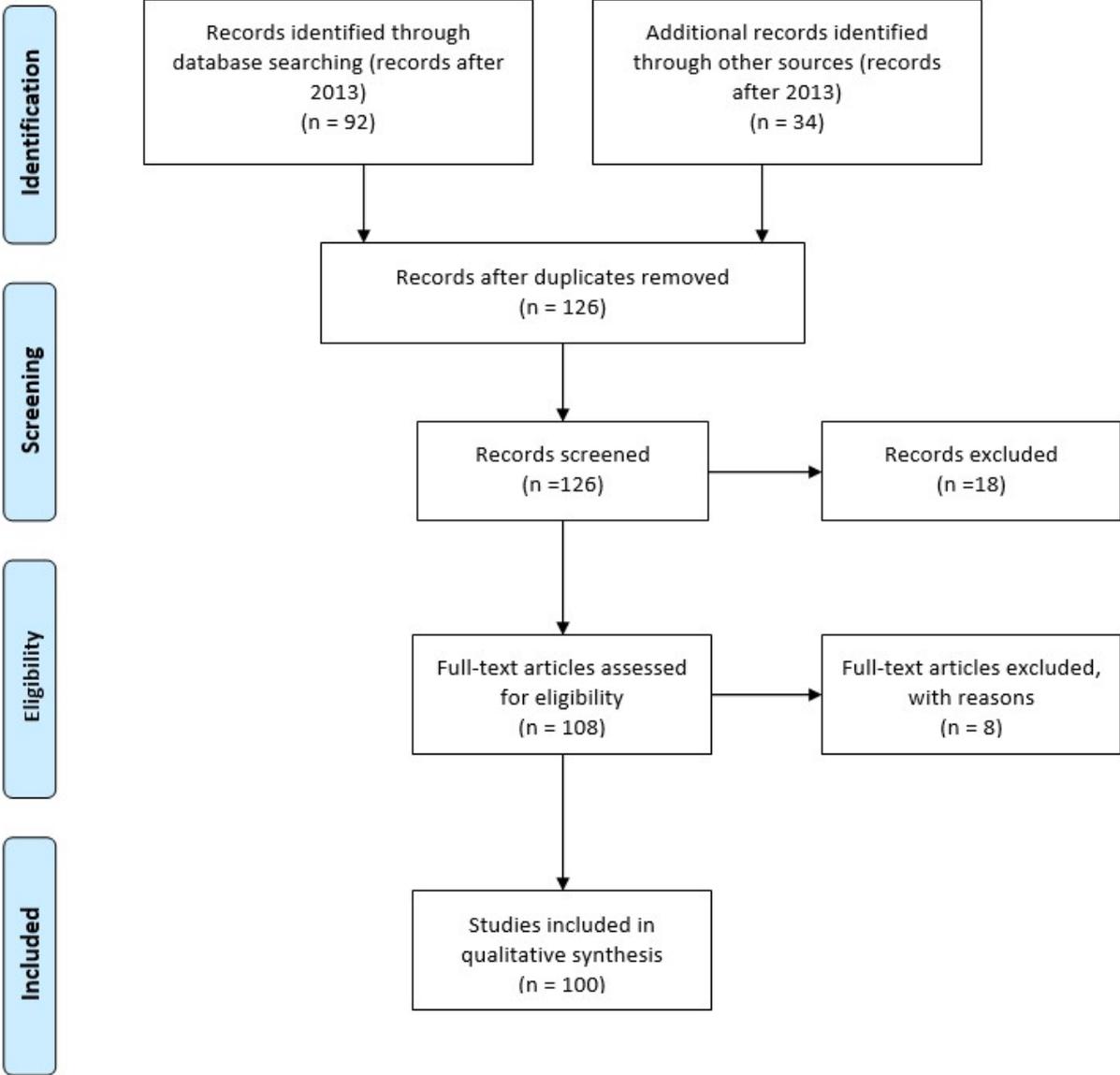
As reported in the PRISMA method, it is now important to define the study selection process, so that it is clearly established what kind of records have been included within the review and which ones have been excluded. Obviously, when a record is excluded, there is always a valid reason that leads to its exclusion. It is important to make clear in order to better understand the selection of results found in the review.

In this sense, a flow diagram that explains the selection process in a clear and summarized way is certainly fundamental. The PRISMA 2009 method envisages a specific flow diagram which analyzes the selection process through four phases: *identification*, *screening*, *eligibility*, *included*. In the initial *identification* phase, English and Italian articles, published in the years after 2013, are selected. The search is carried out through databases considered publicly valid, such as Elsevier, Emerald, Researchgate, Scencedirect, Springer, Taylor&Francis and Google Scholar. These selected articles are found through keywords shown in paragraph 3.3.3. of the previous chapter.

Subsequently, title and abstract are read, in order to verify whether articles could be suitable for review. Of these, 126 were selected which could potentially be valid for the revision covered by this thesis. In *screening* phase, these 126 records are all read twice, in order to have even greater clarity regarding their content. Some of these, are excluded from the research because, even if they addressed the theme of Industry 4.0, they do not deal with the specific aspect of Smart Manufacturing. Therefore, they do not focus on the precise topic of our study. Others, even if they deal with the issue of smart manufacturing, do not deal with the organizational theme. So, these too are not considered suitable for research purposes. In total, 18 articles are excluded at this stage. In the third phase, defined *eligibility*, those records which did not contain any of the variables are excluded, since, while addressing the organizational theme, they focus

on other aspects. In this phase 8 documents were removed. In the end, only 100 articles arrive in the fourth phase, the *included* one. So, they are considered suitable for the review process.

Graphic 4.6. Flow Diagram PRISMA 2009



Personal elaboration

4.2. Organizational Variables Analysis

After defining all the general characteristics of the articles collected in our review, it is time to go into the real part of the study, the one that involves the analysis of organizational variables. As reported at the beginning of Chapter 3, this review aims to answer three main organizational questions, and to understand what kind of impact technologies 4.0 have on organizational variables in companies operating in the manufacturing sector. Obviously, the organizational theme is not simple analysis because the facets within organizations are not few. Therefore it is decided to divide the research into three macro sections, which are previously outlined and explained in chapters 1 and 2:

- 1) **Organizational Structure:** Hierarchy - Centralization - Collaboration
- 2) **Organizational Culture:** Autonomy - Specialization - Flexibility
- 3) **Technological Integration:** Horizontal Integration - Vertical Integration

This paragraph aims to analyse the organizational variables by respecting the structure of the three macro sections, in order to be able to grasp clearly the facets of each section. For this reason, the next paragraph will be dedicated to the variables belonging to the macro section Organizational Structure, then we will analyse those belonging to the Organizational Culture and finally we will face on the variables belonging to the category of Technological Integration.

4.2.1. Organizational Structure

The organizational structure is the first organizational characteristic that we intend to analyse. In fact, the first research question outlined in the previous chapter is:

RQ1: Comprehension of the 4.0 technologies' impact on organizational variables belonging to the organizational structure in companies operating in a manufacturing sector.

Within manufacturing companies, usually the organizational structure adopted in traditional companies tends to take on a vertical structure, where the roles are well defined and the decision-making power is in the hands of the owner of the company, or in any case those who reside at higher hierarchical levels. This happens because in manufacturing companies a high control of the production units is necessary to ensure a high level of efficiency or quality. Consequently, centralized power has always been considered the best strategy to meet the great control needs.

The introduction of 4.0 technologies, as we will see, involves the dismantling of these beliefs, since a more substantial intervention by these technologies allows a reorganization within the factories which facilitates a more decentralized and flat organization. Just to have a clear vision of the organizational changes that the use of new technologies allows, the chosen variables to better delineate this area are *hierarchy*, *centralization* and *collaboration*.

HIERARCHY

Let's start with the analysis of the first variable: hierarchy. As already explained in the second chapter, the term hierarchy refers to the division of roles and powers within an organization. Therefore it provides a vision of the subordination of employees to the various managers. It is a crucial variable to define the organizational structure, because it allows to understand how the control unit is organized within the company.

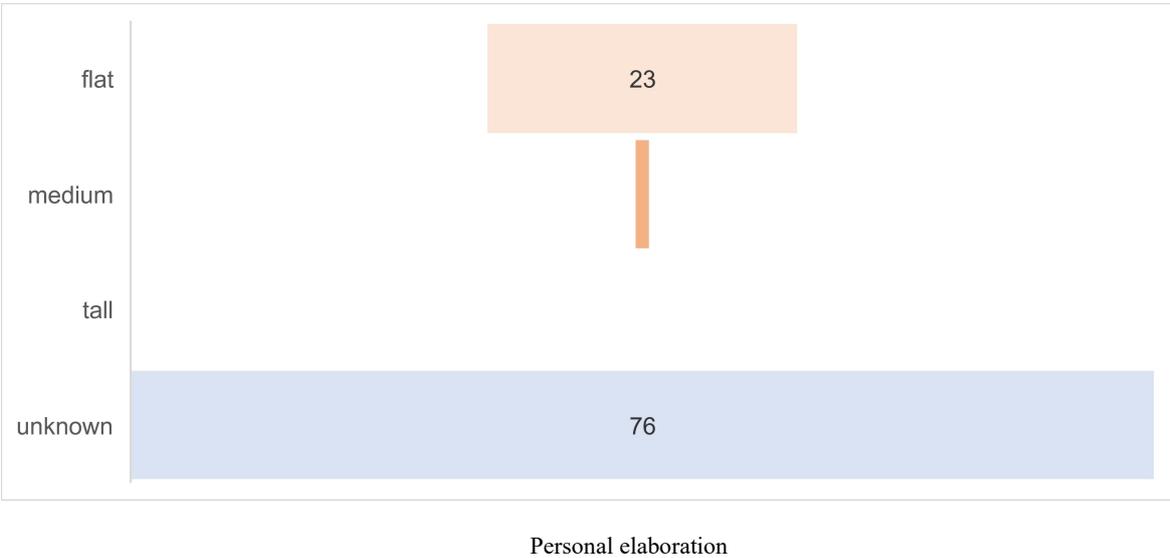
Obviously, all organizational variables still involve reciprocal overlaps, precisely because the organization of a company is determined by many different factors. For example, the concept of hierarchy is extremely connected to that of centralization of decision making. In our revision, to identify the concept of hierarchy, we try to extrapolate within each document the term itself or in any case a term that alludes to a vertical or flatter structure of the company. In this way it

is possible to verify the certainty of the document which has to refer precisely to a change in the hierarchical structure.

What has been observed in our work is the scarce presence of this variable in the selected articles, but a high presence of a similar term, centralization. This is because probably from a practical point of view, the term centralization is more widespread, known and used in 4.0 perspective.

As regards the response of this variable in our review, the articles we found that referred to this concept concern 24% of whole articles. As we will see later with the other variables, the feedback is much lower than the others. In any case, almost all the articles believe that the impact provided by industry 4.0 tend to make hierarchy flatter, or that the flat hierarchy is the kind of organization to be reached in case of 4.0 technologies implementation (Shamim et al 2016, Sivathanu et al 2018).

Graphic 4.7. Results of Hierarchy



The most important authors in the case of hierarchy, they focus on the importance of implementing a flat hierarchy (Shamim et al 2016, Filippini et al 2019, Kiel et al 2017, Sivathanu 2018). The advantages offered by this kind of structure allow countless benefits in the case of use or implementation of 4.0 technologies. In fact, 4.0 technologies are definitely a tool that, especially within manufacturing companies, offers a lot of streamlining of the production chain, but they must be used in the right way and their use must be understood and

shared by people belonging to every organizational level. For this reason, sharing is an essential element in 4.0 manufacturing. Consequently, also the hierarchical structure of companies needs a streamlining that allows greater sharing from different points of view (Bartezzaghi 2019).

In this case, a flat hierarchical structure is much more suitable, as it allows greater cohesion between top management and workers, essential for achieving the high level of sharing just defined (Kiel 2017, Filippini 2017). Furthermore, flat structure allows innovation and organizational learning to expand faster and to take root in all areas and units. So, technologies can be used in a more conscious way and exploited in all their potential (Shamim et al. 2016). Furthermore, it allows the sharing of information, creating a more transparent system and reducing the communication layers, which in turn allows the decision-making process greater flexibility and speed (Sivathanu et al 2018, Davies et al 2017).

Although the analysed documents all agree on the need to streamline the hierarchical structure within the companies, the presence of evidence about these types of streamlining are still significantly reduced. In fact, in the case of hierarchy this evidence is less verified than other variables (Bartezzaghi et al 2019, Cagliano et al 2019). This probably happens for the simple reason that a streamlining of the structure often requires demotion which can be very difficult to manage, and very often they are not implemented by large companies. For example, in the empirical case presented by Bartezzaghi et al 2019, the level of structural de-hierarchization of companies considered within the analysis was low. In fact, only 5 cases out of 15 total cases found de-hierarchization after the implementation of some new technologies, all the others instead have not brought any structural change (Bartezzaghi et al 2019).

In conclusion, the results on the organizational variable defined hierarchy show the need for a flat hierarchy, even if compared to all documents, only 24% include this variable in their discussion. What is missing is a widespread evidence in concrete cases.

CENTRALIZATION

As already described in chapter 2, centralization consists in understanding the hierarchical level in which decisions are made within an organization. When decisions are made at the lowest levels of hierarchy, it is called decentralization.

Decentralization is one of the variables that has been most reflected in the documents analysed in the review. Surely, this is already a first sign of its relevance in the Industry 4.0 paradigm. In fact, very often it is also defined as a pillar in the implementation of new technologies (Oliveira et al 2019, Bertola et al 2018, Flores et al 2019 , Angeles 2019, Qin 2016, Qu et al 2019, Nosalska et al 2019).

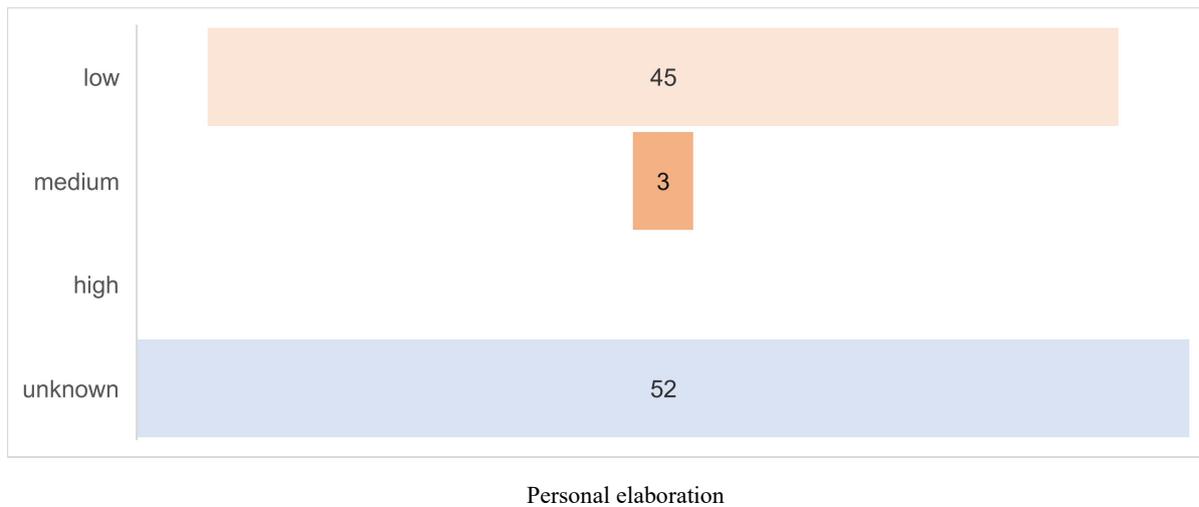
Unlike the previous variable, centralization is conjugated through different ways but always inherent to the Industry 4.0 theme. Many engineering articles that have been included in the research deal with centralization not from a human point of view, but rather from a technological one. However, it does not mean that this does not entail an organizational change. Although a technological decentralization takes place, this still involves a shift of the decision making process from the human component to the technological one, therefore these cases have been integrated within the revision.

The variable taken into consideration is centralization, but in the analysed documents great importance has been placed on its opposite, namely *decentralization*. For this reason, when references to the latter are found in records, low feedback is given for the centralization variable.

As can be seen from Graphic 4.8., the percentage of records that have introduced the following variable in their discussion are considerably greater than those that write about hierarchy. In fact, 48% of the selected articles address the issue of centralization or decentralization. The results also show a clear majority of cases in which centralization is defined as low.

This result is given by the presence of a large number of articles that face the topic of how decentralization is a crucial aspect for the implementation of 4.0 technologies (Oliveira et al 2019, Bertola et al 2018, Flores et al 2019, Angeles 2019, Qin 2016 , Qu et al 2019, Nosalska et al 2019). One of the main characteristics of companies that want to implement new technologies is that of having to deal with a rapidly evolving market, where the need to make timely decisions quickly is essential. Consequently, a decentralized environment favours greater speed in decision making process (Shamim et al 2016).

Graphic 4.8. Results of Centralization



This occurs because in the decentralized environment, decisions are not made only at high hierarchical levels. So, if a problem occurs at low levels of the hierarchical scale, which can be the production environment, the decision on solving the problem must not go through high levels but is taken directly in production. Therefore, it is clearly more immediate and compatible with the implementation of new technologies (Stentoft et al 2019, Shamim et al 2016).

In addition to the speed in the decision-making process, decentralization also offers additional benefits within organizations. In fact, the concept of decentralization is very tied to other concepts, such as that of collaboration or hierarchy as previously stated. Like the flat hierarchy, decentralization is also an organizational feature that favours contact and interaction between all members of the network, and at the same time requires a certain commitment towards collaboration and teamwork (Flores et al 2019).

Certainly, the concept of decentralization is often used in purely engineering articles because it also lends itself to defining 4.0 technologies in themselves. CPS or Cyber-Physical Systems are frequently outlined among the main 4.0 technologies. These technologies are closely linked to the concept of decentralization because they allow companies to carry out decentralization through their use. Usually, they consist of sensors and other systems which, interacting with each other, establish a connection that allows the entire system to be autonomous and to make decisions based on the experiences gained. In this way, decentralization becomes a mechanism implemented by the CPS themselves which become real autonomous decentralized systems (Oliveira et al 2018, Shamim et al 2016, Filipov et al 2016). Linked to this topic, Cagliano et al, establishes the importance of creating a decentralized organization before the

implementation of 4.0 technologies, since this allows companies to better use and less complex work organization (Cagliano et al 2019).

Although, the majority of authors establish that decentralization is certainly one of the organizational pillars for the implementation of 4.0 technologies, from empirical documents analysed we have not obtained much feedback on concrete cases. Indeed, what has been found is often the opposite trend. In fact, Kolla et al 2019 and Bartezzaghi et al 2017 show that organizational decentralization has not yet been implemented concretely within companies. However, these two cases both speak of decentralization of decision making, without involving the technological aspect mentioned above.

In conclusion, decentralization is certainly a fundamental organizational feature for the implementation of cyber physical technology. It should materialize in companies both from a merely organizational point of view, but also from a point of view that allows to combine organization and technology. Probably, from an organizational-technological point of view, decentralization appears as an obligatory choice. When decentralization involves the decision-making process, the change is much more complex. Obviously, these components should not be conceived as standalone, but in each organization, they influence each other.

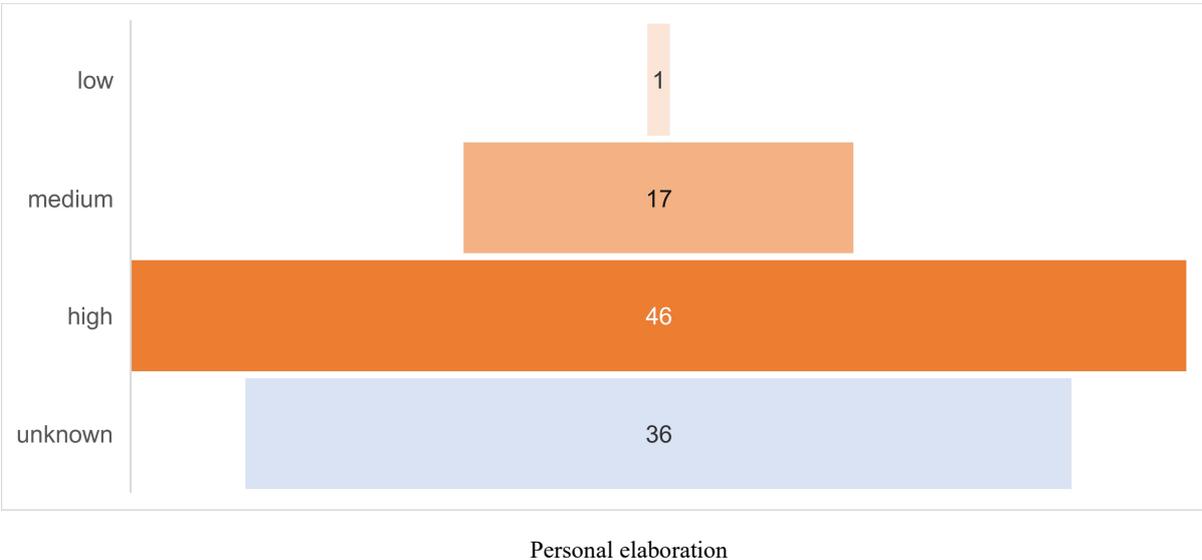
COLLABORATION / TEAMWORK

The last variable introduced in research belonging to the organizational structure category is collaboration. As defined in chapter 2, collaboration consists in the attitude of people who work in the same system to interact and have relationships that favour each other's work. In the analysis of this work, the collaboration is also declined on several different levels. This happens because the articles themselves combine some aspects of Industry 4.0 with various aspects of collaboration.

For this reason, collaboration consists both in the relationship between people who work in the same company and who interact effectively in order to achieve a common goal and people who belong to different companies that collaborate with each other. As for decentralization, relationships are also influenced by the presence of machines for collaboration. For this reason, when we refer to collaboration in smart manufacturing articles, we often allude to the collaboration between machines or the man-machine relationship.

As can be seen from Graphic 4.9., the collaboration variable gets a lot of feedback in the selected documents of the revision. In fact, as many as 64% of the selected articles deal with the topic of collaboration. Most of the documents (n = 47) speak of collaboration as an important variable within the Industry 4.0 organizational landscape; a good part of the articles define it as a variable of medium importance (n = 17), and only one article speaks of collaboration as a non-incident variable for the implementation of 4.0 technologies.

Graphic 4.9. Results of Collaboration/ Teamwork



Despite the presence of some articles that show little or medium interest in collaboration, most of the articles believe that this consists of a crucial variable. This happens because when new systems to work with are introduced into organizations, the presence of a group of people who are able to show the work and be an example for others is often necessary. In fact, the pilot team consists of a method used by companies that want to implement new technologies, because it allows them to develop a spirit aimed at problem solving and the development of new ideas (Jabbour et al 2018, Report PWC 2016). Obviously, teamwork requires a series of interpersonal relationships between the members of the group, among which the fundamental is mutual trust between the team members. When within the team the same values, ideals and emotions are shared while pursuing a common goal, trust is established more solidly (Jabbour et al 2018).

So, in companies that require teamwork, it is precisely the structure of work itself that is brought to radical change. But not all workers have a particular predisposition for teamwork. Precisely

for this reason, relational skills are taking on great importance to face a type of work within a team (Bartezzaghi et al 2019, Hecklau et al 2016).

As regards the external work environment, collaboration is also increasingly required between commercial partners, in order to create an adequate network of relationships that can favour both parties. It is important to build collaborative relationships in the supply chains, to guarantee co-responsibility and partnership, so that all parties are involved in results and profits (Tiraboschi et al 2016).

Finally, collaboration is often understood as a relationship that is established between man and machine. This might have seemed a paradoxical result, as we are always led to talk about collaboration between individuals, but in the 4.0 panorama, the presence of intelligent tools in the production chain should encourage workers to collaborate also with machines, especially in production environments where machines are increasingly present (Di Nardo et al 2020, Baden et al 2019, Rojas et al 2019).

Even in this case, although everyone agrees on the high impact of collaboration within companies that want to implement new technologies, we have conflicting feedback on their adoptions. Many articles show that the level of collaboration within companies is still not satisfactory (Cucculelli et al 2017, Chiarini et al, Kolla et al 2019, Radziwon et al 2013, Carreiro et al 2019, Dutta et al 2019). But we also have empirical examples where the opposite trend is demonstrated, that is, the levels of team collaboration increase during the 4.0 technologies implementation process (Bartezzaghi et al 2019, De Oliveira et al 2019). A more in-depth analysis is carried out by Bartezzaghi et al 2019. Despite the fact that in his study he finds a significant increase in the level of collaboration within companies, he also underlines that versatility could act as an obstacle towards a working system based on collaboration (Bartezzaghi et al 2019).

In conclusion, as for decentralization, the results regarding the collaboration have a great response from a theoretical point of view, in fact most of the articles refer to it as an important element. But from a practical point of view, this organizational change is still difficult to apply.

4.2.2. Organizational Culture

The second organizational macro-section that is important to analyze is organizational culture. The second research question outlined in chapter 3 concerns precisely this topic:

RQ2: Comprehension of the 4.0 technologies 'impact on organizational variables belonging to the organizational culture in companies operating in a manufacturing sector.

Organizational culture consists of a very broad concept which will be analysed specifically in the discussion section. Here it is seen in a purely organizational logic, or as a set of organizational behaviors adopted within companies.

In traditional production companies, workers are often led to adopt a behavior aimed at automating certain pre-established tasks, without knowing the entire production process or understanding the real meaning of their actions. This kind of attitude could have been suitable for the production sites of a few decades ago, but if we think of the current production centers, it is completely obsolete.

The introduction of 4.0 technologies is optimal in those realities that, as we will see, have opposite characteristics. To evaluate the kind of organizational behavior promoted for the adoption of 4.0 technologies, we chose to analyze autonomy, flexibility and specialization variables.

AUTONOMY

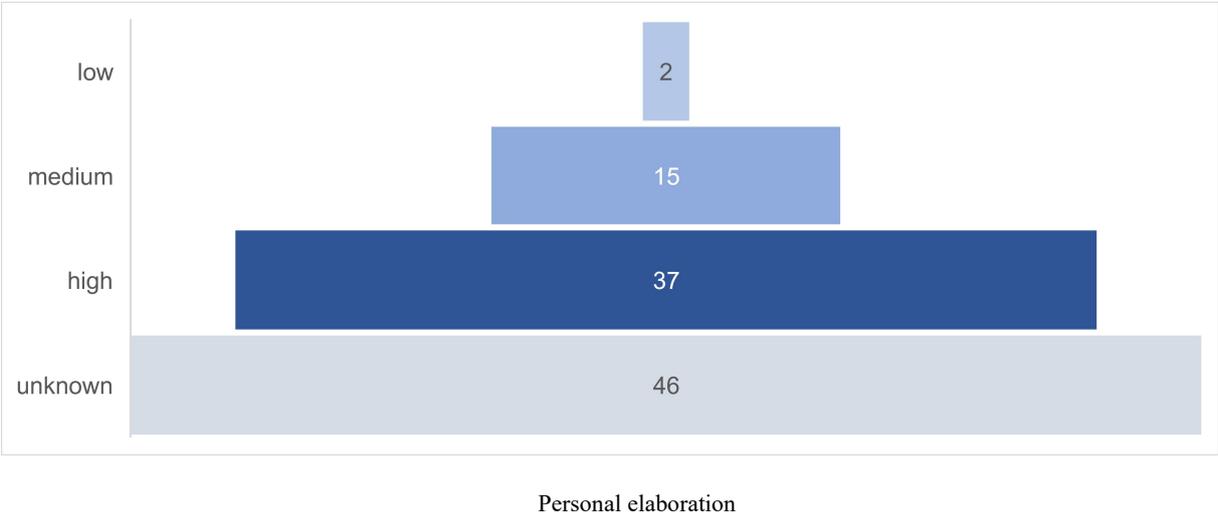
The first variable analysed in the case of the variables belonging to the macro-section of the organizational culture consists in autonomy. It might seem like an uninteresting variable to analyse, because each worker is assumed to be self-employed in his or her job. Actually, this term aims to establish what level of decision-making autonomy is entrusted to the individual worker within a company.

In traditional organizations, the worker, especially the one who works in production chains, carries out a certain standardized task. When problems appear during his work, the worker usually has to turn to another person who supervises his work and who solves the problem presented by making a decision. Instead, the worker with decision-making autonomy does not have to turn to a third party to solve a problem that arose in his job, but he is able to solve the problem independently. Autonomy generates great advantages in terms of time and efficiency.

From the worker’s point of view, autonomy has a double facet, since it can be seen as an opportunity to acquire more skills, and to grow on the job, but it can also be seen as a factor that generates further complexity. Consequently, this is a rather difficult topic, to which a proper attention must be paid.

As regards our review, this organizational variable has determined a good response between the documents. As shown in Graphic 4.10. the majority of documents analysed deals with the variable (54%). 37% believe that autonomy is an important variable in the case of implementation of new technologies, 15% believe that it is a medium relevance variable, and only 2% maintain that autonomy is not a relevant organizational variable or that autonomy needs to be low.

Graphic 4.10. Results of Autonomy



In the documents analysed, autonomy is explained in various ways. Many articles emphasize the importance of providing greater autonomy to workers so that they can manage their work and the problems independently, thus developing good problem solving skills (Cagliano et al 2019, Birasnav et al 2019, Schumacher et al 2016, Flores et al 2019). Instead, other authors, focus on another kind of autonomy, which no longer concerns people but rather machines 4.0 and consequently production systems (Braccini et al 2018, Muller et al 2017, Stentoft et al 2019, Carreiro et al 2019 , Qu et al 2019, Goncalves Machado et al 2019, IRPET Report 2016).

Unlike the other organizational variables, where the thinking of authors was often very concordant and repetitive, here authors, while manifesting the importance of the variable, deal with different aspects. Starting from the decision-making autonomy linked to workers, some

authors argue the importance that managers coordinate the departments and that they themselves delegate and provide greater autonomy to workers (Cagliano et al 2019, Birasnav et al 2019, Schumacher et al 2016). Others argue that because of the development of some soft skills, workers will be able to develop the right level of autonomy (Oliveira et al 2018, Flores et al 2019, Benesova et al 2017).

It is believed that the development of soft skills such as creativity, flexibility and problem solving are the crucial skills that allow a worker to be independent. For this reason, we will see that the autonomy variable is closely connected with flexibility and also with specialization: the more a worker is able to be flexible, specialized and creative on the resolution of possible problems, the more he has the tendency to become autonomous (Benesova et al 2017). In the same way, autonomy is also stimulated by the organizational variable of decentralization. The presence of a decentralized structure in the company imposes the need for increasingly widespread decision-making autonomy.

As for the machine-oriented variation, autonomy is seen here as the ability of the entire system to be autonomous thanks to the presence of CPS that allows a complete system management (Goncalves Machado et al 2019, IRPET Report 2016, Braccini et al 2018, Piccinini et al 2015, Qu et al 2019). In fact, autonomy is defined as one of the central characteristics of Smart Manufacturing Systems (SMS). The autonomy of these systems is important and introduced in this study, since it also encourages the decision-making autonomy of workers. Obviously, if a system is able to manage itself, the worker has tasks related to monitoring the system itself and solving any problems that the system is unable to solve independently. Consequently, a great theme that is connected to this discussion is the need for staff re-training, to avoid being completely replaced in its work performance by an autonomous cyber-physical system.

So, from a theoretical point of view, autonomy seems to emerge as a medium-high importance variable in the implementation of 4.0 technologies. But, from a practical point of view, there are few empirical cases that give evidence of it. The few who give evidence, all establish a clear change of workers on decision-making autonomy, which shows that it has improved considerably (Bartezzaghi et al 2017, European Commission 2015).

Finally, we can establish that autonomy in this review is a variable that has a good response, and at the same time provides great points for reflection on the kind of changes that technology 4.0 can generate, especially as regards the role of workers within smart manufacturing. In any case, this topic will be addressed later, in the last part of this chapter.

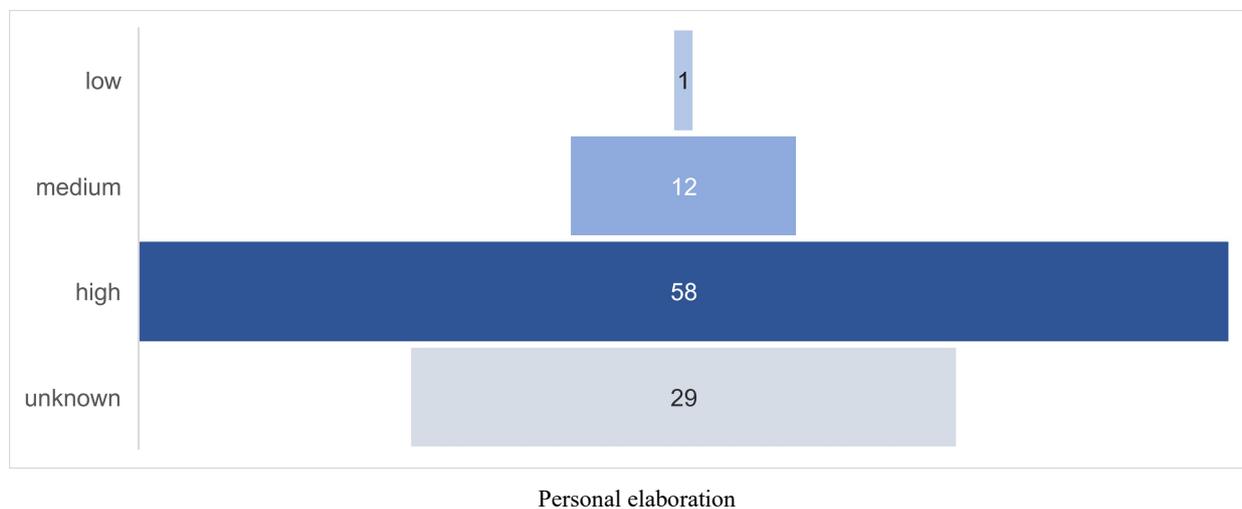
FLEXIBILITY

The last variable of the organizational culture macro-section is *flexibility*. As outlined in previous chapters, flexibility consists in the ability to change quickly when exposed to a specific situation that requires it. Obviously, from a first definition it is easy to guess that it is a very generic concept, which needs a much more detailed explanation than other variables.

In fact, flexibility is the variable that caused the greatest problems regarding the search within documents. This happened not because it is difficult to find, but because it is a term that is abused, consequently identifying the correct meaning of the variable requires additional efforts.

In records analyzed in our review, flexibility has met with great success in many articles as is evident in Graphic 4.11. As many as 71% of the articles viewed have spoken about this organizational variable, 58% believe it to be a fundamental requirement to allow the implementation of cyber technologies. Until now, it is certainly the best response obtained, and this is also due to the multitude of cases to which the term fits.

Graphic 4.11. Results of Flexibility



In this sense, to make the explanation as exhaustive as possible, we have chosen to divide the concept of flexibility into three areas:

1) Worker flexibility: flexibility intended as an organizational characteristic of workers and of systems that involve them personally.

2) Production flexibility: flexibility intended as a flexible organization of the production process that characterizes a smart factory.

3) Machine flexibility: flexibility intended as a substantial characteristic of cyber-physical technologies.

Starting with the first category, flexibility focuses on the worker. In fact, the workforce is required to have ever-increasing flexibility, as it allows to innovate faster, to develop new problem solving skills and to encourage collaboration, These are all skills that are essential in the case of cyber technologies implementation (De Oliveira et al 2019). In many traditional companies, employees are rigid, since they have been stuck for years in a certain role, which does not allow them to see anything else. But employees are also responsible for their work, and in a 4.0 perspective, they must be given flexibility to propose new ideas that can improve the working environment (Radwizon et al 2013). In this sense, there are several documents that address the importance of flexible work. Corporate flexibility should not only concern the worker, but also what the company allows the worker himself. This means that flexibility must also contribute to the well-being of workers through flexible working hours, flexible working content, workplaces, mentalities and so on (Agolla 2018, Pilotti 2017, Hecklau et al 2016).

In some articles, the need for a flexible contractual system is also emphasized, so that flexibility is also recognized from a legal point of view (Bartezzaghi et al 2019, Tortorella et al 2018). All these concepts are now essential in companies that want to implement new technologies, since human capital still has a decisive role within the production sites. Without a synergy between man and machine towards a flexible environment, the intelligent factory will remain a utopian hope.

The second category concerns production flexibility, that is, flexibility that no longer concerns the individual, but the entire production process, which must adapt to market changes as quickly as possible. One of the characteristics of smart factories is the presence of a production system that allows standardized customization. The term *standardized customization* may seem an oxymoron, as what is usually taught in all economics courses is to achieve a competitive advantage that focuses on the standardization or customization of a given product. In this perspective, Industry 4.0 exceeds these concepts, since cyber physical technologies allow contemporary production processes to customize products at a very low cost, comparable to that of mass production (Nosalska et al 2019).

Obviously, mass customization is guaranteed only through an adequate use of 4.0 technologies (Report IRPET 2016). This result is obtained because 4.0 technologies themselves have a certain level of flexibility. In fact, the concept of flexibility is often associated with that of CPS, since these systems allow a better dynamism of various parts of business forms, which accelerate and improve the production process (Tortorella et al 2018 Lu et al 2015, Fatorachian et al 2018). The integration of autonomous robots that are able to collaborate with man also provides increasing flexibility (Goncalves Machado et al 2019).

Even in this case, the theory shows the great need for flexibility within companies that want to implement new technologies, but from an empirical-practical point of view, this kind of feature is not yet fully satisfied. In our review, various articles appear that still express concerns about the level of flexibility achieved by companies (Tortorella et al 2018, Guoping et al 2017, Lu et al 2017, Tiraboschi et al 2016, Kolberg et al 2019). Furthermore, in a 2018 report, the Italian Ministry of Development shows a misalignment between large and small businesses. In fact, large companies show a higher level of production flexibility than the one of SMEs (Ministero dello Sviluppo, Report 2018).

Therefore, flexibility has certainly obtained great feedback in the review. It is interesting to emphasize that despite being a seemingly generic term, it combines in the 4.0 panorama in multiple facets, but maintaining a crucial importance. It should be emphasized that both workers and companies must commit themselves to create a unitarily flexible environment from every point of view: from the implementation of flexible machines to the implementation of new working hours that promote workers' well-being.

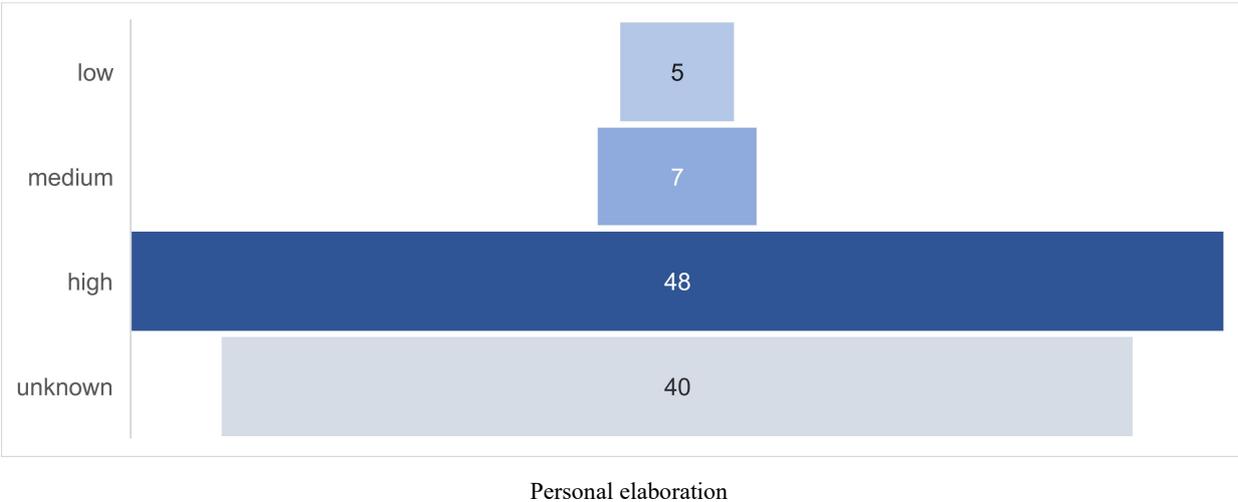
SPECIALIZATION

Specialization is the organizational variable that alludes to the degree with which the organization divides specific objectives into different jobs. Compared to the industrial 4.0 landscape, specialization is a crucial aspect, as new technologies are often a very obscure topic in companies, especially for traditional ones that have always worked without them.

In fact, new technologies often require great knowledge, both from a technical point of view and from a management point of view. Consequently, very often companies find it difficult to implement new technologies because of the lack of adequate technical knowledge.

In our revision, the specialization gets a good response, in fact in Graphic 4.12. we can verify that 60% of records introduce this variable into their discussion. 48% of documents said that specialization in a new technology implementation perspective should be high, 7% declare it should be medium, and 5% declare that the impact of this variable is not significant or it should be low.

Graphic 4.12. Results of Specialization



Therefore, given the feedback on this variable, articles highlight various solutions to implement a higher degree of specialization within companies. Certainly, a decisive role is attributed to universities and other institutes that favour the research and development of new skills, and to the human resources department of large companies.

As for the topic relating to universities, many articles suggest that partnerships may be an excellent starting point. In fact, universities are not only nerve centres for the acquisition of new talents, but also centres of research and collaborations to carry out internal retraining of the workforce (Tiraboschi et al 2016, Bartezzaghi et al 2019).

A point of discussion must relate to the type of workforce to be retrained. On the one hand, there is the need to retrain the professional workforce, which often does not have any technical skills in new technologies, on the other hand, also technicians and engineers need new skills. As far as the professional workforce is concerned, this very often requires a total requalification since technical skills are often very limited. In manufacturing companies that want to implement new technologies, workers are increasingly required to collaborate with technology. But very

often, worker's job consists of a simple repetition of a manual work that could be replaced by a machine. Consequently, to avoid a progressive process of obsolescence, it is important that the requalification takes place in the shortest possible time.

Instead, as regards technicians and engineers, they also need to acquire new technical skills, since new technologies include the use of innovative systems (Kolberg et al 2019). The process of acquiring new skills does not only concern technical skills. On the contrary, the most required skills in each level of employment tend to be relational skills (Hecklau et al 2016, Guarin et al 2017). In this sense, what is required is a high versatility that allows to combine technical skills with a specific variety of soft skills (Bartezzaghi et al 2019). Guarin et al 2017, divides required skills into four categories: technical skills, methodological skills, social skills and personal skills. Technical skills indicate competences which are linked to the utilization of a specific machines. The methodological skills concern the development of problem solving and decision making skills. Social and personal skills, involve spheres related to relationships with others and personal ethics given by one's values and motivations (Hecklau et al 2016). These skills, like the technical ones are in continuous evolution but unlike the technical ones, they are more difficult to automate and learn, since they are often influenced by the cognitive sphere (Kergroach 2017). It is clear that guaranteeing this kind of skills to all workers is not only a great economic cost but also a great cost in terms of time devoted to these activities. So, especially for medium-small companies, these activities are very difficult to put in practice. (Kergroach 2017).

In this panorama of continuous evolution of skills, the role of HR department of companies acquires a fundamental role for the management of this process (Hecklau et al 2016, Benesova et al 2017, Libboni et al 2018). Therefore, HR is entrusted with the whole sphere of training for the acquisition of new skills, the sphere linked to the recruitment of new talents, but also the management of relations with workers who do not always sympathetically accept such training activities (Hecklau et al 2016, Benesova et al 2017, Libboni et al 2018).

Although, almost all authors agree on manifesting the relevance of a high level of specialization in the perspective of the implementation of new technologies, many authors report that the specialization required is still a distant goal (Hamzeh et al 2018, Erro-Garces et al 2020, Slusarczyk 2018, Benesova et al 2017, Kolberg et al 2019, Tiraboschi et al 2016, Guoping et al 2017, Tortorella et al 2018, Bartezzaghi 2017, Cucculelli et al 2017, Report PWC 2016). Whyshall et al 2018, explains that the problem that arises in many contexts is that talents in the

labor market are often not sufficient to satisfy the demand, or there are no specialists of Industry 4.0.

Finally, specialization is an organizational variable which obtain a good response in the systematic review, but at the same time, a good number of articles show empirical results that still demonstrate great deficiencies in the corporate landscape.

4.2.3. Technological Integration

Technological integration is the last organizational feature that we analyse in this work. In fact, the latest research question to answer is:

RQ3: Comprehension of the 4.0 technologies' impact on organizational variables belonging to the technological integration in companies operating in a manufacturing sector.

As already outlined during the analysis of previous variables, 4.0 technologies often serve as a link between different work units, in fact their purpose is to increase integration. Most of the new interconnection systems proposed in the 4.0 environment offer an integration that was not previously considered possible. This also entails great time advantages through which information passes and certain decisions are reached. In addition, the technological integration allows great advantages in terms of transparency achieved and it guarantees agility for the company. All these are features that characterize smart manufacturing.

As already defined in chapter 1, integration can take place vertically or horizontally. Unlike the other variables, the analysis of these will be carried out jointly, given the influence that one has on the other and considering that in the review, articles that dealt with one variable, almost always treated the other.

VERTICAL AND HORIZONTAL INTEGRATION

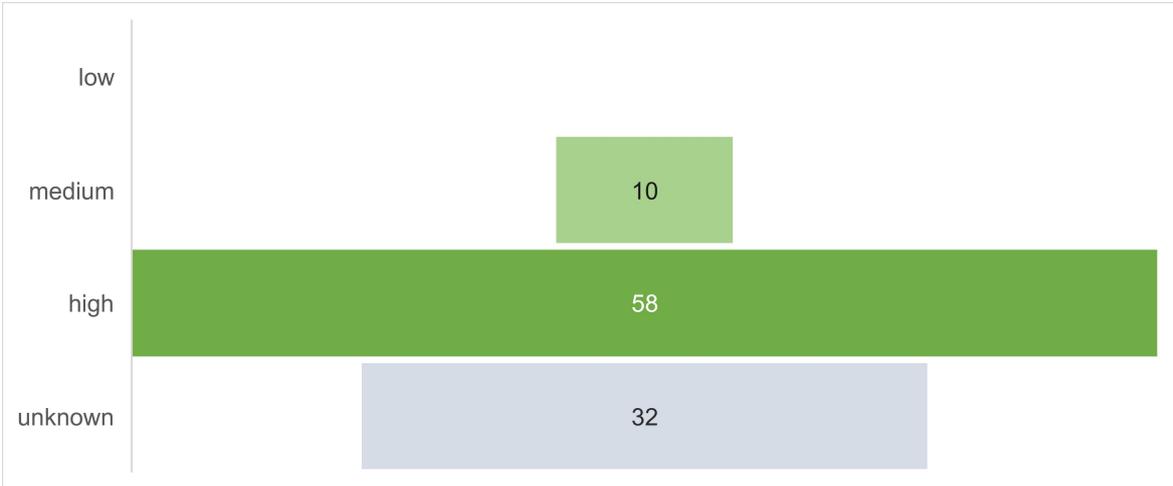
The concept of vertical integration and horizontal integration has been previously exposed in the first chapter, since, according to the Calenda plan, vertical and horizontal integration appear as an enabling technology. Actually, these concepts have much more to do with a concept of technological-organizational relevance. It is thanks to 4.0 technologies if companies today are able to implement better vertical or horizontal integration plans.

To remember the meaning of these two variables, we take back what has already been outlined in the first chapter. Horizontal integration consists of a linking process that involves different organizational units that are placed on the same hierarchical scale. This means that with the term *horizontal integration* we want to allude to a connection between units which from a hierarchical point of view are placed on the same level. An example of horizontal integration is the connection between two production units, or the integration of two different production plants or the connection within the supply chain, which involves suppliers, customers and other partners.

Indeed, *vertical integration* consists of an integration process that involves different organizational units belonging to different hierarchical scales. For example, a link between the production center and the control center, or the information integration between a branch and its holding company, and so on.

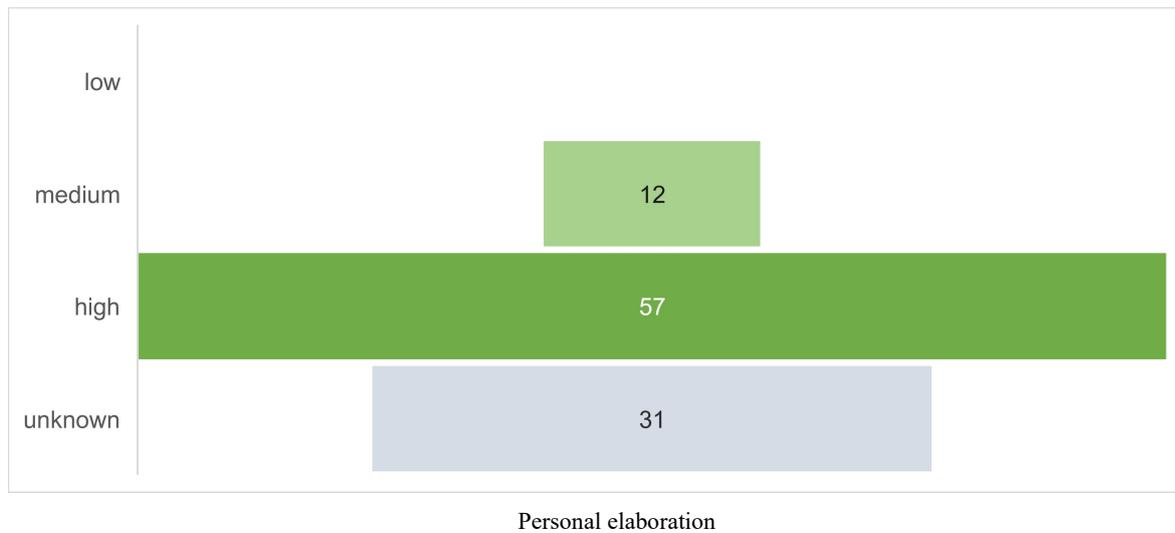
In the systematic review, the variables were analysed separately, but we noticed that usually, the presence of one variable also implied a reflection on the other. This happens because vertical and horizontal can be considered two complementary aspects to deal with the more general issue of integration. As for horizontal integration, 68% of the selected articles deal with the topic, and 58% affirm that horizontal integration is a crucial organizational feature to be achieved in 4.0, only 10% consider it of medium importance and no article defines it as low. Horizontal integration shows more or less same results: 69% of articles deal with the topic, 57% declare that the variable is important and 12% declare that it is of medium relevance. Moreover, there is no evidence of articles declaring that the variable has to be low or irrelevant.

Graphic 4.13. Results of Horizontal Integration



Personal elaboration

Graphic 4.14. Results of Vertical Integration



By deeply examining some aspects of articles analysed during the review process, it is noted that concepts related to integration are always accompanied by evidence regarding particular 4.0 operating systems. Therefore, it often happens that organizational issues are completely overridden by those of technical-engineering relevance. Although these IT systems do not belong specifically to the organizational discussion, they still play an important influencing role. The best known systems are: PLC (Programmable Logic Controllers), MES (Manufacturing Execution System), ERP (Enterprise Resource Planning), SCADA (Supervisory Control and Data Acquisition), M2M (Machine-to-Machine Communication) (Cagliano et al 2019).

The great presence of the concept of integration combined with the concept of Industry 4.0 is justified by the great advantage that integration can guarantee to organizations. This justifies companies' search for new technologies and systems that contribute increasingly to the integration process. Report from the Ministry of Development states that in 2018 in Italy, companies that invested in technology 4.0 have horizontal integration as their main objectives, in addition to safety. In particular, among medium and large-sized manufacturing companies, the most popular investments, in addition to IT security, were in vertical and horizontal integration of information (Report from the Ministry of Development 2018).

Investments in vertical and horizontal integration are justified by the great advantage they offer to manufacturing companies. In fact, integration offers great value not only to the company but also to the product or service offered to third parties, such as consumers, suppliers or third

parties. The advantage is given by the great collaboration that arises between partners, who manage to work more closely, quickly and efficiently sharing all the necessary information. Moreover, the synergic system that is created when all the parties collaborate towards a common goal, moving in the market almost as a single entity, is another important advantage (Birasnav et al 2019).

From an empirical point of view, we do not find great results on today's situation of manufacturing companies. Some articles show that the integration, both vertical and horizontal, present in companies is still low (PWC 2016, De Oliveira et al 2019, Chiarini et al 2019, Jabbour et al 2018). Other articles show the opposite trend (Stock et al 2016, Erro-Garces et al 2020). So, it is difficult to establish what is the real trend of this variable. In any case, the great evidence from a theoretical point of view can only encourage companies to take further steps in this direction.

4.3. Discussion

After analyzing all the organizational variables included in the review, it is the moment to discuss the overall results obtained and identify what the main discussion points outlined in the review of the articles are. For this reason, this discussion paragraph will be divided into 3 main parts:

- 1) a first summary part regarding the results obtained from the organizational variables, focusing attention on the three research questions and the macro sections identified.
- 2) a second part of discussion on the difference between theoretical results and empirical tests highlighted in the review.
- 3) a third part summarizing and discussing the main organizational challenges that today's companies will have to face in order to overcome the changes brought about by new technologies.

After this discussion we will try to provide a guideline on what can be the correct management system for the organizational theme in case of implementation of new technologies.

4.3.1. Summary of evidence

In the previous session we analysed the variables separately, looking at the results obtained by each variable. Now is the time to understand results obtained from the review by observing the variables as a whole and to make comparisons between macro sections.

As outlined by the previous paragraphs, the variables sought in the review all provided more or less high feedback. Going to observe the results provided by each variable, they all obtained a rather high relevance of "high" or "low". This means that the articles are fairly coherent with each other, showing agreement on the organizational variables analysed.

In any case, there were differences between the three macro sections, in fact some of them got more feedbacks than others. As can be seen from Table 4.1., the variable that found the most evidence is flexibility, instead the one that found the least evidence is hierarchy.

Table 4.1. Summary of results

MACROSECTION	VARIABLE NAME	HIGH	MEDIUM	LOW	EVIDENCE	UNKNOWN
ORGANIZATIONAL STRUCTURE	HIERARCHY	0	1	23	24	76
	CENTRALIZATION	0	3	45	48	52
	COLLABORATION	46	17	1	64	36
<i>evidence media</i>					45,30%	
ORGANIZATIONAL CULTURE	AUTONOMY	37	15	2	54	46
	SPECIALIZATION	48	7	5	60	40
	FLEXIBILITY	58	12	1	71	29
<i>evidence media</i>					61,60%	
TECHNOLOGICAL INTEGRATION	HORIZONTAL INTEGRATION	58	10	0	68	32
	VERTICAL INTEGRATION	57	12	0	69	31
<i>evidence media</i>					68,50%	

Personal elaboration

Instead, an intermediate result is achieved by centralization and autonomy variables, which is around 50% evidence. However, the variables specialization, horizontal integration and vertical integration and collaboration, have obtained rather high evidence by wandering on numbers greater than 60% of the review articles.

Moreover, it is also right to refer to macro sections, as they certainly allow a better understanding of the result defined by the set of variables outlined. In this sense, of the three macro-sections, the one that got the most importance was undoubtedly technological integration, since it is certainly one of the central themes on which Industry 4.0 is based.

In fact, on average 68.5% of the articles dealt with the topic of technological integration. Organizational culture ranks second. The evidence for the topic is on average around 61.6% of the documents. Finally, the organizational structure is configured as the least treated organizational theme, in fact the evidence is around 45.3% of the articles. Surely here, the hierarchy variable lowers the total evidence making the difference.

Trying to understand the reasons for these differences, we can try to outline possible reasons. First of all, the organizational structure obtains significantly less average evidence than the other two macro sections. This probably happened because the theme linked to the organizational structure is the one which contains purely organizational variables, which are inherent to the structure of the company, consequently they are less simple to manage and to analyze. However, the macro section that got the most feedback, appears to be that of technological integration. This probably happened because it is a variable that focuses on the

theme of industry 4.0 and which refers purely to the presence of technology, obviously the articles who talk about industry 4.0 talk very often about technological integration.

By focusing not only on the evidence, but also on the result that each variable has achieved, we try to summarize the results obtained.

As for the organizational structure, results show that the three variables analysed outline a clear situation of the needs demonstrated by Industry 4.0. With a view to implementing new technologies, companies are required to have a structure characterized by decentralization, flat hierarchy and not individual work but teamwork. In fact, this kind of structure allows companies to have greater organizational agility. The decentralized structure allows a much more efficient and rapid decision making process. At the same time, a flat hierarchy favours a better distribution of company control, enable a greater speed in the dissemination of information and at great transparency. Furthermore, a decentralized and flat structure implies the lack of that subordination relationship that characterizes vertical and centralized structures. Consequently, the work is no longer determined by orders given by a superior but takes place through mutual collaboration and teamwork.

In turn, teamwork not only helps to outline a flatter structure, but also guarantees a working method aimed at improving meritocracy and the sharing of ideas, in order to achieve a common goal. If we think of the manufacturing environment, it is easy to understand that it is still complex to speak of flat hierarchy, since it is the production environment itself that implies the presence of hierarchy, this justifies the scarce evidence of this variable. Moreover, it is also true that the introduction of technology 4.0 still favours a more decentralized environment, where the organizational structure changes not only in relationships between people, but also by taking advantage of new relationships between workers and machines. At the same time, the smart factory no longer focuses on the traditional production vision where each person has the task of carrying out a certain activity in order to create an assembly line. In the smart factory, repetitive activities are carried out only by machines. Instead, workers are assigned different roles such as monitoring, coordination and resolution of uncommon problems, roles that imply and facilitate mutual collaboration and decentralization of decisions.

To this argument, the second macro-section is clearly connected: the one of organizational culture. A decentralized decision-making process and a flat hierarchy obviously imply a greater level of autonomy and specialization. Organizational culture is a macro section that in many articles is defined a cornerstone for a correct business organization. Obviously, the

organizational structure focuses on an organizational landscape at the macro level, instead the organizational culture focuses more on the micro level. The organizational culture promoted by Industry 4.0 is based on a predisposition of the worker to flexibility, autonomy and specialization, especially in manufacturing context. These characteristics are fundamental to be able to obtain the macro-organizational environment just discussed.

In the 4.0 manufacturing environment, employees are required to carry out activities such as monitoring, control, supervision, coordination, all activities that require problem solving skills, decision-making autonomy and also specific skills in their work. All these characteristics are not trivial, especially for the workforce that has always worked differently, following pre-established orders and taking advantage of the minimum indispensable skills. Obviously, this change involves a great deal of effort on the part of these people who find themselves having to change the way they work suddenly. In our review, the organizational culture involved a large number of documents, in fact all the variables analysed found medium-high values.

Of course, flexibility is the most successful variable. As already mentioned, its very general meaning applies in different ways. In the production environment, flexibility is certainly a substantial requirement, both in the decision making process and as a characteristic that manages to guarantee a high level of adaptability. Since 4.0 technologies are still a little-known topic on a practical level, but with an unexplored potential, flexibility can guarantee a better result when accompanied by specialization and autonomy. On the one hand, specialization is seen as technical requalification to understand the functioning of -often complex understanding- new technologies, on the other hand, specialization is intended with a view to acquiring all that set of soft skills necessary to face a radical technological change. Furthermore, autonomy allows to create a more decentralized organizational environment, where problem solving and decision making activities can also be entrusted to the factory operator himself, since he is able to solve it.

Finally, technological integration is the variable that has found more success than the others. The reason lies in the fact that it consists of an organizational variable closely linked to the technological aspect and it suits especially with manufacturing companies. In manufacturing companies, technological integration offers many advantages, from sharing information throughout the production chain, to links and data sharing between plants, to transparency along the entire supply chain from the board of directors to production operators. For companies that need integration, cyber technologies are still very helpful, although very often, technological

integration is not enough to mitigate integration needs. In this sense, integration must be seen as a mechanism that allows all parts of a system to be involved, not only technology but also the company's human capital. Only through the involvement of human capital there is a true vertical and horizontal integration. In this way, companies are able to acquire a decisive competitive advantage, since it allows full synergy not only within the same company, but also with the various partners, from suppliers to the final consumer.

4.3.2. Comparison between theory and reality

Another result that appeared from the analysis of records is the presence of discrepancy between what is expressed by authors as relevant, and what is implemented within companies. Certainly, this is a big point to emphasize: despite the great variety of studies that demonstrate the importance of organizational adaptation during the implementation process, companies do not seem to perceive this importance. In fact, the organizational adaptations in the elaborated articles are always somewhat scarce. Therefore, it is logical to ask why these disparities exist, especially because 4.0 technologies are provoking a good level of implementation in many European countries, but this implementation does not seem to be supported by an equally significant attention to the organizational theme.

This misalignment has several justifications. First of all, the first reason is a lack of awareness of how an adequate implementation of 4.0 technologies should take place. This leads to investing their capital in the most advanced technologies, but not to support them by an adequate implementation system. The belief in the need to invest only in new technologies is at the basis of the common mindset that lies in the idea of smart factories. Thinking about the smart factory, most people are convinced that the implementation of new technologies is the definitive solution that allows to consider a factory as "*smart*" only for the presence of smart technologies.

Secondly, even modern incentive systems do not help to pursue the right alignment between technological innovation and organizational innovation. An example is the incentive system promoted by Italy, which proposes incentives for the purchase of new technologies, without proposing an incentive mechanism that involves the organizational issue. This system not only brings to companies a clear disparity given by the presence of one-way incentives, but it brings also to an approximate adoption of new technologies. This can often be seen as a mere interest

in the tax incentive rather than in a company innovation system. So, the Italian incentive system has certainly brought benefits in terms of technological incentive but leaves shortcomings from an organizational point of view.

However, the Italian model is not the only one to highlight deficiencies. The PWC 2016 Report, which involves most countries worldwide, highlights how organizational deficiencies are not only a critical point in Italy, but that they are a significant problem elsewhere as well. According to the report, the biggest challenge is not the infrastructure alignment or the achievement of pre-established standards, but rather the awareness of the direction that companies should take from a leadership, culture and organization point of view (Report PWC 2016, p. 17). Additionally, if investments are completely concentrated on the technologies purchasing, it is very difficult for company's staff to be informed about the organizational changes required for the correct introduction of new technologies.

Therefore, companies have to make a further effort towards a valorisation of human capital in relation to the development of an integrated system. In this sense, the main directions on which companies must focus are, on the one side, the enhancement of human capital within the company and, on the other side, the acquisition of new skills and new resources from the outside. Surely, these are the two main conditions that allow a different enhancement of the organizational theme in an Industry 4.0 perspective.

Actually, an organizational change requires more effort than that used for technological implementation. The technological implementation involves a more financial than a working effort, and once the effort is made it runs out. Instead, the effort used for an organizational adaptation is much more substantial, as it involves a financial effort but also a personal effort of workers towards a new conception of work, an effort for training activities and for the achievement of new skills.

In summary, from the comparison between theoretical results and empirical findings, it emerged that organizational adaptation is underestimated, although the broad consensus on its importance by experts. To compensate for these weaknesses, companies should deal with two fundamental aspects: on the one hand, the development of an adequate organizational culture within companies, on the other hand, the acquisition of the right skills that allow them to exploit the full potential of 4.0 technologies.

4.3.3. The importance of building the right organizational culture

From the last paragraph, it is deduced how relevant it is to build an appropriate organizational culture within a company and in line with the company's objectives. As anticipated in chapter 2, organizational culture is configured as being *"set of shared value and norms that controls organizational members' interactions with each others and with suppliers, customers and other people outside the organization"* (Jones, p.9, 2013).

In this review, the organizational theme has already been partially covered, through the analysis of some variables that are able to better explain the organizational theme linked to Industry 4.0. Actually, organizational culture must be seen as a single integrated system of behaviours and norms socially accepted by people, but which is expressed through different methods and aspects.

Many articles do not refer to a specific variable which belongs to the "organizational culture" macrosection, but they referred precisely to the idea of organizational culture, as a single integrated system. In this sense, these articles make explicit the importance of creating this unitary cultural environment, because it is necessary and essential in a climate of change and adaptation that the introduction of new technologies can bring (Agolla 2018, Tortorella et al 2018, Baden et al 2019, Kolberg et al 2019, Sivathanu et al 2018, Telukdarie et al 2018). Indeed, the sense of disorientation that a corporate change can bring is often a source of great unease, which only a united and cohesive corporate environment is able to manage. Precisely for this reason, organizational culture has great importance, because it allows to work in harmony, to avoid communication and understanding problems, to create a strong organizational identity and to foster collective commitment.

All this provides stability of the social system that is difficult to scratch and it is the largest weapon that a company can use in case of significant organizational changes.

Despite this, experts continue to manifest a major shortage of a cohesive organizational culture within companies. This is however justified by the simple fact that the development of a cohesive organizational culture within a company is not a simple result to achieve. Studies regarding organizational culture are certainly not small, obviously each author makes a different distinction on what may be the keys to understanding the culture inherent in an organization.

One of the leading experts in this regard is the American psychologist Edgar Schein, who addresses the issue of organizational structure with a view to transformation. He argues that the

reasons for which a change in organizational culture is necessary can be manifold and that among these there are also technological barriers, as in the case of 4.0 technologies. But an organizational change is often difficult to implement, as a very slow and at the same time delicate process, since it can be interpreted by people in different ways. Consequently, before making a change of this kind, Schein believes it is necessary to analyse the individual business case to understand if an organizational change is necessary in that particular situation or if it is not. All this attention is due to the big consequences that a change of this kind can bring. In fact, it is possible that people reject this kind of change and that the company turns in on itself. In any case, Schein defines three types of processes for changing organizational culture in a company: top-down, side-to-side and bottom-up process. The top-down process consists of a transformation encouraged by the units that reside on the upper levels of the hierarchical scale. The side-to-side process consists of a transformation that takes place due to the change in work processes. Finally, the bottom-up process involves a cultural change that occurs from the units residing at the lowest levels of the hierarchical scale (Schein, 1985).

Precisely for these reasons, a process of cultural change within companies is a difficult and complex process, in fact few companies are able to put it into practice. Surely, the most appropriate tools for this type of change are adequate corporate training and communication, so, the company's HR department gains great importance. Obviously, this process is not only difficult but also expensive, consequently it is easier putting it into practice in large realities rather than in small ones. For this reason, the references to the need for change in organizational culture often refer to those smaller and traditionally based realities, where certain ideas about work are often difficult to eradicate (Kolberg et al 2019). Very often the culture within companies is based on an inflexible, critical and intolerant attitude, where alternative approaches are mocked and considered useless, thus ripping out any expression of creativity (Agolla 2018).

Instead, the organizational culture suitable for the implementation of 4.0 technologies must encourage the creativity of individuals, incentivize and reward it (Agolla 2018). In an environment where experiments are allowed and rewarded, workers are enabled to find innovative solutions to foster the unexpressed potential of new technologies. For this reason, the culture promoted by authors is always associated with the concepts of openness, learning, continuous improvement, and so on (Sivathanu et al 2018, Kolberg et al 2019, Tortorella et al 2018, Agolla 2018). Only thanks to an open attitude it is possible to create an active and proactive environment, aimed at multidirectional development.

4.3.4. Competencies and engagement

Another central theme highlighted in this review is the one of skills. As highlighted by the review, skills and soft skills certainly play a substantial role when there is a need to make an organizational change.

In the review, the specialization variable obtained significant feedback in the analysis, and this is the variable that most closely approximates the topic of skills that we will address in this paragraph. Two main trends were highlighted in the specialization variable: the importance of acquiring specific skills necessary to guarantee a high knowledge of new technologies, but also an urgent request for soft skills that allow to manage the approach to new technologies with the right attitude.

Certainly, an obvious problem concerns the training and retraining of the staff who works in factories, both blue and grey collars. The vocational retraining is a need that we find for the first time in an industrial revolution. As previously stated, unlike the other industrial revolutions, the fourth is characterized by much shorter times which do not allow a normal generational change, but which must necessarily deal with a retraining of existing staff.

This change implies an adjustment in HR department's objectives. The recruiting activity remains important but must be supported by an increasingly consistent and qualitative training activity. Consistent, since it requires a larger training size than before, also given the need for great versatility within the factories. Qualitative, since it requires an effort also towards the kind of training performed. The goal of the HR department should be not to make training a duty for the worker, but an attractive personal growth opportunity that can bring added value not only to the job role, but also from a personal point of view. This means that the purpose of HR is to increase worker engagement, so that new technologies are not perceived as an enemy or a complication in personal work, but as a tool that can facilitate it.

This is a very complex objective to achieve, as it is closely linked to the organizational culture tools which characterizes the company. Generally, there are training strategies that have often proved successful in manufacturing realities. First, a type of training based on gaming, which allows to acquire new skills in a relaxed and stimulating atmosphere, which uses the game as a vehicle for acquiring important notions (Stock et al 2016). Another type of highly encouraged training is that of field experimentation and learning, which allows a more practical and consequently more receptive approach to problems (Bartezzaghi et al 2017). This type of

training obtains good results especially within the production centers, as skills change due to a particular configuration of the production center, or because of strong links of vertical or horizontal integration. For this reason, on-the-job training is crucial to fully understand the skills required. (Bartezzaghi et al 2017).

Another training system that is very suitable for the production sector is that of working groups aimed at continuous improvement. Having the ability to work in a team within the production centers is very important, because it allows operators to develop all that set of soft skills necessary for an organizational change. Teamwork allows to develop communication skills, relationship skills and problem solving, which from a 4.0 perspective are crucial. Usually, teamwork is initially led by a specialist from outside the company, who is able to direct the team towards the right objectives. But then specialized internal workers are trained, so that the team is able to manage itself autonomously (Bartezzaghi et al 2017).

Another kind of practice adopted to attract people proactively to the skills needed in the 4.0 field is an incentive system that allows workers to be rewarded economically in achieving certain objectives.

So, from this speech we can summarize by saying that training is essential for a company, when it wants to introduce a new organizational system coherent with the adoption of cyber physical technologies. However, training has a dual purpose: on the one hand, it must provide adequate skills with a view to staff retraining, but on the other hand, it must be able to create an atmosphere of enthusiasm and engagement towards this change, since an optimistic predisposition is able to make a difference on the final results.

4.3.5. The integrated strategy

Throughout this last chapter of discussion, we have determined that a technological evolution is not sufficient to determine a real advantage for the company. Technological investments are not enough and often are not the solution to make a manufacturing company a real smart factory.

In this review, the goal was to understand how relevant organizational change is when it is decided to introduce new technologies that would allow us to adhere to the 4.0 paradigm, and the response is more than positive. The great majority of collected records established that the

structural, cultural and technological organizational variables play an important role during the implementation process. It is now clear that the organization has a crucial role, but surely also the organizational culture promoted within the company is also essential, and also the technologies that are adopted.

Therefore, it is clear that during the adoption of these new technologies, it is important to take into consideration every facet of the company, since every part of it is relevant. Linked to this concept is the importance of adopting a holistic approach, or a paradigm that considers the company a united, interconnected entity, as body, mind and spirit are for man. The holistic approach allows to consider the company as a single entity but at the same time considers all its facets in such a way that no aspect is overlooked or overshadowed. The company is an organism, which needs a balance of well-being and harmony. So, a change in one aspect of the system, involves an imbalance that must be managed by taking advantage of the other aspects that are part of the system.

Similarly, the management of technological innovation should be managed following a systemic vision of innovation. The term systemic vision refers to the need for a synergic operation between the various aspects of an organization, so none of these are left out and the balance within the company is maintained.

For this reason, what is needed is a strategic project that is tailor-made for the company. In this case, the one best way solutions do not ensure any success, on the contrary, they are very often risky and difficult to adapt. What is needed is an *ad hoc* project, because through this it is possible to take into account many characteristics of a company that establish its peculiarities, such as the social system, the technologies adopted, the pre-existing organizational system, the environment in the company operates, and much more.

Bartezzaghi, during the *Lectio Magistralis* held on 11 February 2020, defines 2 approaches to design the implementation of new technologies: sequential approach and integrated approach. The sequential approach consists of a strategy where only the technological aspect is considered, and subsequently the other aspects are adapted and modified according to the needs demonstrated by the company. According to this approach, the other aspects, including the organizational one, are secondary, in fact they are taken into consideration only after the technological one. So, the social aspect, the environment, the human aspect, are considered only in a second moment. This approach may be simpler to plan at first, but later it may be very risky for a company. By not immediately considering the social, environmental or human

consequences, the company is subjected to various risks of collapse, lack of participation, demotivation and so on. These risks can also lead to serious problems that cannot be solved easily.

Instead, the integrated approach takes into consideration various aspects in addition to the technological one, in order to build a strategy that involves various facets simultaneously. This approach allows to ensure greater balance than sequential, since an integrated strategy puts on the same level various relevant business dynamics, which otherwise would not be taken into consideration. Furthermore, the integrated approach allows to consider in a single project different objectives, which are inherent in different business areas. For this reason, Bartezzaghi highlights how the integrated approach is the most useful to be used in the case of the implementation of 4.0 technology, since it allows simultaneous, interactive and iterative intervention in multiple business areas.

Concluding this discussion, we can affirm that the organizational aspect is a crucial aspect that must be taken into consideration when a technological change takes place, but it is not the only one. An integrated approach is certainly essential because it allows to create a strategy that involves every aspect of the company. It is important to remember that the central idea behind the new technologies is a requalification of human work within the smart factory, allowing a re-evaluation of the role of human work. Consequently, new technologies must be directed towards the support and enhancement of human capital, and not vice versa.

An integrated strategy that guarantees a holistic approach to the company, seems to be the only alternative for a coherent, smart and collective- well- being- oriented technological integration.

Conclusions

Now is the moment to draw some conclusions. The results of the present thesis show that the organizational environment certainly has a substantial impact when new technologies are introduced. Review's results show that the organizational environment certainly has a substantial weight when new technologies are introduced. The work carried out in this document allowed the analysis of many variables related to the organizational theme through a systematic literature review. This system consists of the collection of a multitude of documents and their analysis by selecting some organizational variables previously chosen. The systematic literature review was adopted as the most appropriate method for this kind of analysis, as it allows to synthesize the information contained in a large number of documents, articles and reports, that were available in our case.

To simplify the discussion, the variables are divided into three main sections: organizational structure, organizational culture and technological integration. This distinction allowed to highlight, during the discussion, the differences between the results of a particular organizational aspect compared to another. The method used to carry out the systematic literature review is named PRISMA and it was adopted because its structure is well suited to the present paper. In fact, the 27 points of the PRISMA method's checklist were strictly fulfilled during the research design and in the discussion part, to get a complete review process.

As regards the results obtained from this review, all the analysed variables got a response greater than 50% of the selected articles, except for hierarchy and centralization variables which score respectively 24% and 48% of evidence. In any case, the results demonstrate a high congruence. In fact, in all of them there is a clear preponderance of results that are around "high" or "low" values. For any variable, there are no fluctuations or ambiguities in the determination of the results. This means that most of the authors agree on the importance of a given variable in relation to the introduction of new technologies in smart factories. Consequently, even for the macro sections the provided results are rather clear.

Starting from the organizational structure, this macro-section got less evidence with respect to the others (45.3%). However, the outlined situation is clear, even if the evidence is still lower than the other macro-sections.

The variables included in this macro-section are hierarchy, centralization and collaboration / teamwork. The hierarchy is the only variable in our analysis that obtained a rather low response,

only 24% of the articles involved in the analysis deal with this variable. In any case, the documents that treat it, seem to agree on the need for a flat hierarchy. Instead, the centralization variable obtained an 48% response, therefore considerably greater. Here too, most articles agree that the level of centralization in a company that aims to introduce 4.0 technologies should be low. As regards the collaboration, even here the evidence obtained is satisfactory, in fact it is around 64% and the authors agree on the outcome of the variable, in fact in a 4.0 perspective it is important that collaboration and teamwork are high. So, in manufacturing companies that want to implement 4.0 technologies, structural organizational change must be implemented by favouring a flat hierarchy structure, decentralization of decision-making activities and work aimed at collaboration and team building. This kind of approach allows to reach an organizational agility that is now essential within smart factories. In fact, decentralization allows a faster and more efficient decision-making process stimulated by teamwork. In turn, flat hierarchy favours an equally collaborative climate by allowing to escape from the vertical structure's perspective where workers must undergo simple executive tasks ordered by the superior. So, the role of worker is no longer a simple executive activity, but it is characterized by greater awareness and autonomy.

Another result obtained by this review is the evidence manifested by the variables belonging to the macro-section named organizational culture. This macro-section received great feedback within the selected articles, in fact 61.6% of the articles deal with organizational culture's variables. Summarizing what is highlighted by this work, it can be deduced that the introduction of 4.0 technologies leads workers towards greater decision-making autonomy, a higher level of specialization and a greater flexibility in their work. The autonomy variable got a good response, in fact 54% of the documents treat autonomy, and 37% of these show the need for a high level of this variable for the introduction of 4.0 technologies. Decision-making autonomy is an obvious consequence of the decentralized structure and it favours the company's agility. Moreover, a greater degree of decision-making autonomy can be guaranteed to employees only through the acquisition of the appropriate skills. These skills not only concern a technological specialization, but they involve the behavioural sphere or the acquisition of soft skills. Specialization also obtains good results, in fact 48% of the documents declare the need for a high level of specialization, instead only 5% are convinced of the contrary. In particular, soft skills are considered increasingly important and requested, especially during the recruiting process for the acquisition of new talents. The review demonstrates how the most requested characteristics are creativity, proactivity, collaboration, and flexibility. The latter variable is the

one that gains most feedback in the review, in fact, 71% of the selected documents address this topic and 58% believe that it should be high. In fact, flexibility allows workers to manage their work and goals more efficiently. In a continuously changing environment, working without flexibility and adaptability is very complex and often counterproductive. For this reason, the presence of this requirement in workers is increasingly crucial and required.

Finally, the last macro-section analysed is technological integration. This is the macro-section that has obtained the most feedback within our review, in fact 68.5% of the selected documents treat this variable. However, high evidence was expected, because of the great connection between the themes of technological integration and smart factories. As defined by the Calenda Industry 4.0 Plan, technological integration is one of the pillars on which Industry 4.0 is based. In fact, the role of many 4.0 technologies is precisely to connect various work units, in order to speed up many processes and eliminate many information delays. The analysed variables, horizontal and vertical integration, provided almost identical results, 68% of evidence for the former and 69% of evidence for the latter. The great majority of the highlighted results affirm that horizontal and vertical integration are two substantial organizational characteristics for the introduction of 4.0 technologies. In addition, these two variables are very related, in fact most of the articles that argue one variable also deal with the other. In particular, manufacturing companies acquire many advantages from vertical and horizontal integration. Vertical integration allows to share a lot of information throughout the production chain, from production units to the top of the power, so that maximum transparency and sharing is guaranteed. Instead, horizontal integration is very useful because it allows to quickly disseminate information horizontally throughout the supply chain. Consequently, also from this point of view, the dissemination of information and transparency are guaranteed and become important determinants for the competitive advantage definition.

As for other results obtained from this thesis, it is necessary to point out the presence of doubtful and deficient results on the effective application of these organizational characteristics in the concrete plan. In fact, all the analysed organizational variables provided limited information on the actual implementation of the necessary changes. Rather, some articles showed a certain shortage of these applications within companies.

However, there are various considerations that can justify this misalignment. On the one hand, there is a lack of awareness of the right methods to be adopted to simplify the technological implementation. The majority tends to invest all the capital in technologies, without supporting

them with the right reorganization. On the other hand, modern incentive systems often lead companies to find benefit only in technological investment rather than in an integrated strategy that involves all the business aspects. However, these consist of simple hypotheses to respond to these deficiencies, but the results found in this paper are not sufficient to develop a real response in this regard.

A clear result of this review is the importance of developing an adequate organizational culture. Many documents address this issue not by referring to individual variables, but rather by analysing the concept considering it as a single system. For this reason, this concept also requires further study in the discussion phase.

Many articles highlight how culture within the company is a key element to facilitate the implementation process. However, at the same time, it is a characteristic of difficult mutation, since it is extremely intricate with the social texture and personality of individuals. In any case, the most suitable method to give the right boost to a change of this kind seems to be the one that involves the adequate staff training and retraining activities. Human resources departments are in charge of all the staff retraining activities, that should be organized maintaining a high engagement that manages to create interest and a proactive environment.

Finally, the coherence between the various facets that constitute the company appears very important from a 4.0 perspective, since only through collective progress it is possible to create a unified working ecosystem. Consequently, the best approach is the integrated one, which aims to create a strategy that involves all business aspects in such a way that there are no inconsistencies or problems during implementation. Certainly, this kind of approach is in line with a holistic concept of the company, as an integrated ecosystem composed of many different facets that convey into a single corporate entity. In this way, the company is able to grow, change, adapt effectively to all circumstances, reaching that agility that modern production centres can no longer give up.

In any case, the revision still has limitations related to some factors.

First, systematic reviews have a certain risk of error given by the subjectivity of the reader who can interpret the results provided by the documentation in a different way. In particular, in this review this risk is also accentuated by the presence of a single reader, while in case of a multi-readers review the risk given by subjectivity would be more mitigated.

Furthermore, another subjective trait is given by the choice of the variables that characterize each section. In this sense, the choice of different variables could have provided slightly different results in the macro sections compared to those found in this review. Furthermore, some articles refer to macro sections rather than to individual variables, and obviously this information are excluded from the data collected by the revision. However, efforts were made to take them into consideration during the discussion phase.

In any case, the ideas provided by this review leave ample room for future research. First of all, the issue inherent in the effective application of the organizational considerations proposed by the authors in companies would deserve further attention. Furthermore, this study underlined the importance of organizational culture for companies that aim to implement new technologies, but further specifications regarding the kind of training activities necessary to allow this kind of change would be needed. Even if this study certainly provided attention to this aspect, it could not specify it in detail.

This review focuses on the technological implementation as a whole, leaving out the nuances that concern the type of cyber technology used. Certainly, this could provide further considerations on organizational analysis, perhaps with more specific details than the technology used. This could be a great advantage for companies, as it would allow them to be directed towards a technology that is more favourable to their needs and organizational characteristics. Furthermore, it would be interesting to analyse possible findings and compatibility between the manufacturing environment taken into consideration in this thesis, and that inherent to the services, in order to observe if there are points of divergence in the organizational aspect.

Appendix

Appendix A – References of documents selected in the Systematic Literature Review

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