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"Resilience: can digitalization help companies overcoming crisis?"

RELATORE:

CH.MO PROF. CAMPAGNOLO DIEGO

LAUREANDO/A: FIORATI ANGELA

MATRICOLA N. 1207025

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A mia madre e mia sorella

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Firma dello studente

Angela Finotti

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INTRODUCTION

The diffusion of COVID-19 has significantly changed our lifestyle by forcing us to stay at home and live with social distancing. The economic repercussions that will follow this emergency are still uncertain but it is easy to deduce that they will have profound effects on the entire global economy. Companies all over in the world, have had to face this crisis situation, which has put their survival in serious difficulty. In general, to overcome a difficult moment the only solution is to be resilient; resilience, indeed, represents the fundamental resource for anyone who wants to overcome physical, economic and emotional difficulties without problems.

The current state of crisis, however, has also highlighted the central role that technology has in overcoming this difficult moment, generating an acceleration of the digitization process within organizations, indeed, due to COVID-19, companies were forced to move to a digital way of working, adapting to new agile and digital operating models to survive and, unfortunately, not all companies were ready for this. Indeed, companies which had already developed investments in technologies, did not have problem to overcome these difficulties, unlike other companies which, due to their lower degree of digitization, have faced many problems (Garcia, 2020). For example, Siemens company, thanks to the technologies developed and the Smart-working programs launched over the years, have not experienced any problems or difficulties in continuing their work during the pandemic (Gabanelli & Querzè, 2020). Same thing for Gasparini Spa, which recorded positive results even during the emergency, indeed the CEO of the Company declared that thanks to the technological tools already available to them, they encountered no problems in implementing Smart-working for administrative and technical staff and there was no negative effect on production during the period (Pendolini, 2020). Gruppo Dallara, in collaboration with the Parma hospital, through the use of a 3D printer, have created a valve that allows you to transform the Decathlon snorkelling mask into a non-invasive respirator, useful to help COVID-19 patients who do not require intubation, highlighting the central role that technologies also have in the health sector. (Ciriaco, 2020). Amazon, the e-commerce giant, has seen an exponential increase in sales with revenues of \$ 75.5 billion in the first quarter of 2020, resulting in the brand that has earned the most during the lockdown

(Mincuzzi, 2020), Bosch thanks to its investments in the Internet of Things (IoT) has been able to continue to focus on intelligent production to ensure flexibility and reliability for manufacturing companies, indeed Rolf Najork, member of the Board of Bosh and responsible for the Industrial Technology sector, established that: *“Especially in exceptional times such as those we are experiencing with the current crisis, connectivity makes companies less vulnerable and helps them maintain a balance”* (Bruno, 2020).

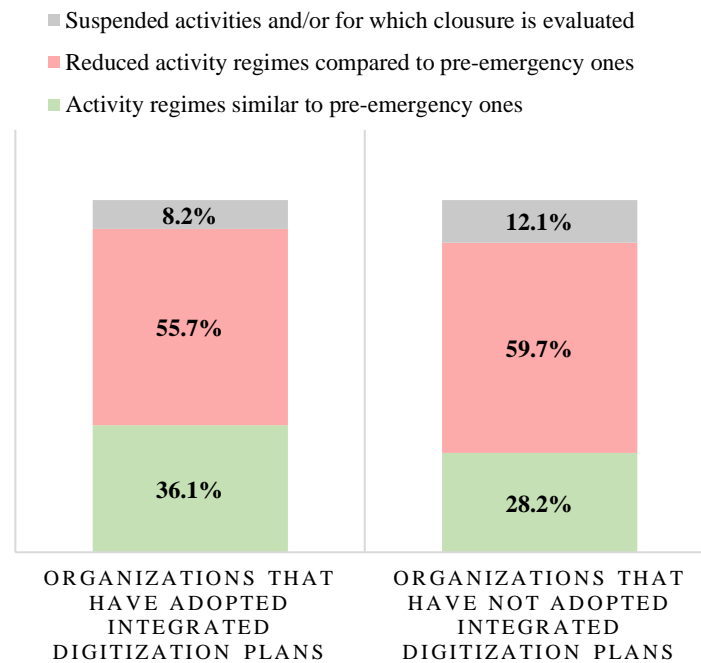
These are just some of the examples of companies that, thanks to digital investments, have managed to cope with the current crisis situation. The central role played by technologies has been widely discussed, indeed, according to Margrethe Vestager, the executive Vice-President of the European Commission, *“The Covid-19 crisis has demonstrated how vital it is for citizens and businesses to be connected and able to interact with each other online. We will continue to work with Member States to identify the areas that need more investments so that all Europeans can benefit from digital services and innovations”* (European Commission, 2020). The same thing was widely discussed by Paola Pisano, Minister for Technological Innovation and Digitization, who at the Fifth Edition of the Open Innovation Summit said *“The crisis has highlighted the need for digital systems and solutions in the cloud, for automation, cyber security of the country and the use of new technologies such as robotics and artificial intelligence [...] The crisis leads us to a clear choice: we retreat or advance. We are all called to implement new models based on innovation and digitization of businesses and public administration”* (Elerdini, 2020).

Digital transformation has therefore become more crucial than ever; in a recent survey proposed by the Boston Consulting Group (BCG), 75% of the executive agreed that they regard digital transformation as becoming more urgent in light of the COVID-19 crisis and 65% said that they anticipate increasing their investments in digital transformation. As almost every organization’s depending on digital technologies grows, we can say that adopting and managing digital technologies will be critical to business resilience (Boston Consulting Group, 2020).

According to the study of Unioncamere *“Impatti dell’emergenza COVID-19 sulle imprese e prospettive di ripresa rilevati attraverso il Sistema informativo Excelsior”* published in July 2020, the digital maturity of companies it is proving to be an important resilience factor in dealing the shock of the crisis. According to this study carried out between May and June 2020, from the 1.380 thousand companies analysed, almost 450 thousand were located in positions not too far from the previous operating conditions, while most of the companies, over 800 thousand, declared that they operate in reduced regimes compared to the pre-COVID-19 situation and just over 133 thousand companies were still suspended or were considering not to resume their activity. Based on a more in-depth study of the companies involved in the research,

it emerged that the stable presence in an international market and the degree of digitization within organizations contribute to the survival of a company in a crisis situation and cooperate for the creation of organizational resilience (Unioncamere, 2020). As we can see from the graph below (Figure 1), comparing the companies that have adopted digitization plans with those that have not yet adopted them, we note that: the first group was already operational in 36.2% of cases at pre-crisis levels compared to 28, 2% of the second group, while the suspension and assessment of closure of the activity concerns 8,2% of the digitized against 12,1% of the non-digitized.

FIGURE 1 SITUATION OF ORGANIZATION COVID-19 EMERGENCY



Source: Unioncamere, 2020

As we can see from these data, there is an advantage for companies that had developed digitization projects within their organization, indeed, companies that have made investment in the most used technologies such as Big Data and Analytics, Internet of Things (IoT), Augmented Reality and Additive Manufacturing are able to react to this situation of crisis also because these investments in digital technologies permit to react to the crisis situation in a flexible way guaranteeing the adaptability to the situation (Unioncamere, 2020)

On the basis of the above examples and on the data presents, the aim of this thesis is to identify whether within an organization, during a crisis situation, there could be a positive relationship

between resilience and technology by analysing which technologies can be most useful to apply and understand in which organizational processes this correlation is present and more advantageous. Trying to understand this, it will be treated and analysed some business case, that allow us to better understand if this positive relationship exists.

The thesis will be divided into three chapters, in particular, the first chapter will deal with the concept of organizational resilience trying to understand what it is, why it is so important for an organization, how it can be built and if there are some ways that allow it to be measured or otherwise to distinguish a resilient organization from a non-resilient. In the second chapter, however, we will explain the technologies used in organizations and the corporate digitalization processes. There will be an analysis of data relatively to the digitization and we will try to understand if there is a theoretical relationship with resilience. Finally, in the third chapter, we will analyse real cases of digitized Italian manufacturing companies. The goal is to investigate how these digitized companies have responded to the current crisis situation and if the adoption of Industry 4.0 technologies has allowed them to overcome the crisis situation, leading us to understand if there is a positive relationship between resilience and digital.

CHAPTER 1: FROM A CRISIS SITUATION TO ORGANIZATIONAL RESILIENCE

1.1 INTRODUCTION

The crisis that we are experiencing today generated by the COVID-19 health emergency, is just the latest of the great challenges that organizations have found themselves facing. Indeed, when a crisis occurs, organizations must be able to cope with situations that can threaten their performance and functioning (Boin, 2009). Many scholars have begun to explain both the nature and impact of the crisis and how organizations effectively prepare, respond to, and overcome their various forms and levels to preserve performance, recover or prevent decline and even failure (Meyer, 1982).

More recently, especially after 9/11, there has been an increase in the degree and range of challenges that threaten organizations; and in response to these trends a lot of organizational research has been done in order to better explain what we know about the crisis, including how to develop organizational resilience not only to respond to adversity but also to mitigate them before they arise (Williams & Shepherd, 2016). Resilience is a concept closely related to the occurrence of a crisis situation, in fact there can be no resilience without a crisis or adversity situation. In this case, we can find the figure of the resilient actors who can be individuals, organizations and / or communities, who are those who allow us to avoid the crisis.

In this chapter we will address the various steps that lead to the identification of the crisis and then move on to the definition of organizational resilience and the development of a resilient organization, highlighting the factors that distinguish a resilient company from one that is not.

1.2 ORGANIZATIONAL CRISIS

The concept of crisis is not a unique concept especially because the research on crisis are highly fragmented since there is a lack of agreement on the definition of the term crisis.

From the organizational perspective, crisis can be considered such as a situation perceived by managers and stakeholders as highly salient, unexpected and potentially disruptive, that can threaten the aims of an organization and have profound implications for its relationships with stakeholders (Bundy et al., 2016). There are four principles characteristics which could be useful to recognize a crisis: first, crises are source of uncertainty, disruption and change (James et al., 2011); second, crises are threatening for organization and their stakeholders (James et al., 2011); third, crises are consider behavioural phenomena, indeed the literature has recognized that crisis are socially constructed by the actors involved rather than a function of depersonalized factors of an objective environment (Lampel et al., 2009) and four, crises are parts of a larger processes, rather than a discrete events (Pearson & Claire, 1998).

Related to this last point, it is important to take up again the distinction reported by Williams et al. (2017), according to which, the crisis can be conceptualized in two different approach: crisis as an event and crisis as a process.

Crisis as an event focuses on the notions of incidents or accidents as the unit of analysis, since accidents or incidents constitute contingent and/or peculiar events with respect to routine, regularity and experience. Generally, they could be information, disturbance, problems or tension that interrupts the balance of the organization (Forgues, Roux-Dufort, 1998).

The definition of crisis as an event is based on the work of Hermann which identify three core components of an organizational crisis: first, it threatens high-priority values of the organization; second, it presents a restricted amount of time in which a response can be made and, finally, it is unexpected or unanticipated by the organizations (Hermann, 1963). At these components, James et al., (2011) add three additional components: rarity of the event; significance of the event and level of the impact on stakeholder. These three additional characteristics are essential for interpreting the crisis as an event.

When we consider crisis as an event, the definitions focus in the triggering properties of the event (Shrivastava, 1987). Triggering events can be considered as a kind of active constituent that tests the organization and pushes it to its extreme limits. Through the event approach, the focus is mainly on the nature and the consequences of a crisis, in this way, crisis is explored through the lens of the triggering event (Forgues, Roux-Dufort, 1998).

Crises are negative events and in the event view of crisis management, crises are usually defined as damaging and harmful disruptions or perturbations that threaten the survival of the organization (Reilly, 1993).

With this approach, however, there is the risk of having only partial view of the crisis situation as it focuses only on the nature of the event and the consequences that this event has in the post-crisis situation. A different and more completely view is presented by the crisis as considered as a process.

Crisis as a process is an approach that brings a complementary perspective. Differently from the event approach, which is focuses on the nature and the consequences of crisis, the process approach includes more definitions referring to the causes and the dynamics of the crisis. Shrivastava (1995) established that crisis are not events but processed and suggests that crisis must be consider in an extended span of time and space. The principles of the process perspective mostly lie on the idea that crises manifest in phases. Different stages are traditionally distinguished: warming signals, triggering event (which represent the acute phase), amplification and resolution (Shrivastava, 1995). This approach established the existence of a genealogy of crises that may be potentially tracked long before the acute phase. The process prospective thus acknowledges that crises are the ultimate moment of a continuous cumulative process of organizational failures (Bowonder and Linston, 1987).

As asserted by Deschamps et al. (1995) systematic management is needed to study crisis because they reveal hidden systematic patterns by including different fields that go beyond the boundaries of organizations. Systematic analysis of crisis usually highlights the dynamics of a crisis, focus on the need to understand crisis-fostering environments, process of organizational weakening, crisis evolution and how organizations respond to stages of crisis (Deschamps et al., 1995).

Treating crises as a process with a systemic management rather than an event, generated an influence on the analysis of the consequences. In the event view consequences are mostly treated according to their negative outcomes and threats; instead, in the process approach, crises are also accompanied by great uncertainty of consequences and a dose of chaos, but rather than considering these outcomes as purely negative, the process view tends also to uncover the positive aspect of crises (Shrivastava, 1995). Indeed, the systemic study of crises seems particularly relevant to show that crises have revealing properties and to uncover hidden factors that the organization wouldn't have been aware of if the crises had not occurred. In this perspective, it is shown that crises bring about changes and transformations at different levels of the organization and across different areas. (Pauchant and Mitroff, 1992).

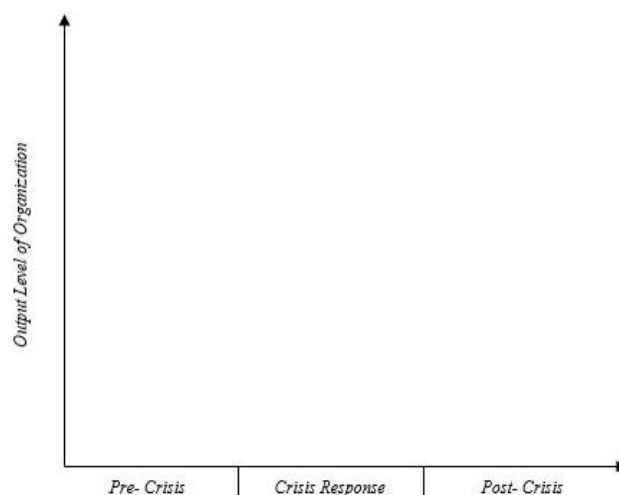
We could say that the crisis situation we are experiencing follows that said by Pauchant and Mitroff (1992). Indeed, the current crisis situation has caused enormous damage to the global economy and has led to changes within organizations; indeed, organizations found themselves in an unprecedented situation, in which they found themselves forced to reorganize their processes and space, to modify sales channels, to cancel investment plans and to adopt new business models (Accenture, 2020). But at the same time, these emergency situations had made it possible to discover the central role that technology has in organization, underlining the need for organizations to invest in digital, accelerating the digital transaction, since, as we will see in the following paragraphs and chapters, technology represents the necessary tool to guarantee business continuity.

For these reasons, we can say that the type of crisis we are experiencing can be considered as a crisis as a process.

1.2.1 Crisis Management Phases

As we have said before, as a process, crisis management is not just one thing. Crisis management can be divided into three different temporal phases: pre-crisis, crisis response and post-crisis. The pre-crisis phase is concerned with prevention and preparation of a crisis situation; the crisis response phase is when management must actually respond to a crisis also thanks to a Recovery Plan, and the post-crisis phase looks for ways to better prepare for the next crisis and fulfils commitments made during the crisis phase (see Figure 2).

FIGURE 2 PHASES OF CRISIS



Source: Author's elaboration

Pre-crisis Phase: as mentioned above, the pre-crisis phase is concerned with the prevention and the preparation for a crisis situation. This phase is influenced by the Plan to Resist Approach (Figure 3), which is useful in preparing to resist at events that occur with a certain degree of regularity and those adverse effects that could be estimated. Prevention involves seeking to reduce known risks that could lead to a crisis, instead, preparation involves creating the crisis management plan, selecting and training the crisis management team and conducting exercise to test the crisis management plan and crisis management team. A crisis management plan (CMP) is a document that describes the processes that an organization should use to respond to a critical situation that could adversely affect its profitability, reputation or ability to operate. Crisis Management Team is created to protect against the adverse effects of crisis. It is formed to respond immediately to warning signals of crisis and execute the crisis management plan to overcome emergency situation.

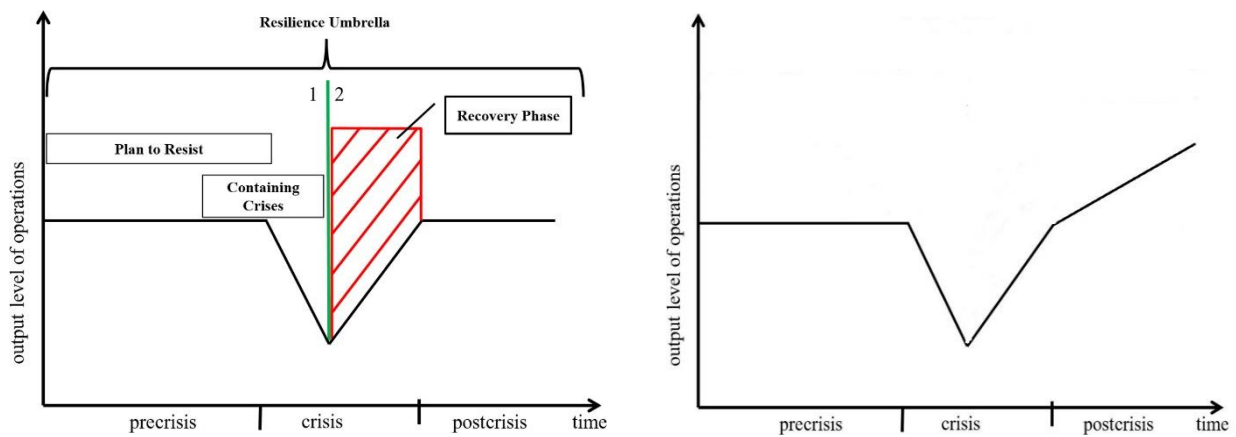
Barton (2001) and Coombs (2006) established that organizations are better able to handle crisis when have a crisis management plan that is updated at least annually and have a designated crisis management team. The planning and preparation allow crisis teams to react faster and to make more effective decisions.

Crisis Response Phase: in the response phase there are the actions taken during a crisis to meet the emergency needs that arise. Through the implementation of the Containing Crisis Approach (Figure 3), organization try to avoid unexpected situation in the moment that they occur despite preemptive measure established in the previous phase. In this stage the priorities are to maintain safety the public and the organization through the implementation of recovery activities implemented through the help of the Recovery Plan (see Figure 3). An important role in this stage is played by the communication, and the crisis management communication is available to everyone, from stakeholders to employees and clients. According to Coombs (2006), the aim is to contain the crisis and to make it there are three points to focus on: being quick, accurate and consistent. In particular, quickness and accuracy are two fundamental characteristics of this phase. Being quick, means provide a rapid response to a crisis situation. Through an adequate crisis preparation, it will be easier for the crisis managers to respond quickly and solve crisis situation. In addition, the information that are shared need to be accurate about what happen and how that event might affect them. Because of the time pressure in a crisis, there is the risk on inaccurate information and these inaccuracies make an organization inconsistent. Leaders and employees work together to send a clear and consistent message to ensure that the key audience is kept informed and survived. The principles characteristics of

this communication are: honesty, transparency and openness. Employees should be informed at every action that will be taken to ensure business continuity.

Post-Crisis Phase: the last phase consists in bringing the organization back to a pre-crisis situation or to better performances (Koronis et al., 2012). In this way we can distinguished two perspectives: Bounce Back and Bounce Forward (see Figure 3).

FIGURE 3 BOUNCE BACK VS BOUNCE FORWARD



Source: Darkow P. M., 2018

Bounce Back perspective, represents the capacity of an organization to go back to the pre-crisis situation; therefore, through this perspective there is a rebound that brings the organization back to the performance levels recorded before the advent of the crisis situation. Through this perspective, however, the organization can ignore the opportunities to innovate and take advantage, indeed, overcoming crisis situation could be consider such an opportunity to break into a new, even more advantageous trajectory and this is what the Bounce Forward tries to explain.

Bounce Forward perspective, indeed, represents a dynamic and in a certain sense strategic dimension, which consists in a rebound toward superior performance. As we can see from the graph above on the right (Figure 3), the performance after the crisis is superior. In this way, the crisis becomes a learning moment for the organization and can draft its abilities to get out of the crisis and, moreover, this prospective require a high level of adaptation to the crisis situation, as the organization will have to know how to adapt.

The situation that we are experiencing today, requires a Bounce Forward perspective, so it require a rebound forward compared to the pre-crisis situation (McKinsey, 2020). This is because, the Bounce Back perspective, at the level of previous performances, adapts to situations in which the crisis is predictable and, therefore, could have been foreseen; or to situations in which the post-crisis situation remains unchanged.

The current situation, on the other hand, is a situation of structural change in which the critical success factors that are useful for exiting from this crisis situation are different in many sectors compared to the critical success factors prior to the crisis (McKinsey, 2020).

Up to this point., we have spoken of crisis as an event and as a process and of the general phases that distinguished a crisis situation; but now we will focus on overcoming these crisis situations by organizations. The organizations that manage to overcome these crisis situations are called resilient organizations. For this reason, it can be seen that there is a strong relationship between resilience and crisis. But, what does it mean to be a resilient organization and how can this resilience be built? In order to be able to answer to these questions, it is first necessary to have a complete view of the definition of resilience and its fields of application.

1.3 WHAT IS ORGANIZATIONAL RESILIENCE?

As reported in the previous paragraph, organizations are subject to crisis situations and to survive in uncertain environments and to foster future success, organizations must be able to handle all of these manifestations of the unexpected. Firms need to develop a resilience capacity which enables them to adequately react to unexpected events and to capitalize on events that could potentially threaten an organisation's survival (Lengnick-Hall, 2011).

Resilience is a concept that, in psychology, indicates the ability to cope with traumatic events in a positive way, to positively reorganize one's life in the face of difficulties, to rebuild oneself while remaining sensitive to the positive opportunities that life offers, without alienating one's identity. Resilient people are those who, immersed in adverse circumstances, manage, despite everything and sometimes against all odds, to effectively face contrarities, to give new impetus to their existence and even to reach important goals.

Applied to an entire community or society, rather than to a single individual, the concept of resilience is affirming itself in the analysis of social contexts following serious natural disasters or due to human activities such as, for example, terrorist attacks, revolutions or wars (Vale & Campanella, 2004). From the original psychological meaning the concept has also spread to the

economic one. Therefore, an organization (enterprise, company and/or similar) is resilient when it is able to face risks, seizing opportunities even in negative situations. In practice, it knows how to evolve out of a crisis situation as it is capable of managing change.

Before focusing on organizational resilience, it is necessary to take a brief excursus on the fields of application of resilience.

The term “resilience” comes from the Latin word “RESILIRE” which means to leap or jump back. The first used of the resilience was in the field of ecology. Holling (1973) considered that resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes variables, driving variables, and parameters, and still persist. After that, resilience has been developed in many areas such as engineering with Hollnagel, who establish that a system is resilient if it can adjust its functioning prior to, during, or following events (changes, disturbances, and opportunities), and thereby sustain required operations under both expected and unexpected conditions (Hollnagel et al., 2006); and organization management (Weick, 1993).

While the resilience concept has a long tradition in some disciplines, especially in psychology how we have seen before, it is relatively new in business and management research. Organizational resilience comprises numerous and divergent themes, according to Sutcliffe and Vogues (2003), organizational resilience often has been used to refer to the ability of an organizations to absorb strain and preserve functioning despite the presence of adversity or to the ability of an organization to recover or bounce back from untoward events. Literature study proves the existence of two discrete approaches on organizational resilience. Some studies see organizational resilience as simply an ability to rebound from unexpected, stressful, adverse situations and to pick up where they left off, while others see organizational resilience as the safety cushion between structure and chaos.

In particular we can distinguish three main perspective on organizational resilience: the first group of scholars consider the organizational resilience as the ability of an organization to resist to adverse situations and/or the ability to recover and return to a normal state, in that case we found the definitions of Home and Orr (1998) and Robert (2010). For example, Robert defines organizational resilience as a “firm’s capacity to maintain or restore an acceptable level of functioning despite perturbations or failures” (Robert 2010).

A second group of scholars look beyond the maintenance and restoration of organizational functionality and focuses on the adaptation of organizational process and capabilities; in the follow we can found the definitions of Robb (2000) and Lengnick-Hall (2011). These researchers indicate the need to make adjustments to any changes to come out of the crisis stronger than before. In particular, Lengnick-Hall define organizational resilience as “a firm’s

ability to effectively absorb, develop situation-specific responses to, and ultimately engage in transformative activities to capitalize on disruptive surprises that potentially threaten organization survival” (Lengnick-Hall et al., 2011). Finally, the third and last group of authors argue that the concept of resilience is related to the anticipation, indeed, Somers argued that: “resilience is more than mere survival; it involves identifying potential risks and taking proactive steps to ensure that an organization thrives in the face of adversity” (Somers 2009). In particular, we will see how the latter definition proposed by Somers fits our analysis. In the table below, are summarized some of the main definitions of organizational resilience explained before. The definitions proposed by these authors represent the main definitions reports in the academic articles and in the main books that take up the themes of resilience, moreover, these definitions will allow us to better contextualize the concept of organizational resilience and its applications.

TABLE 1 DEFINITIONS ORGANIZATIONAL RESILIENCE

Definition Organizational Resilience	
Home & Orr 1998	Resilience is a fundamental quality of individuals, groups, organisations, and systems as a whole to respond productively to significant change that disrupts the expected pattern of events without engaging in an extended period of regressive behaviour
Mallak 1998	Resilience is the ability of an individual or organisation to expeditiously design and implement positive adaptive behaviours matched to the immediate situation, while enduring minimal stress
Sutcliffe & Vogus 2003	Organizational Resilience is the maintenance of positive adjustment under challenging conditions such that the organization emerges from those conditions strengthened and more resourceful
Hamel & Valikangas 2003	Organizational Resilience refers to a capacity for continuous reconstruction. It requires innovation with respect to those organizational values, processes, and behaviours that systematically favour perpetuation over innovation
Somers 2009	Organizational Resilience is more than mere survival; it involves identifying potential risks and taking proactive steps to ensure that an organization thrives in the face of adversity
Robert 2010	The firm’s capacity to maintain or restore an acceptable level of functioning despite perturbations or failures
Lengnick-Hall et al. 2011	The firm’s ability to effectively absorb, develop situation-specific responses to, and ultimately engage in transformative activities to capitalize on disruptive surprises that potentially threaten organization survival

Source: Author’s elaboration

Some of these authors mentioned above, have tried to shape models to understand, from a theoretical point of view, how an organization can become resilient. Through the explications of these models we can analyse more in detail how resilience can be considered under different perspective. The models shown below are: Mallak, which is one of the first author that analyse the concept of organizational resilience, Lengnick-Hall and Beck, which established the relationship between Human Resource Management and resilience and Sutcliffe & Weick, with the explication of the High Reliability Organizations.

Mallak (1998)

The model presented by Mallak (1998) was one of first model that was used for tried to understand how implement resilience in organizations. The author believed that there were seven principles to be followed in order to generate a greater resilience within an organization (Mallak, 1998). These principles are:

- Perceiving experiences in a constructive way: even in the face of negative events you need to be able to take the positive aspects and move forward
- Engage in positive adaptive behaviours: when we talk about resilience, we refer to unscheduled responses, these responses must be provided to unexpected events. Consequently, when these situations occur, the organization must be able to perceive changes as opportunities, rather than limits
- Obtain adequate external resources: businesses that have access to adequate external resources have a greater ability to adapt positively following various possible events
- Broadening decision-making boundaries: delegating greater decision-making power to employees. Obviously, employees cannot make decisions of strategic importance, but if they were given greater decision-making power, they could solve problems within their competence by reducing overall response times
- Have the ability to use separate elements to find a solution
- Develop the ability to make decisions even when you have less information than you would like to have
- Building a virtual role system: the resilience capacity of an organization is greater when the members within it know how to understand and perform the activities carries out by others and, if necessary, could replace them

According to Mallak's model, by following these principles it is possible to build a more resilient organization and, moreover, it provides a series of behaviours that managers should adopt such as:

- Providing feedback, public recognition, adequate rewards for employees in order to encourage them to take a positive attitude towards the organization
- Broaden decision-making boundaries: to follow this principle, it is necessary to ensure that individuals within the organization have sufficient information to be able to make good decisions and that they can have access to the necessary resources to be able to put the decisions made into practice
- Provide adequate training employees

Lengnick-Hall and Beck (2005)

The Lengnick-Hall and Beck Model is completely different from the model presented before. This model established the existence of a correlation between the management of human resources and the generation of organizational resilience. Indeed, they have demonstrated that the ability of a company to develop organizational resilience can be achieved through the strategic approach of the Human Resource Management (HRM) in order to create individual skills among its employees which, once aggregate at the organizational level, allow to the organization itself to effectively absorb the uncertainty, develop specific responses to threats in such a way as to take advantage of events that can potentially threaten its survival (Lengnick-Hall and Beck, 2005).

The model presented by Lengnick-Hall and Beck Model established that an organization for being consider resilient need to have three components to enhance people resilience and increase the firm's ability to understand its current situation (Lengnick-Hall and Beck, 2005).

These three components are:

- *Cognitive component*: the cognitive component allows us to interpret uncertainty in a creativity way, analyses the situation and provides solutions that go beyond simple survival; those who possess the cognitive component are able to generate innovative and appropriate solutions
- *Behavioural component*: the behavioural component allows you to take advantage of the collaboration between the individuals involved in the organization. A resilient organization has a high behavioural component when individuals are able to learn from both positive and negative events.

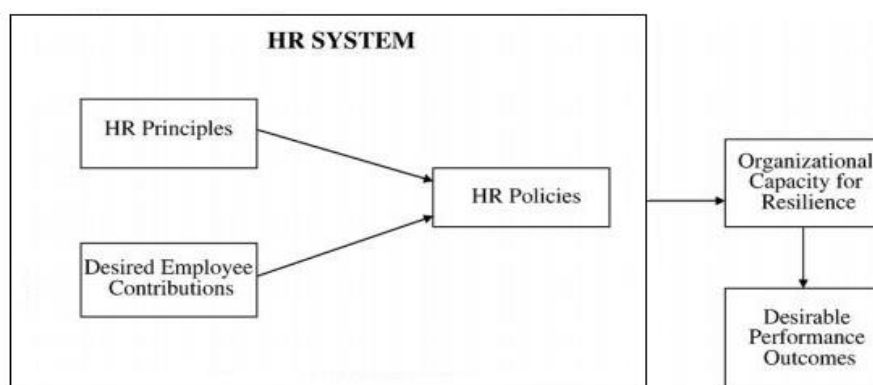
- *Contextual component*: the contextual component is composed by relationships and resources; indeed, it is composed by two sub-components which are human capital, that is, the set of relationships between people and between people and organization; and a large network of tangible and intangible resources. This component helps the organization to develop a higher level of resilience.

These components, in turn, depend on a combination of Knowledges, Skills, Abilities and Others attributes (KSAOs) of each individual and, consequently, HRM can intervene by implementing a series of Human Resources practices aimed at developing or increasing all those KSAOs deemed necessary for the growth of cognitive, behavioural and contextual components that allow to develop resilience in the organization.

The Human Resource Management system (HRM) can therefore be considered as a multilevel construct composed by: general and transversal elements (called HRM principles) that provide a general direction for the management of human capital; some mid-range elements (HRM policies, HRM programs) that provide alternative approaches to align human resource management practices with the strategic objectives of the organization; and some low-end elements (HRM practices, HRM processes) that reflect the actual Human Resource activities implemented in specific circumstances. (Lengnick-Hall and Beck, 2005)

How we can see from the Figure below (Figure 4), the three components of the Human Resource System provide organizational resilience. It is important that this System is strong enough in order to clearly communicate the objectives, expectation and necessary characteristics to employees so that workers can understand them and behave appropriately.

FIGURE 4 STRATEGIC HRM SYSTEM IN DEVELOPING A CAPACITY FOR ORGANIZATIONAL RESILIENCE



Source: Beck and Lengnick-Hall, 2005

Sutcliffe & Weick (2007)

Sutcliffe & Weick (2007) establish that unexpected events verify our resilience. This means that each unexpected event measures how well people are able to cope with it and their resilience after the event in question (Sutcliffe & Weick, 2007). The work of Sutcliffe & Weick presents an interesting analysis of how the operational practices of some organizations reduce the effects of unexpected events and how these organizations significantly speed up their recovery process. These organizations have been named by the authors as "High Reliability Organizations". These organizations develop knowledgeable tools to manage unforeseen risks and focus mainly on two lines of action: the ability to anticipate, and the ability to contain the unexpected. The first element, the ability to anticipate, includes the practices of becoming aware of the unexpected early enough to act before the problem becomes serious. To reach this level of awareness, it is necessary to pay attention to small failures, avoid simplification or categorization, and operate with a high sense of the context that surrounds us. The second element, concerning the unexpected, is inherent in the act of preventing unwanted outcomes after an unexpected event. The organizational structure, in order to avoid these unwanted outcomes, needs a real commitment to resilience and a great deference to competences (Sutcliffe and Weick, 2007). A conscious infrastructure requires the organization to constantly evaluate the environment and focus on its strengths. Also, the organization needs to be flexible not just to respond to stimulate the context, but also to improve the ability to make decisions that have a purpose. When organizations fail to manage risk, their ability to become resilient drops dramatically. The ability to anticipate risks allows you to create a work culture that is able to embrace instability, and to accept adversity proactively. Even when organizations are dealing with unpredictable risks, precisely because they include risk as part of their manageable competencies, they are better prepared to find creative ways to solve or contain the unexpected. Here because risk management represents a fundamental tool in the process that starts when one goes to face adversity and tries to become resilient (Sutcliffe and Weick, 2007).

Even if the organization carefully respects the management process of risk, however, following the process is by no means sufficient, because it does not ensure success. Only people who use the results of the process to change decisions, behaviours and actions will be able to achieve complete and effective risk management. Each stage of the process requires decisions to be made, and each of these decisions is influenced by people's attitudes towards risk (Hillson, 2009). Attitude towards risk is influenced by three main factors: what is aware, what is not aware and affective factors. Conscious factors are the visible and measurable characteristics of

any risk. The unconscious ones are the mental biases formulated about based on previous experience and, finally, the affective factors are the feelings and emotions that tend to influence personal reactions (Hillson, 2009).

After discussing in detail these three models which, as we have seen before, analyse organizational resilience under three different aspects that will allow us to better analyse our goal, let's now go to see how resilience can be built within organizations.

1.4 BUILDING A RESILIENT ORGANIZATION

Organizational resilience, as we saw in the previous paragraph, is an important and necessary resource for companies, with which they can overcome moments of difficulty. Resilience is especially important today because the business environment is becoming more dynamic and unpredictable, but at the same time, it is very difficult for entrepreneurs or managers to introduce and implement it in their organization, since first of all they must have a resilient character themselves and subsequently be able to export it to employees and to the company. A prerogative fundamental for organizational resilience is undoubtedly the experience; thanks to it, companies become increasingly stronger and able to adapt to adversity. In general, there are two approaches towards resilience: the first approach is oriented towards performance and the achievement of objects for obtain an immediate survival, focusing everything on the present, with the defect to not invest in innovation and change; the second approach, instead, are based on the adaptation and learning, focusing on the long term with the aim to prepare the company to face possible future crisis (Robb, 2000). From this distinction, it is easy to deduce that the first approach is very often unsuccessful since to face crisis and adversities it is necessary to prepare in time and balance short and long term.

In the following paragraphs, we will discuss in detail the tools and drivers that allow to make an organization resilient.

1.4.1 Attributes of Organizational Resilience

Organizational resilience consists of various organizational skills that generate resilience outcomes. These capabilities are process capabilities, because they emerge from within the process of dealing with the unexpected. They are complex, deeply rooted in an idiosyncratic social context and expressed by organizational routines (Nelson and Winter, 1982).

The starting point of the new conceptualization of organizational resilience is its definition as a set of capabilities by which companies anticipate, cope with and learn from unexpected events (Duchek, 2019). Therefore, three dimensions of organizational resilience can be distinguished - each referring to another time horizon -, since resilient organizations respond not only to current problems (concurrent action) or to the past (reactive action), but also to the future (anticipatory action). On this basis, the conceptualization pays attention to the underlying resilience capabilities.

Below, I will elaborate on the main skills of each dimension.

Anticipation capabilities

The first dimension of organizational resilience capabilities is represented by anticipation. This dimension represents the proactive behaviours that an organization takes to anticipate a crisis situation (Soomers, 2009). The main objective of these capabilities is therefore to manage the crisis before it occurs. In order to try to be ready for the occurrence of a crisis situation, many companies prepare a Business Continuity Plan, through which the organizations implement a strategy that allows them to continue to carrying out their activities in the case of negative situations. It is important that this plan is direct, so that it can provides a clear direction; adaptable, so that it can be applied to different crisis situations; concise and relevant. To draw up a good continuity plan, it is necessary to carefully observe the internal and external environment and identify potential threats that may exist and the activity used to look for weak signals is called “environmental scanning” (Hiltunen, 2008). Business Continuity, however, does not necessarily eliminate risks altogether, and therefore needs to be complemented by Business Resilience Management. Resilience is about building in flexibility that enables organizations to respond and adapt to unexpected circumstances, such as adopting alternative ways of ordering from normal or backup suppliers if normal channels/methods are not available (Warwick, 2020). “Preparation”, which is a term used by Weick, Sutcliffe and Obstfeld (1999) referring to the ability of high reliability organizations, is an important and fundamental part for the anticipation dimensions. According to this, Wildavsky established that organizations

can prepare for inevitable surprises “by expanding general knowledge and technical facility, and generalized command over resources” (Wildavsky, 1991). Thus, preparation does not mean planning for the unexpected, but it means that organizations prepare without knowing if, when and where an expected event will occur in the future.

Resilient organizations can gain an advantage in anticipating the crisis situation, but it is also true that not all crisis situations can be anticipated. An example is the current crisis that we are experiencing, indeed, many organizations were not ready for this type of crisis and for this reason they found themselves in great difficulty. A particular situation, however, is represented by Danieli & Officine Meccaniche which, having a secondary office in China, experienced in advance what would have happened soon in Italy and this gave them an advantage over other companies as it allowed them to develop technological systems and solutions to guarantee the business continuity, in particular, through the help of the IT Department in 48 hours all the company's PC were made remotely usable and were established some networking and Cyber-security solutions. (Cervelli, 2020).

Coping capabilities

In addition to the anticipation of and preparation for critical events, an organization that wants to be considered resilient needs also coping “with unanticipated dangers after they have become manifest” (Wildavsky, 1991). According to Madni and Jackson (2009), the ability of coping with the unexpected can be distributed into different single capabilities: capability to accept a problem; capability to search a solution and the capability to implement a solution. These capabilities imply immediate and/or short-term action in response to unexpected events and, moreover, traditional forecasts are not effective in the coping capabilities.

- *Accepting*: when an organization faces unexpected events the first thing to do is to accept the problem. Catalan and Robert (2011) establish that the acceptance dimension of organizational resilience is composed of three elements: understanding the environment in which the system operates, defining a reference state for the system and being aware and accepting the failure of the system.

As we can see, these elements show some similarities with the anticipation capabilities seen above. Hence, it can be assumed that anticipation and coping skills are closely related and promoting anticipation skills can also have positive effects on the ability to accept a problem.

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- *Searching for solution:* When a crisis occurs, organizations must put their crisis plans into action and develop ad hoc solution. Developing solutions in the face of crisis is always a combination of sensemaking and acting (Weick et al., 2005). Weick established “the basic idea of sensemaking is that reality is an ongoing accomplishment that emerges from efforts to create order and make retrospective sense of what occurs” (Weick, 1993). Sensemaking means that individuals or groups try to make things rationally accountable to themselves and others. Only the people that are able to understand a crisis situation are those that are able to act on it (Weick, 1993). For obtain an effective sensemaking, there must be continual feedback between understanding and action, which means that sense must continually be made and remade. One of the most important principle that facilitates the collective sensemaking process is “bricolage”: the capability to improvise and to apply creativity in problem-solving. In the paper of Weick et al. *Organizational change and development (1999)*, Weick explain that bricolage is enacted thought informal “epistemic networks”. These networks have no formal status; they allow for a rapid pooling of cognitive knowledge to handle events that were impossible to anticipate. Epistemic networks represent a strategy for flexible crisis intervention and an example of the generalized, uncommitted resources that are necessary if one is to cope with the unexpected in a resilient manner.
 - *Implement solution:* To implement a solution during the crisis, it is necessary to enable organizations to maintain a shared vision among it constitute parts. In this context, Weick (1993) established for the importance of virtual role system, in which each member cognitively reproduces the organization.

Adaptation capabilities

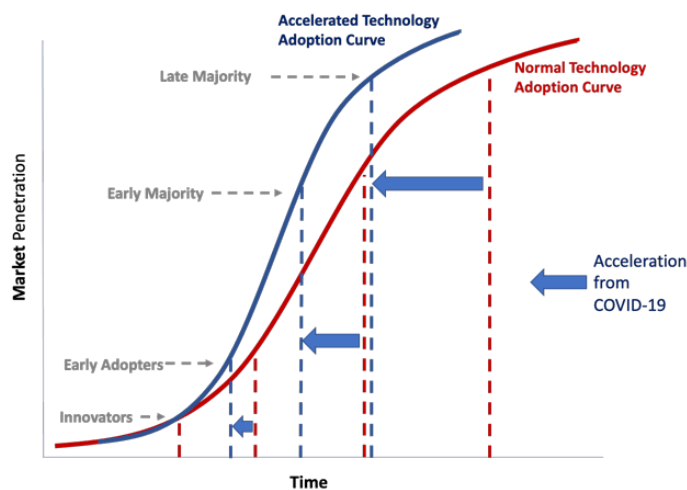
The last capabilities are the adaptation capabilities. The ability to adapt is a very important prerogative for companies that want to be consider resilient. Adapting means knowing how to adapt to the crisis situation, also leading to change one’s strategies in order to survive the crisis situation. We can say that the ability to adapt is one of the most complex soft skills to develop as it requires a good ability to understand the context and the strength to go beyond the normal conditions; and given the difficulty of this ability, only organizations that have develop an adequate resilience internally, succeed in this adaptation.

The adaptation of a crisis situation starts with the reflection and the valuation of the crisis situation, its causes and effects. The gained experiences can be incorporated in the existing knowledge base. Academic literature on organizational learning demonstrated that

organizations learn from past experience. It can be assumed that knowledge gained from one crisis needs to be analysed, transferred stored to avoid and to mitigate future crisis.

The Health emergency that we are experiencing, has required organizations to adapt to this new situation and according to Istat, in 69,7% of cases, have been foreseen forms of adaptation of work organization and production processes (Istat, 2020). Companies have had to adapt to the new labour rules extremely quickly and the success of their businesses depended heavily on the flexibility with which staff could adapt to this change. To adapt to this situation many organizations have had to accelerate the digitization processes. As we can see from the graph below (Figure 5), indeed, the red curve, that represent the normal trend in the adoption of technologies, has undergone an increase represented by the blue curve which represent new adaptation curves accelerated by COVID-19.

FIGURE 5 ACCELERATION OF TECHNOLOGIES



Source: McGrath M., 2020

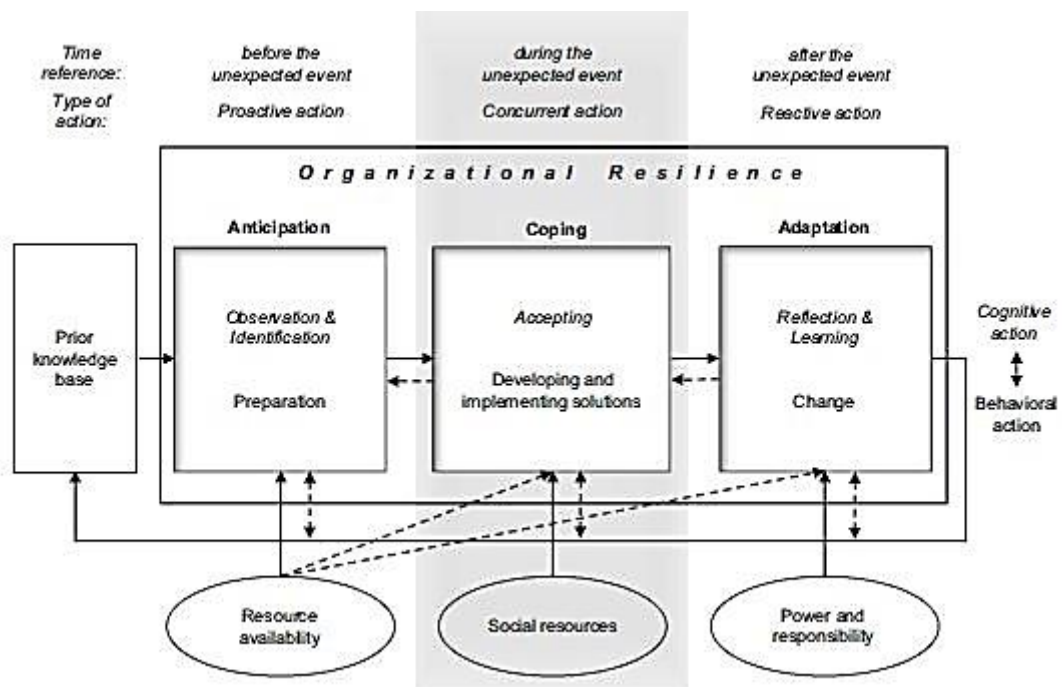
This is because digital has proved to be the most important tool to survive this emergency situation, the main investment areas to accelerate the digital transition of businesses include solutions and technologies to strengthen resilience and business continuity, from advanced Smart-Working and digital workspace, service continuity, rationalization of cloud computing models, also related investments in cybersecurity for securing corporate networks and devices (Longo, 2020).

Moreover, the adaptation of organizations is also seen in their ability to reconvert their production to produce useful products to overcome the crisis. For example, Giorgio Armani has converted the production of all its Italian production plants to create disposable gowns for the

individual protection of healthcare workers. The Prada group has started the production of 80 thousand gowns and 110 thousand masks for the healthcare personnel and Calzedonia has also converted some of its factories for the production of masks. The Davines group, a cosmetic company based in Parma, has started the production of a hand sanitizing gel and LVMH in France will also use all the facilities of its brands (Dior, Guerlain and Givenchy) destined for the production of perfumes to produce the gels (Carli, 2020)

The following is the Ducken model (2019) which relates the three capabilities above. As we can see (Figure 6) the relationship between these three capabilities is non unidirectional but is reciprocal. Indeed, these three capacities should not be considered separate from each other as they are fundamental and dependent on each other.

FIGURE 6 ORGANIZATIONAL RESILIENCE: A CAPABILITY-BASED CONCEPTUALIZED



Source: Duchek S., 2019

1.4.2 Drivers for the implementation of Organizational Resilience

When a crisis breaks out, companies must do everything to not fail and be able to survive in the long term. To face these pitfalls, organizations must possess some distinctive traits within themselves that allow them to obtain a competitive advantage and survive the crisis. These characteristics are: Leadership; Organizational Culture; Strategic Planning and Innovation. These characteristics must pre-exist within an organization and for this reason we can say that these characteristics are the prerogatives that allow an organization to be defined resilient. There is a strong relationship among these characteristics and the capabilities explained before, indeed, the presence of a resilient leadership, a strong organizational culture, an adequate strategic planning and a set of innovative tools represent the basis for being able to anticipate, cope with and adapt to a crisis situation as these characteristics provide the necessary tools for ensure resilience. To better understand the existing relationship, it is appropriate to analyse these four characteristics in detail.

Leadership

One of the first fundamental characteristics that an organization must have to be defined resilient is the presence of a resilient leader. As we know, leadership is an innate characteristic that is difficult to acquire in the course of the life and, for this reason, represents a distinctive characteristic of an organization. Leadership of a person is always visible but becomes stronger in times of difficulty; on this last point, however, it is important to say that a good leader does not always correspond to a resilient leader able to face a situation of necessity. When an organization finds itself in a crisis situation, managers must be the first to direct the company towards a resilient path as at that moment managers represent the only point of reference (Williamson et al., 2011). The main point around which leadership revolves lies in the leader's ability to create a constructive dialogue between the internal and the external components of the company, driven by the aim of achieving resilience. A leader who aims to make an organization resilient will try to incentivize a continuous exploration of external sources that can influence the company's future success. This future-oriented vision aims to anticipate what will happen, thus stimulating the company to achieve positive performance. This discussion, focused on the future and the external environment, will create a greater sensitivity, within the organization, to the external forces that are emerging, thus leading to a better understanding of the need to innovate. Of whatever type and entity, the innovation is, it is certainly a necessary factor in order to achieve success. Consequently, a leadership that encourages a discussion

regarding the external environment and its future creates the basis for change. Only a continuous debate about the future of the organization and the external environment can allow the company to understand the reference context, within which it operates, in a sufficiently thorough way to allow it to adapt better to changes and be consider resilient.

Organizational Culture

Organizational culture consists of the set of values, rules and behaviours that characterize an organization, contributing to the formation of a well-defined environment. Organizational culture is something that is built over time, with written and unwritten rules with a series of more or less rooted habits, and that holds an organization together, influencing the way people interact (Jones, 2010). Organizational culture represents one of the most difficult characteristics to develop within an organization, but at the same time it is essential to be able to develop a resilient company. Leadership and organizational culture are closely linked as leaders must be able to transmit the resilience capacity to the components of the organization and to do this they must operate through an adequate organizational culture. In this way, the more an individual is involving in the organization, the grater will be his commitment and will be more likely to adopt a resilient attitude. In this way, following a sudden event with a negative impact, it will not break down, but will have the aim of making the organization survive and improve it. As in the case of leadership, organizational culture is a fundamental characteristic that must pre-exist within an organization. Indeed, if an adequate organizational culture has not been developed when a crisis occurs and we find ourselves in a situation in which the components of the organization do not communicate with each other; it is inevitable that the organization will have difficulties in coping with the crisis. For this reason, the resilient organization must implement a series of proactive actions aimed at developing an adequate organizational culture before crisis situation occurs.

Strategic Planning

In addition to leadership and organizational culture, a very important aspect on which resilient organizations are based is the strategic planning process. The adaptation mechanism that an organization must be able to implement revolves around this planning process; the aim of this plan is to analyse and work on the competitive capacity of the organization and on the predictions of future developments. It follows that the strategic planning process is the

adaptation mechanism which coordinates and directs the proactive activities and the anticipatory capacity of an organization. From this emerges the link between the above capabilities and this strategic plan, indeed without an adequate strategic plan an organization it is difficult for an organization overcoming a crisis situation, it is, therefore, necessary to develop this plan in order to guarantee operational continuity. The strategic planning process is based on the fundamental idea of continuous improvement applied and incorporated into a company's innovation strategy, products and processes. In this way the organization becomes more capable of continuously implementing an adaptation mechanism aimed at planning and improvement. However, constant improvement is not enough to make a company resilient, innovation is needed. Companies that focus only on continuous improvement, sooner or later, will be swept away by the competitor who knows how to innovate (Pellissier, 2011).

For this reason, it is absolutely necessary that the strategic structure on which the whole organization is based is not focused only on the simple improvement of strategies, processes or products, but rather on innovation which, moreover, must be continuous.

Innovation

In order for an organization to be defined resilient, one cannot stop at mere improvement as with sporadic and occasional innovation, but must be motivated by the desire to always go further and always make new and different innovations. Innovation, today, needs to be part of an organization's culture, indeed, a resilient, innovative organizational culture can help organizations withstand disruption in the future while offering important benefits immediately (Deloitte, 2020). Innovation is the essence or the main reason for firm's survival because in most cases only those firms that can successfully innovate are able to build and sustain a competitive advantage in the market (Wagner 1999). Investing in advanced technologies and using resources effectively can increase an organization's resilience in the face of change. By acquiring and employing the best people, technology and financial resources, companies can improve their competitive position and prepare for future disruptions (Deloitte, 2020).

According to a study of the Boston Consulting Group there are six dimensions of resilience in which the leader of an organization needs to focus on: protecting and growing the top line; development of agile operations; enabling persons; accelerate the adoption of digital data and platforms; improve IT security; and strengthening of financial data (Boston Consulting Group, 2020). Resilience comes from each of these dimensions, but business leaders also need to consider them in combination, in order to gain resilience from their interactions. Technological capabilities are critical to building resilience in all six dimensions. Resilient companies are

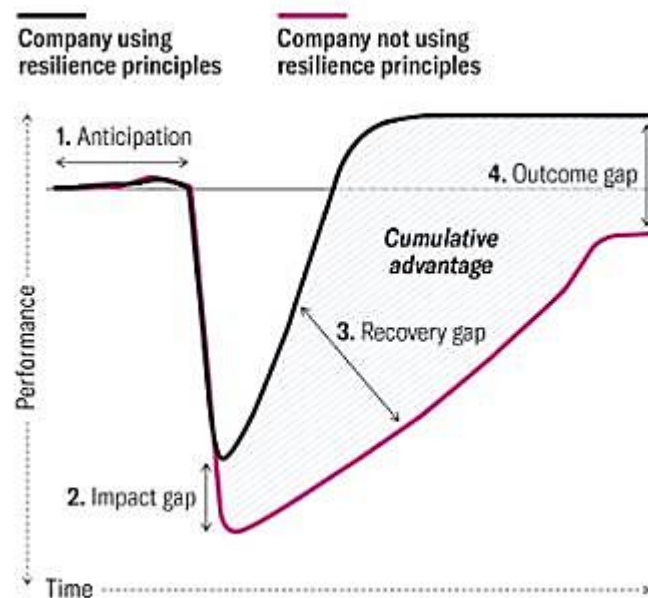
likely to adopt an operating model with an integrated view of the relationship between people and technology - what we call The Bionic Company - that brings out the best in both (Boston Consulting Group, 2020). According to a study carried out by the consulting group KPMG in 2019, 71% of the investments made by resilient companies concern the development of new technologies to innovate the production process (KPMG, 2019). In the next chapter, we will focus on better defining these technologies and the relationship between technology and resilience.

As mentioned above, these four characteristics represent prerogatives that must exist in an organization when a crisis occurs. Moreover, to these characteristics, there may be other factors that allow you to develop a resilient organization. The first factor is speed, indeed the speed with which an organization is able to respond to a crisis situation allows to verify its level of resilience, indeed the faster an organization will face a crisis situation, the higher its level of resilience is. Then we have the adoption of lean organizational structure. The adaptation of this structure allows continuous communication among individuals within the organization and, moreover, allow an easier and flexible management of the company making easier the adaptation to changes due to crisis and/or sudden shocks. Through redundancy, an organization can protect systems from unexpected shocks, duplicating elements, such as having multiple factories producing the same product, or having different elements achieving the same end. However, redundancy causes a reduction in short-term effectiveness. Modularity allows individual elements to fail without the entire system collapsing, although it gives up the efficiency of a tightly integrated organizational design. Because a modular organization can be broken down into smaller chunks with well-defined interfaces, it's also more understandable and can be rewired more quickly during a crisis. Moreover, a company can implement migration strategies, such as shifting its business portfolio mix across products, channels, geographies or business models to maximize opportunities and minimize adversity. Finally, companies can increase their resilience through collaboration with other actors. Business ecosystems, such as digital platforms, can increase their collective resilience through access to new capabilities, greater flexibility, and reducing the fixed cost of entry into companies where resources can now be shared. Shared platforms essentially create "real" insurance against the unexpected through investments in shared execution, adaptation and innovation mechanisms.

1.4.3 Benefits of Resilient Companies

When faced with an unexpected crisis situation, an organization that uses the principles of resilience has a series of advantages that take place in sequence (Figure 7) compared to an organization that does not use these principles.

FIGURE 7 ASSESSING COMPANIES' RELATIVE RESILIENCE



Source: Reeves M., 2020

As we can see, these benefits are closely related to the resilience capabilities extensively discussed above. The first advantage, indeed, is represented by anticipation, which consists in the ability to recognize threats more quickly. The next advantage, on the other hand, represents the ability of a resilient organization to better resist the initial shock, in fact, as we can see from the Figure 7, a resilient organization has a lesser impact than a non-resilient organization and this can be achieved by developing through the above principles with better preparedness for unexpected events and a more agile response (Reeves, 2020). An additional benefit is represented by the speed of recovery, which indicates the ability to recover from the shock more quickly by identifying the adjustments needed to return to the previous operating level and implementing them quickly effectively (Reeves, 2020). Finally, there is an eventual benefit in terms of results, which represents greater suitability for the new post-shock environment.

Cumulatively, the four gaps produce a significant difference in value. As we observed in China during the initial shock of COVID-19, most sectors and companies fell rapidly and synchronously, but during the recovery phase there was a marked divergence in corporate performance, thus highlighting, a stark difference between resilient and non-resilient organizations (Reeves, 2020)

1.5 MEASURING ORGANIZATIONAL RESILIENCE

Resilience, as we have seen previously, is an abstract concept, defined by multiple factors internal and external to the company; leadership, corporate culture and the preparation of internal workers are only a part of the factors that we have seen before useful for building resilience within an organization. Consequently, due to the abstractness of resilience and the large number of factors that make it up, it is very difficult to calculate it or even distinguished between resilient and non-resilient company. Despite this, some authors have tried to build indices that can measure the level of resilience. This is very complicated because it consists in transforming a theoretical concept into a quantitative application. A greater difficulty is encountered in going to measure the level of latent resilience, that is the level of resilience that an organization possesses even before a shock occurs, because, generally, resilience is demonstrated after a crisis has occurred (Wildavsky, 1988). Despite this, some authors such as Mallak (1998) or Somers (2008) have tried to measure the level of latent resilience by identifying factors and building measurement scales. In particular, these authors believe that organizations that possess certain characteristics and that aspire to have a higher level of resilience should be more likely to adopt adaptive behaviours.

Differently, other studies have found methods useful to estimate resilience based on the company's economic results per period given a simply calculation since they are presents in the financial statement. For example, Watanabe et al. (2004) proposed to use the Operating Income to Sales to measure resilience. If the sales come from the operating income of the company, so the core business is generating revenues, the firm should be in a good situation. Therefore, even if a crisis arises in the market, the company knows its strength and its survival odds. Dalziell & Mcmanus (2004) suggested to measure resilience based on Key Performance Index (KPIs) defined taking into account the organization's objectives. Normally KPIs are various and different depending on the company. There are financial KPIs as profit, cost, COGS, day sales outstanding or sales by region, because through the analysis of which regions are meeting sales objectives, you can provide better feedback for under-performing regions. These if we are dealing with operational indicators. Other commonly important are cash flow from financing

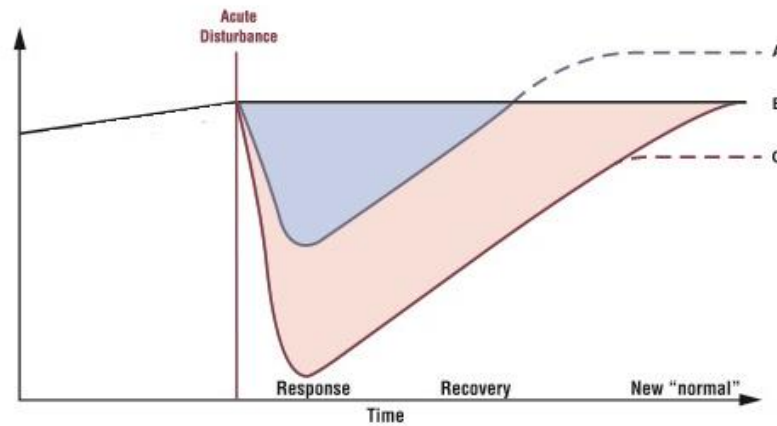
activities to demonstrate an organization's financial strength, or EBITDA measurement of revenue after expenses are considered and interest, taxes, depreciation, and amortization are excluded.

Venzin and Perotti (2014) prefer to build a model in which the measurement of resilience is based on two objective criteria: first, the company must be subjected to a crisis, a catastrophic event, a shock; second the company must have above-average performance before, during and after the shock. Following this model, the aim of resilient companies is to generate a SSP, that is, a Stable and Standard Performance over time. The SSP, and consequently the level of resilience, can be measured through an indicator called VOLARE (Volatility and ROE¹). This indicator is composed by: the volatility of the ROE, which measure the risk, and the long-term ROE, which indicates the profitability; as regards the long-term ROE, we take into consideration the average of ROE over a period of 10 years. The higher the volatility, the riskier is the stock and so the company. A low volatility suggests a good stock performance and so lower possibility of default.

Moreover, to the measurement based on indicators, others studies focus the measure of resilience on the base of the organizational recovery (Figure 8). In this case, the authors measure resilience based on how the organization recovers from failure. This way to measure resilience is only valid after the organization has suffered some shocks. Hence resilience becomes the ability to prevent disruptive events, or the ability to prevent consequences of that disruptive event becoming worse, or the ability to recover from a disruptive event that has happened. The Recovery Time, is the time that is necessary for an organization to cope with a crisis situation and return to operating in optimal condition. The level of this recovery time influences the degree of resilience within an organization.

¹ ROE: Return on Equity (Net Income/Equity)

FIGURE 8 RECOVERY TIME DURING RESILIENCE



Source: White et al., 2015

Indeed, how we can observe in the graph above (Figure 8 , lower is the recovery time and higher is its degree of resilience and its ability to respond to crisis situation in a better way, increasing also the performance respect to the precrisis situation (Figure 8, line A), instead a high time to recovery means that the company has not the capacity and the skills to be able to react to crisis situation, and in this way the company will have a low degree of resilience (Figure 8, line C). On the base of this recovery time, some authors have implemented some theories.

Rose and Liao (2005), for example, propose to determine a quotient of failure probability, reduced consequences from failure, and reduced time to recover. Probability of failure is selected as a metric which indicates the ability to prevent disruptive events, reduced consequences from failure is a metric of the ability to prevent the consequences of that disruptive event, and finally the reduced recovery time is the metric for ability to recover from a disruptive event. Westrum (2006) classified these critical events on the base of their predictability, their potential to disrupt a system and the origin of that disruptive whether is internal or external. To measure the level of resilience after a crisis situation, Henry and Ramirez-Marquez (2010) propose to evaluate the level of recovery of the organization against its losses. They suggest to measure resilience quantitatively as the ratio of Recovery and Loss. Here, Loss is the deterioration from the original state after the disruption and Recovery is the amount it bounces back from the disruptive state to the recovered state. The authors

acknowledge that the limitation is not to consider the money and time to recover and, moreover, they do not consider what we should evaluate to measure loss and recovery. Erol, Henry, Sauser, et al. (2010) also include to the recovery time, the initial vulnerability and the potential loss averted. They proposed to measure resilience based on recovery time, level of recovery, initial vulnerability and potential loss averted. However, they do not indicate how to assess these items. Classifying the types of disruptive events or threats help to create preventive actions and to model how a system will react in case of that threat.

1.6 CONCLUSION

In this chapter it was explored the theme of Organizational Resilience. As we have been able to read the concept of resilience is not unique but, on the contrary, it is the result of different definitions that analyse the concept of resilience from different points of view. Organizational resilience is influenced by many authors who over the years have elaborated its concept and enriched it with new and more current definitions. As we know, the ability of an organization to be resilient or not derives from a crisis situation, which, as we have seen, can be understood as a process or as an event. Despite this distinction of crisis, no author of those proposed in this paper has highlighted a difference in the concept of resilience with respect to the type of crisis, identifying organizational resilience simply as the ability of an organization to deal with a crisis situation. In order to be resilient, an organization must develop capabilities such as the ability to be able to anticipate a crisis situation, the ability to cope with the crisis and its ability to adapt. It is important to underline that these three capabilities are fundamental and connected each other in order to build organizational resilience. Leadership and organizational culture represent two of the fundamental characteristics that are necessary to establish a resilient organization. It is important, however, that these two characteristics are present within the organization before the crisis, as if one does not have resilient leadership and a well-defined organizational culture, an organization is not able to face the crisis situation. To maintain operational continuity, a company must be flexible and to be flexible it must invest in the continuous training of its resources. Developing soft skills guarantees to spread an identity culture and continue to increase performance. Decision making is essential to ensure performance. Resilience in the company depends on the active involvement of both human resources and the organization in promoting well-being at all levels.

Although resilience is an abstract concept, some authors have tried to propose methods to be able to measure it, however these methods have some limitations, the most important is that it provides that resilience can be measured only when a shock occurs.

The current crisis has highlighted the need to invest in technologies in order to guarantee resilience, in the next chapter the concept of technology will be better explored and the technologies most used for surviving the crisis will be analysed in detail.

CHAPTER 2: INDUSTRY 4.0 TECHNOLOGIES AND THEIR APPLICATIONS

2.1 INTRODUCTION

In the first chapter, we explored the concept of organizational resilience, which is considered as the ability to adapt and absorb variations, changes and disturbances, being able to manage the variability of the environments (Horne & Orr, 1998). As we know, resilience comes from the occurrence of a crisis situation and from the organization's ability to adapt to the changes that this crisis situation can bring. As we saw before in *Figure 5: Acceleration of Technologies*, the current crisis due to the health emergency has caused an acceleration of digitization processes within organizations. Today, in the actual socio-economic contexts, in the case that an organization face to an expected change, this organizational capacity is more required and become increasingly linked to the availability of technologies (Foray, 2006). Indeed, the Industry 4.0 technologies are converging an important role in the actual organizations. Industry 4.0 is considered as a new industrial stage in which there is the integration between manufacturing operations system, information and communication technologies (ITC) forming the so called Cyber-Physical System (CPS) (Wang et al., 2015). This new industrial stage is affecting competition rules, the structure of industry and customers' demand (Gilchrist, 2015), it is changing competition rules because companies' business models are being reframed by the adoption of ITC concepts and digitization of factories (Wang et al., 2015). From the market point of view, digital technologies allow companies to offer new digital solutions for customers and from the operational perspective, digital technologies are useful to reduce set-up times, labour and material costs and processing times, resulting in higher productivity of production processes (Brettel et al., 2014).

For these reasons, in this chapter, after focusing on the explanation of the Fourth Industrial Revolution and its distinctive features, we will analyse the enabling technologies of Industry

4.0 identifying the most used in the crisis period and we will analyse the main opportunities, but also some limitations, that digitization processes bring within the organization.

2.2 THE FOURTH INDUSTRIAL REVOLUTION

To better understand the current contest of Industry 4.0, it is necessary to know the origins of that change. Industry 4.0 is not considered as a sudden transformation or a radical modification of the reality totally disconnected and independent from the past, but rather we refer to a further step forward within the industrial sector, which guarantees a continuation with previous industrial revolutions (Hermann et al., 2015).

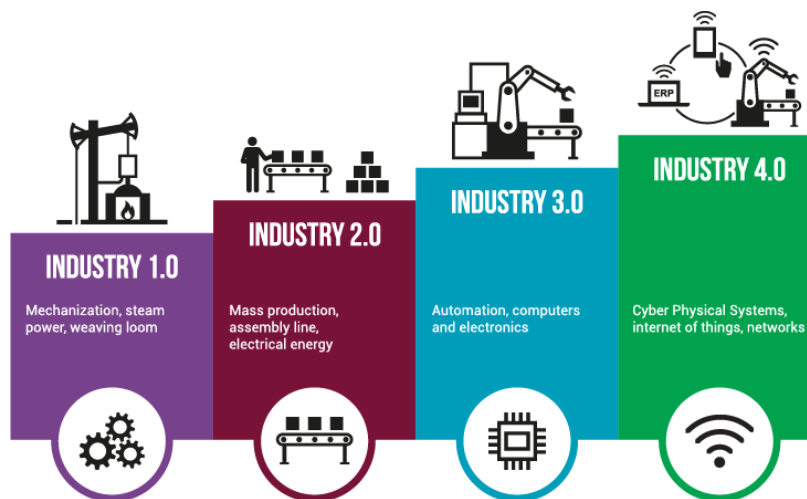
The First Industrial Revolution took place in 1760 in England and was decisive for the introduction of steam engine in factories which favoured the development of industries, especially the textile and steel industries. In this context, the new machines made it possible to relieve the physical efforts of the workers, guaranteeing an overall faster and more efficient production (Xu et al., 2018). On the other hand, the Second Industrial Revolution was developed in the Nineteenth Century and had a wide geographical spread than the previous one. The main symbols of this change were the use of new energy sources such as electricity, the internal combustion engine and oil and the start of the assembly line for mass production thanks to the design of the Fordist factory. This latest innovation, introduced by Ford in its factories, was studied and replicated in almost all business context of the time, becoming the protagonist of industrialism of the following century. The Fordist entrepreneurial philosophy was based on the principles of “scientific organization” of work proposed by Taylor, according to which, through a strong hierarchical control, it was possible to break down the production process into elementary tasks, monitoring and reducing time and costs to a minimum. However, Ford overcome the concept of Taylorism hierarchical control through an automation type control, according to which it was the work of worker that was subordinated to the time of machine and not vice versa, but at the same time he managed to compensate for that tiring work through an increase in wages and therefore a general improvement in social conditions (Tunisini et al., 2014). The Third Industrial Revolution began in the Twentieth Century through the use of the first forms of digital technology relating to information technology, electronic and telecommunications. The beginning of the digital transformation of factories found its foundations in the oil crisis of the 70s, as it determined the need to find replacement energy resources, thus starting a new phase of research and development in the technological field (Xu et al., 2018).

The Fourth Industrial Revolution, instead, is still in progress and for this reason a starting date has not been identified, which will probably be defined only ex-post.

The first three revolutions were characterized by a diffusion like wildfire, arising from a more or less broad central fulcrum (England, USA, China etc.) and then gradually expanded; otherwise, the actual revolution has taken on a global character since its origins, having simultaneously outlined several points of origins and evolution around the world. Another difference respect to previous revolutions is given by the fact that in today's case, change and innovation are applied both to production and even more to the organization and management of the factory itself, thanks to the new communication technologies that do not limit themselves to creating contact between humans or between human and machine, but also between machines themselves (Cooper & James, 2009).

In the Figure 9, it is possible to see the passage among the different industrial revolutions that have followed one another over the years since the end of the Eighteenth Century. The last fifty years of history have been outlined by the transition from automation to Industry 4.0, that represent the union of experience and skills with total automation and interconnection of production (Kucera et al., 2018).

FIGURE 9 THE FOUR INDUSTRIAL REVOLUTION



Source: Kucera E. et al., 2018

The term Industry 4.0 was used for the first time in Germany in 2011 during the Hannover Fair, at the initiative of the working group managed by Siegfried Dais and Henning Kegermanns. In that context, the German government began to lay the foundations for a project that was part of the broader “High-tech Strategy 2020” plan aimed at promoting German industrial development. The government program was based on the assumption that the industrial production of the future will be characterized by a strong individualization of the product, by a highly flexible production capacity on a large scale, by the integration of customers and suppliers in company processes and by the connection between production and highly qualitative services that leads to obtaining the so-called hybrid products (Schütte, 2012). Industry 4.0 involves a transition from automated production to the concept of intelligence production, where the machines are equipped with sensor and decision-making capacity that make them smart and in which the physical and virtual dimension develop in parallel. The Fourth Industrial Revolution mitigates the burden of current challenges for manufactures in order to make the companies more flexible and responsive to business trends. Among these challenges there are the ones of increasing market volatility, shorter product lifecycles, higher product complexity and global supply chains. Moreover, Industry 4.0 allows the transformation of modern economies to become more innovative and hence increase productivity (Schmitt, 2015). Through the technologies of Industry 4.0, the role of consumers changes, indeed, it highlights the role of customer as a co-producer and puts them in the centre of all activities; satisfying each individual customer request is one of the main added valued of Industry 4.0, with the possibility of creating product changes in limited quantities or even individually (Wang et al., 2017). The availability of all relevant information in real time will allow production systems to meet customer requests, minimizing machine programming and reconfiguration times. Industry 4.0 will enable sustainable prosperity through the use of modern technologies to find solutions to the challenges relates to energy, resource, environment and social and economic impacts.

The fusion of the physical and the virtual world is one of the most important prerogatives of the Industry 4.0 (Kagermann, 2014). This fusion is made through the Cyber-Physical Systems (CPS). In 2008, Professor Edward A. Lee from the University of California, Berkeley, defined Cyber-Physical Systems as follows: “*Cyber-Physical Systems (CPS) are integration of computation and physical processes. Embedded computers and networks monitor and control the physical processes, usually with feedback loops where physical processes affect computations and vice versa*”. Indeed, the CPS represents a set of collaborating computational systems that have an intensive and constant connection with a surrounding physical world and

with the processes in progress (Monostori, 2014). In this way, open and reticular systems are developed, these new systems allow to collect, interpreted and made available data. These systems can react through actuator systems to processes within the physical world and therefore they can influence the behaviour of equipment, things and services (Geisberger & Broy, 2012). Such Cyber-Physical Systems can be also used within manufacturing systems, where the intelligent cross-linking can be achieved, for example, via sensors, processors, software and connectivity incorporated into the product, together with a product cloud through which the product data is stored and analysed (Blunck et al., 2017). Through these data you can make improvements to the functionality and performance of the product.

Another important element of the Fourth Industrial Revolution is the Internet of Things (IoT). There is no a single definition of IoT as it is described in different ways by companies and organizations. Despite this, however, the Internet of Things can be commonly described as an “ecosystem of technologies that monitor the state of physical objects, acquire significant data and communicate these information’s through network to software applications” (Blunck et al., 2017). The Internet of Things consists of objects with embedded or attached technologies that enable them to sense data, collect them and send them for a specific purpose. Depending on the object and goal this could be capturing data regarding movement, location, presence of gasses, temperature, ‘health’ conditions of devices, etc. This data as such is just the beginning, the real value starts when analysing and acting upon them, in the scope of the IoT project goal. IoTs include a set of intelligent objects, tools that allow machine to machine communication (M2M) and radio frequency technologies (Thrasher, 2014). Thanks to their smart technology, they are able to connect everyday objects in order to establish their status remotely via computer systems that allow to collect continuous and updated information on physical objects and processes. This technology will be seen in detail in the next paragraph as it represents one of the enabling technologies of Industry 4.0.

Through the implementation of these new technologies, there is the need to move from the old concept of factory to the new concept: Smart Factory (Dutton, 2014). The aim of Smart Factory is to produce fully flexible production at the highest speed, requiring a comprehensive transformation from traditional methods to advanced technologies. Indeed, the new factory will be based on a digitalized and dynamic production, in which the production processes will be interconnected and able to make the best use of available resources (Buchi et al., 2018).

The Smart Factory operates on three main levels:

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- *Smart Production*: smart production includes new production technologies that create collaboration between all the elements present in production or collaboration between operator, machines and tools
 - *Smart Services*: smart services represent all the IT infrastructure and techniques that allow systems to be integrated; but also include all the structures that allow, in a collaborative way, to integrate companies (supplier-customer) with each other and with external structures
 - *Smart Energy*: smart energy is a new company philosophy aimed at reducing energy consumption, aiming at the creation of more performing energy systems capable of reducing waste, with a view to sustainability.

2.3 ENABLING TECHNOLOGIES OF INDUSTRY 4.0

In order to achieve Industry 4.0, it is necessary to implement and integrate various technologies that are considered like enabling technologies. The Boston Consulting Group has identified nine enabling technologies that could be considered as the pillars on which the Fourth Industrial Revolution is founded (Figure 10). These technologies make it possible to innovate processes within the organization, products and services in all economic sectors as they are associated with a high intensity of research and development and rapid cycles of innovation (Boston Consulting Group, 2015).

In the following paragraphs, each of these enabling technologies will be analysed in detail and then we will identify the technologies most used during the crisis.

FIGURE 10 ENABLING TECHNOLOGIES



Source: Boston Consulting Group, 2015

2.3.1 Big Data and Analytics

According to the consulting firm McKinsey Global Institute, a Big Data system refer to a set of data whose volume is so large that it is beyond the ability of relational database system to capture, store, manage and analyse data (McKinsey, 2011). For that reason, when we use the term Big Data, we refer to such a large set of data that it is necessary to define new technologies and new methods to extrapolate, manage and process information in a reasonable time.

Oracle (2012) has established that there are four characteristics that define Big Data and that characteristics refer to 4Vs:

Volume The volume of data refers to the size of the set of data that must be processed and analysed. The analysis of this volume of data requires new processing and storage technologies compared to the traditional ones.

Velocity The velocity refers to how quickly data are generated. To generate data faster, it is necessary to develop new and more innovative processing techniques.

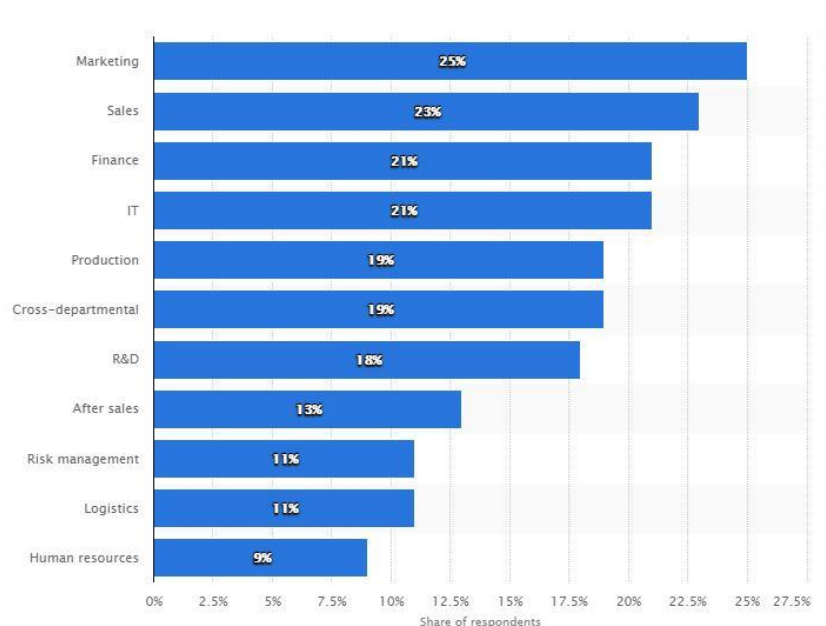
Variety Big Data generally come from a wide variety of sources and can be categorized into three types: structured, semi-structured and unstructured data. This variety of data requires advanced data processing capabilities and specialized algorithms.

Veracity The veracity refers to the quality of data being analysed. Data with high veracity are those data that significantly contribute to the results, while low-veracity data contain a high percentage of meaningless data. The veracity of data can be measured through advanced technological tools.

Through the collection, processing and analysis of large amounts of data, future trends can be predicted and planned; the quality of production can be optimized and there could be savings in terms of costs and energy.

In an Industry 4.0 context, the collection and evaluation of data from different sources will represent a standard tool to support corporate decision-making process in real time. Indeed, Big Data can be used in different business areas and if exploited correctly can give companies feedback on market conditions and customers behaviour. How we can see from the graph below (Figure 11) from Statista, the company functions that most use the technology of Big Data are: Marketing (25%), Sales (23%), Finance (21%), IT (21%) and Production (19%). How we can see, these are functions strictly related to data analysis, whose use of Big Data can lead to the development of competitive advantages for the organizations.

FIGURE 11 USE OF BIG DATA AND ANALYTICS IN AN ORGANIZATION



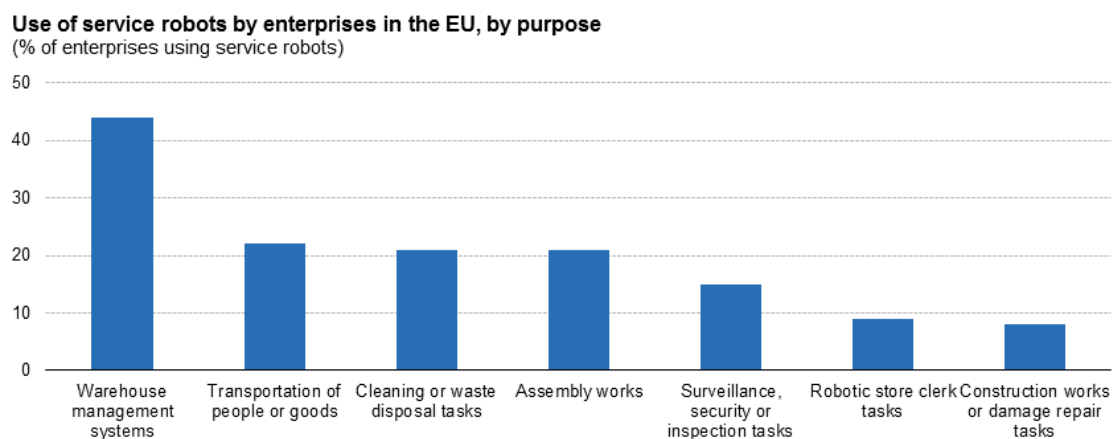
Source: Statista, 2017

2.3.2 Autonomous Robot

Robotics has always been used in the industrial sector for years, but in the recent years they have been subject to changes in term of flexibility, autonomy and cooperation. Indeed, robots will be able to interact reciprocally and work beside workers trying to learn from their behaviours (Rüßmann et al., 2015). Through the new robotic solutions, it will be possible to make production systems more flexible and effective, indeed the robots are used to carrying out autonomous production systems in a more precise way, guaranteeing to work in places where human work would be limited, ensuring a safety in the working environment. Collaborative robotics is developing very quickly thanks also to the progress made in the engineering field, creating a more efficient production process in which the work of machines and humans are coordinated with each other. In this way, it is possible to combine the flexibility typical of human work and the precision that comes from machines (Richert et al., 2016). The collaboration between workers and machine takes place through interfaces that ensure gestural and vocal interaction. The global use of robots is being expanded and it will expand ever further, indeed, according to a study of Boston Consulting Group, global spending on robotics will reach \$87 billion in 2025, to include various functions such as production, logistics, and office management for distributing documents (Boston Consulting Group, 2017).

According to a study conducted by Eurostat in 2019 (Figure 12), the main areas in which robots are used are warehouse management systems (44%), followed by transportation of goods (22%), cleaning or waste disposal tasks, as well as assembly works (21% each).

FIGURE 12 USE OF ROBOTS BY ENTERPRISES IN THE EU



Source: Eurostat, 2019

2.3.3 Simulation

Virtual simulation is a very important tool, which can be used in various scientific and technological fields. The simulation consists in reproducing a copy of the real world in the form of virtual model (*Digital Twin*) including also machines, products and humans. In this way, the virtual copy can be tested and optimized in order to reduce errors and increase quality and efficiency. Problems can be identified and anticipated by reducing costs related to design and optimizing the production cycle (Boston Consulting Group, 2015).

This technique is used a lot in the manufacturing sector as it allows you to evaluate before the complexity of the systems; change configurations even during construction and evaluate the organizational effects that may occur in changes in operational strategies.

2.3.4 Horizontal and Vertical Integration

The adoption of new technologies generates digitization but also the integration of the entire value chain. This integration can be divided into vertical and horizontal integration and aims to generate a unique integrated system to which all departments and company functions are part. Through this integration, it has become possible to better coordinate activities at different levels of the value chain and reducing inventory costs. Horizontal integration refers to the integration between a resource and an information network within the value chain with the aim of obtaining cooperation. On the other hand, vertical integration consists of a set of IT processes that are put into network and executes in an integrated way, making data and information available to all company departments. According to a study carried out by Pwc (2016), through vertical integration an organization can obtain some benefits; indeed through an internal harmonization processes the organization can improve the internal collaborations; in addition a more integrated and coherent production is obtained with the logistics and financial planning within the company; a greater control of production processes and quality assurance is generated and, finally, there is a reduction in warehouse and production costs.

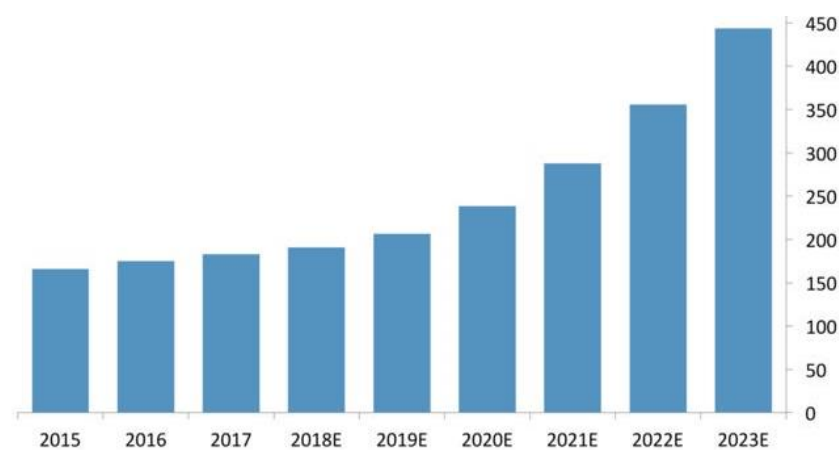
2.3.5 The Internet of Things (IoT)

As we anticipated earlier, the Internet of Things (IoT) is one of the most important dimensions of Industry 4.0. IoT describes the network of physical objects— “things” —that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet. These devices range from ordinary household objects to sophisticated industrial tools (Boston Consulting Group, 2015). Over the

past few years, IoT has become one of the most important technologies of the 21st century. Now that we can connect everyday objects—kitchen appliances, cars, thermostats, baby monitors—to the Internet via embedded devices, seamless communication is possible between people, processes, and things by means of low-cost computing, the cloud, big data, analytics, and mobile technologies, physical things can share and collect data with minimal human intervention. In this hyperconnected world, digital systems can record, monitor, and adjust each interaction between connected things. The physical world meets the digital world and they cooperate. The internet of things helps people live and work smarter, as well as gain complete control over their lives. In addition to offering smart devices to automate homes, IoT is essential to business. IoT provides businesses with a real-time look into how their systems really work, delivering insights into everything from the performance of machines to supply chain and logistics operations. IoT enables companies to automate processes and reduce labour costs. It also cuts down on waste and improves service delivery, making it less expensive to manufacture and deliver goods, as well as offering transparency into customer transactions. As such, IoT is one of the most important technologies of everyday life, and it will continue to pick up steam as more businesses realize the potential of connected devices to keep them competitive. The use of this technology is increasingly growing especially in the production phase thanks to the clear and quantifiable effects that this solution can have on operations.

An article from Business Insider predicts an increase in this technology, predicting that annual IoT spending in the manufacturing sector will reach approximately \$ 450 billion per year by 2023 (Figure 13) (Greenough, 2016).

FIGURE 13 ANNUAL IOT SPENDING IN MANUFACTURING



Source: Greenough E., 2016

2.3.6 Cybersecurity

With the development of Industry 4.0, there has been an increase in people and companies connected to the network through the use of standard communication protocols but also an increase in the tools suitable for these connections. At the same time, however, cyber-attacks have increased, through sophisticated techniques and systems, which have made it necessary to focus the attention on the issues of cybersecurity and the protection of sensitive data.

The term Cybersecurity represents the set of all those processes that allow the protection of information through: the identification of the assets that must be protected, identifying possible threats and critical issues to be monitored; identification of any attacks or anomalies of system through the Intrusion Detection System (IDS) and finally reaction to these attacks by restoring the system to bring it back to its original security conditions or by deciding to eliminate the source of risk (Boston Consulting Group, 2015).

To build an effective cybersecurity system it is important to pay attention to several factors such as ensuring cooperation and interconnection between the various IT components in order to be part of a global protection system and sharing information on risks and incidents that occur in certain industrial sectors so that cyber-attacks can be managed in real time.

2.3.7 The Cloud

Cloud computing includes a number of services offered by external providers, which can be used by connecting to the Internet. The services offered concern to the storage, processing or transmission of data, backup and communication services. These services are characterized by on-demand availability through the Internet, by a set of resources that can be configured and quickly provided with a minimum effort of management and interaction with the service provider (Mell et al., 2011). The objective of this model is to make the functions of a software available without having to purchase the application itself, according to a service mode when necessary, guaranteed a reduction of fixed costs for software and hardware. For this reason, we talk about Software as a Service (SaaS) which refers to the possibility of using programs installed on a remote server. Through the cloud, companies can reduce costs and optimize space as there is no need to have physical spaces in the company managed by dedicated personnel. This technology gives the possibility to adapt contract conditions to suit greater or lesser need without having the worry about reconfiguration architectures.

2.3.8 Additive Manufacturing

Additive manufacturing is not a recent phenomenon but it is a production technique developed in the 1980s by the inventor Chuch Hull, president of 3D System, who in 1986 launched the first SLA printer model in the market. This technology, called 3D printer, allows you to create real objects starting from the data of a digital model created on the computer using CAD (Computer Aided Design) software. These 3D printers, through the three-dimensional mapping of the digital object, are able to recreate the model in an additive way until the desired product is obtained (Sher et al., 2015). Additive Manufacturing has gained significant momentum and recognition in recent years. Escalated growth of Additive Manufacturing can be credited to patents expiring, credibility in the processes, success stories of global brands using Additive Manufacturing and advancements in the development of 3D Printing technology, software, and materials. The principles sectors in which Additive Manufacturing are most uses are: Motor Vehicles, Consumer Products, Business Machines and Medical. This technology played a fundamental role during the COVID-19 emergency, indeed when the number of infections increased all over the world, the potential of 3D printing was quickly exploited to quickly produce machinery and equipment in the medical field.

The advantage of this technology is the absence of constraints relating to the shapes that can be produced, ensuring the production of unconventional shapes. Furthermore, the use of the 3D printer allows to eliminate the problem of production waste and, by printing an assembled product, labour costs are saved. In addition, additive manufacturing applications make it possible to reduce the TtM (Time to Market), that is the time that elapse between product conception and placing on the market.

Despite these advantaged, production times and costs may make this technology unsuitable for mass production. The application of additive manufacturing is almost infinite as it can be applied to almost all production sectors.

2.3.9 Augmented Reality

Augmented reality can be defined as a system formed by a set of computer devices capable of allowing a new type of human-computer interaction. The input systems are the technological tools through which the user has the ability to interact with the virtual environment. These tools adapt more and more to the body movements of those who use them, allowing an increasingly realistic involvement. On the base of the type of interaction, we can distinguish three types of virtual reality:

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- **Immersive virtual reality:** this type of virtual reality is mainly composed by a virtual reality headset that allow to isolate the used in a sensory level, immersing him in a completely virtual world.
 - **Non-immersive virtual reality:** this virtual reality uses screens and monitors through which the user perceives augmented reality and can interact with it.
 - **Semi-immersive virtual reality:** finally, this virtual system is a hybrid, in which the user is placed in a room where images of the virtual world are projected on the walls, isolating the user almost completely.

Augmented reality, as for other technologies mentioned above, finds application in various field

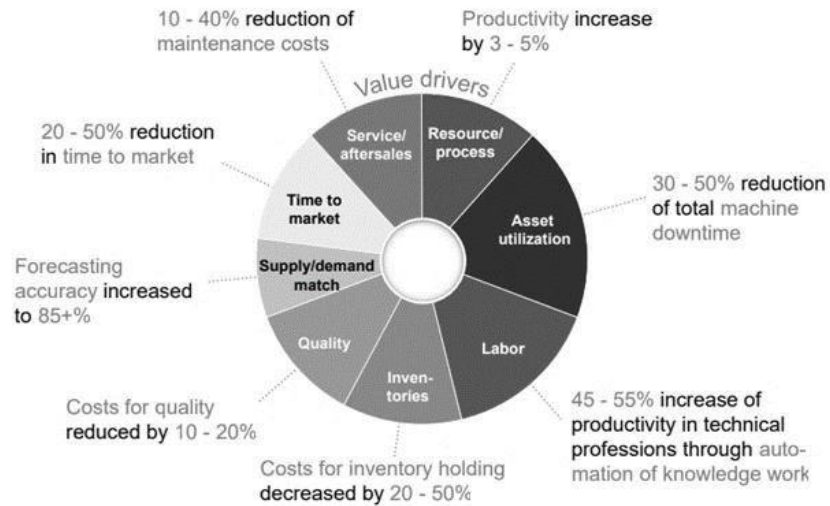
After having deepened from the theoretical point of view which are the main enabling technologies and their characteristics, in the next paragraph we will analyse opportunities that the adoption of these technologies gives to the organization and then the role that these technologies have had in the current crisis situation and their relationship with resilience.

2.4 BENEFITS AND LIMITATIONS OF THE INDUSTRY 4.0

The digitization that took place in companies thanks to Industry 4.0 technologies has led to improvements within companies. These improvements do not concern a single business function but the entire company and, consequently, generating benefits for customers and the environment (Nagy et al., 2018).

Figure 14 shows McKinsey's study (2015) which highlights the expected benefits that the use of these technologies has within organizations. This study is very important as it represents the basis on which many authors have relied to define the benefits within organizations. In the course of the paragraph these data will be deepened with studies by other authors.

FIGURE 14 EXPECTED BENEFIT DIGITIZATION



Source: McKinsey, 2015

From an operational perspective, the enabling technologies of Industry 4.0 allow to optimize process, in particular though virtual simulation and vertical and horizontal integration can be achieved some positive benefits on the supply chain, guaranteeing shorter lead times and a decrease of the Time to Market. Through these reductions, it will be possible to offer the products on the market first, obtaining an advantage over competitors (Rudtsch et al., 2014). Through the digitization process, it is possible to obtain rapid and flexible responses to volatile markets demands or to the sudden customers changes (Schmid et al., 2014). The technology allows you to monitor all sectors of the company in real time. Understanding how processes take place makes gaps and strengths more evident and therefore improves productivity. According to McKinsey (2015), we can obtain a 3-5% increase of productivity with technologies and, moreover, switching to automated production 4.0 can boost productivity in technical professions by 45-55%.

Smart components are able to monitor the production process as well as variation in quality autonomously; in this way, companies get a reduction in process errors, a lower percentage of waste and a more reliable production system (Herman, 2015). Having constantly updated data means being able to control the resources that are used within the production process. Each part of the process can thus be optimized reducing the waste of time and energy (Nasi, 2018). These effects allow to obtain an increase in the quality of production process (Kiel et al., 2017). Moreover, connected goods enable to collect information on the use and characteristics of the

product during the entire life cycle of the product; these can be used to further develop and improve product quality continuously (Lee et al., 2014). A greater efficiency and quality of production process are directly and positively correlated to a reduction in costs; moreover, through the additive manufacturing, which is one of the most important and useful enabling technologies of Industry 4.0, physical and logistical transport processes are reduced, ensuring costs savings. According to McKinsey (2015), it is estimated that this reduction of cost is between 10-40% for the maintenance costs and a decrease in inventory costs between 20% to 50% (Figure 14).

As we know, Industry 4.0 is based on the cooperation of virtual and physical production, through this new way of operating, organizations are able to offer highly customized products and services. For this reason, Fourth Industrial Revolution, inevitably, generates effects also in a strategic perspective. Industry 4.0 leads to the development of new business models that are based on a digital, technological and data-centric business logic. The main areas affecting these new business models concern: advanced product customization, intensification of customer relationships, new know-how based on IT systems and software, considered as key resources, and greater interconnection and collaboration with key partners (Kiel et al., 2017). In defining these new strategic aspects, a fundamental role is played by data, as a growing fusion of physical products and services with data-centric digital improvements and solutions is expected. Therefore, it is needed an organization capable of interpreting data and orienting them towards service. Indeed, services have an important role within Industry 4.0 as we are concerned with how the product is served before, during and after the sale (Trennung et al., 2016). It is important to underline the important role of data, as if correctly interpreted they allow us to anticipate needs but above all crises (Nasi, 2018).

Regarding the social aspects, the flexibility linked to Industry 4.0 and the improvements of processes and management decisions are made possible by the availability of real time data along the entire supply chain. Through the digitalized connection of corporate functions, new processes have been developed such as home office and Smart-Working; across these new models, the working time becomes more flexible and adaptable to the needs of the individual workers. Moreover, through the use of smart devices and robotic assistance systems, ergonomically unfavourable and physically demanding workstations will be carried out by them, preserving the health and productivity of the employees, generating a safe working environment (Hirsch-Kreinsen, 2016). Smart and autonomous production systems take care of monotonous and repetitive tasks, generating a sense of motivation and satisfaction toward workers. These approaches qualify for meeting current demographic challenges since work environment is designed age-appropriately (Kagermann et al., 2013). This coordination

between machines and humans allow to improve labour productivity; indeed, the waiting times among the different production phases can be reduced and, moreover, the R&D process can be accelerated.

Despite the above opportunities, Industry 4.0 is related to numerous challenges and takes place in a highly dynamic competitive environment (Porter et al., 2014). It reshapes industry boundaries, creates entirely new industries and exposes established manufacturing companies to new competitive challenges. For example, new competitors offering intelligent and connected product solutions or even entirely new business models, such as platforms, can emerge rapidly, threatening the current market position of established players. Similarly, increasingly competitive dynamics and the easier entry into the market of new competitors are among the most critical challenges in the era of Industry 4.0 (Müller et al., 2018).

When it comes to Digital Transformation, companies that undertake a similar path take into consideration the technological aspect of change as a fundamental element without considering the human one, linked to cultural changes (Sironi, 2018). Preparing the workers of the Digital Transformation era for change, mainly working on the corporate culture and the fundamental concept of speed that transformation brings with it, represents the great challenge that organizations must face. One of the biggest obstacles to be faced is called resistance to change. Resistance to change does not allow to exploit the machine and technology in all its potential, since the approach one has towards the tool is always "inferior" and scepticism (Sironi, 2018). Furthermore, to design and develop a business model based on the enabling technologies of Industry 4.0, require a substantial initial investment in terms of both costs and time (Singer, 2015). In fact, the capital expenditure for the development of Industry 4.0 is very high. This high initial cost is also to be considered connected to the necessary highly skilled labour. As the implementation of Industry 4.0 implies the need for multi-skilled employees, there is a shift in job design (Waschull et al., 2017). Indeed, the technical skills expected from employees are cutting-edge knowledge, technical skills, process understanding, multimedia skills, coding skills, and understanding of IT security (Sony and Naik, 2019). Employees will need to acquire new skills to manage and maintain Industry 4.0 systems (Bonekamp & Sure, 2015).

Resistance to change, a more competitive environment, high initial costs and the need for skilled labour are just some of the difficulties that today's businesses encounter in the transition from traditional to smart business. Small and large companies face these critical issues differently: while large companies mainly resort to new hiring and training of employees, small companies are sometimes forced to purchase services from third parties or have collaborations (Ministero dello Sviluppo Economico, 2018). In order to guarantee companies, the possibility of digitizing

their processes some funds have been allocated by the Italian government for investments of an Industry 4.0 nature.

The table below summarizes the main benefits, but also some limitations, which we discussed above regarding the application of technologies within the production and strategic process of the organization (Table 2).

TABLE 2 BENEFITS AND LIMITATIONS OF INDUSTRY 4.0 WITHIN ORGANIZATIONS

Benefits	Limitations
Higher quality and flexible production	Resistance to change
Advanced planning and controlling with relevant real-time data	High initial costs
Rapid reaction to changes in demand	Need for highly skilled labour
Increased productivity	Change in the way of working at the operational level
Personalization of products	
Increase in competitive advantages by the successful digital business model implementation and technology creation	
Cost and waste reduction	
Safer work conditions	
Work life balance	

Source: Author elaboration

2.5 TECHNOLOGIES AND RESILIENCE

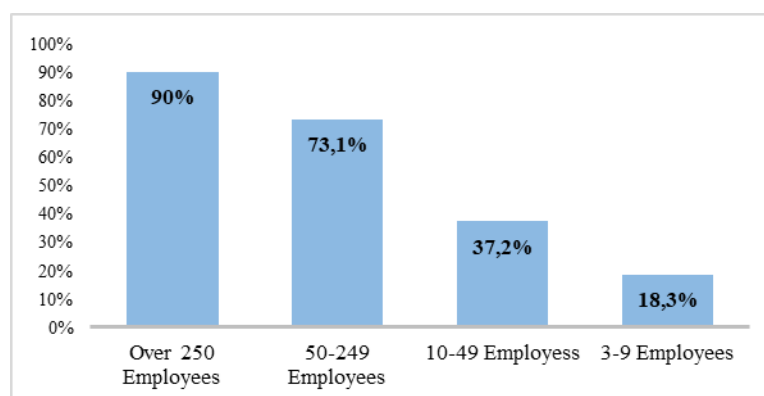
The COVID-19 is producing disruptive changes, and our future depends on managing these changes. Flexibility, the ability to learn and to adapt, to transform threats into opportunities, are the characteristics that will determine the success, and in the long term the survival, of our businesses, cities, districts, territories (Magnani, 2020).

The enabling technologies help companies to be more competitive in the current socio-economic and health scenario and guarantee a principle of business continuity (Longo, 2020). This approach is also due to the growth of all the main IT components and above all the most innovative ones, from the IoT to the Cloud, which drive digital transformation.

Cloud platforms, in particular, have become useful for organizing and managing work remotely, this way of carrying out work in the form of Smart-Working or advanced teleworking, has been the most widespread measure to ensure operational continuity (Amicucci et al., 2020). Before the Lockdown caused by the COVID-19, agile work in Italy was performed by a very low percentage of workers and concerned only 1.2% of company employees, of all sizes (Voltattorni, 2020). According to the study of Istat “*Situazioni e prospettive delle aziende nell'emergenza sanitaria COVID-19*”, with the quarantine the percentage has risen to 8,8%, with peaks of 50% for sectors such as communication and information and 40% for technical and scientific activities. In particular in the crucial moment of the crisis (March and April), Smart-Working was used by 90% of the large Italian companies (over 250 employees) and by 73,1% in medium-sized companies (50-249 employees). Even smaller companies have resorted to this form of agile work, indeed, as regards small business (10-49 employees), the 37,2% adopted the Smart-Working, while for the micro companies (3-9 employees), the 18,3% (Istat, 2020). Figure 15 summarizes these percentages using a graph, distinguishing the companies on the basis of the number of workers.

Even in the end of the Lockdown period (May-June) the shares of remote workers remain significant especially in large and medium sized enterprises (25,1% and 16,2%) (Istat, 2020). Through the joint use of IT and organizational solutions, it has allowed the applications, in emergency conditions, of forms of work previously limited to a small number of staff in order to ensure continuity of work.

FIGURE 15 SMART-WORKING IN COMPANIES



Source: Author's elaboration based on Istat data, 2020

Digital channels such as E-commerce and Social Networks, on the other hand, have represented the most effective solution to promote and sell products, indeed, with the onset of the pandemic, there was a shift of buyers from the physical place of exchange of goods to the virtual showcase of E-commerce (Portinaro and Di Maggio, 2020). The Istat surveys also confirm that "E-commerce, the only growing form of sales, shows an acceleration" in April, achieving "a marked increase" on an annual basis, equal to + 27,1% (Istat, 2020).

According to a study carried out by the B2C Observatory of the Politecnico di Milano, in this period of crisis there has been a growth in online purchases and an increase in online sales of 26% is expected in 2020 compared to the previous year (Figure 16) (Gerino, 2020).

FIGURE 16 ONLINE PURCHASES



Source: B2C Observatory of the Politecnico di Milano, 2020

E-commerce, after being considered for years a secondary sales channel, has now acquired a decisive role in the redesign of sales and consumer interaction strategies. Just think of the results achieved by Amazon, the leader in online sales, which recorded revenues of 75 billion dollars in the first quarter. For these reasons, many organizations that did not use E-commerce channels before the pandemic have had to adapt and introduce these new sales methods into their strategies accelerating in this way the digitization process (Riccio, 2020).

In order to develop these online sales, companies were able to choose between opening their own E-commerce site or relying on third party experts in the online sales sector, as they did not have the necessary technological skills. Among the sectors most affected by the growth in online sales are above all the food, household items, pharmaceuticals and personal care sectors. For example, the Milanese Vitavigor, historic company of made in Italy food, has created an advanced ad hoc online portal dedicated to breadsticks and snacks, thus guaranteeing the possibility of buying products and receiving them expressly in just 48 hours (Riccio, 2020).

Idexè, a company in the children's clothing sector, was present in the national territory only with physical stores, with the advent of the emergency, however, it had to adapt and open an E-commerce section within its website (Idexe, 2020).

It is obvious, however, that to open an E-commerce site, even with the collaboration of third parties, requires certain skills as the E-commerce process requires an adequate logistics system and constant updating of products.

Moreover, the health emergency has highlighted the potential of the use of advanced Big Data and Analytics to monitor the flows and movement of the trend of the virus also with a view to containing and preventing contagion and triggering international collaboration.

Other technological trends that have guaranteed the survival of numerous companies and allowed them to continue production within the smart factory were: additive manufacturing, in fact through the use of the 3D printer it was possible to produce spare parts internally, reducing in this way the dependence on suppliers. Furthermore, the use of the 3D printer has also become useful in the medical field an example of this is represented by the Dallara group which, as mentioned in the introduction, during the pandemic created a non-invasive respirator simply using a 3D printer. Through the collaboration with Isinnova, creator of the valves, it was possible to transform a snorkelling mask into a non-invasive respirator. Through this innovative method, one hundred breathing valves were produced in 24 hours and then distributed within hospitals. The project was not for profit, as the fundamental objective was to obtain a non-invasive respiratory system with low resources, so as to be able to help the greatest number of patients. In addition, the Dallare Group has made the project data available on its open source platform, so that anyone who owns a 3D printer will be able to use it (Pastuglia, 2020).

Furthermore, collaborative and interconnected robots have helped to respect social distancing, allowing to decrease the gatherings in the production sites (Marigonda, 2020). Through augmented reality, it was possible to carry out remote maintenance interventions inside the factories during the lockdown period. Finally Simulation and Digital Twin supports managers, designers and operators in their tasks thanks to the use of intelligent software tools such as CAD / CAM, PLM (Product Life-cycle Management), ERP (Enterprise Resource Planning), which allow you to predict behaviour systems, allowing decisions to be made in real time and making models more reliable, in order to adapt to the surrounding environment as well (Marigonda, 2020).

Based on these data and information, we see how much in this situation of crisis the adoption of technologies is essential for survival, becoming the key factor on which to base one's own organizational resilience.

The study of Marcel Morisse from the University of Hamburg in collaboration with the consulting company Deloitte (2017), identified the positive correlation between resilience and technologies. Indeed, they identify in the technologies of Industry 4.0 not only the tools to increase productivity and competitiveness but also a tool to overcome the crisis situation in an optimal and fast way in order to generate a better economic performance (Morisse, 2017). In particular, according to this study the most useful technologies concern: Big Data and Analytics, Cloud, IoT, Additive Manufacturing and Augmented Reality. At the same time, however, this study presents some critical issues as it does not identify in which crisis situations these technologies are most useful, established that organizations that over time have developed digitization processes have an advantage over the others as they have developed a greater flexibility in adapting to changes, thus identifying a general positive relationship between resilience and technology.

The socio-economic and health crisis has highlighted the "technological gap" between companies that have invested in research and innovation and other companies that have instead continued to navigate in their "technological unawareness". Indeed, in order to be able to put the above technological solutions into practice in a period of crisis, it is necessary that organizations have previously developed digitization processes.

In the graph below (Figure 17), we can see the comparison of reaction to unplanned event between traditional companies and digital companies, which are companies that introduce in their organization process of digitalization. Generally, every unplanned event causes a reaction and finally an action. The path to action, however, is often long and difficult. How we can see from the graph there are four phases:

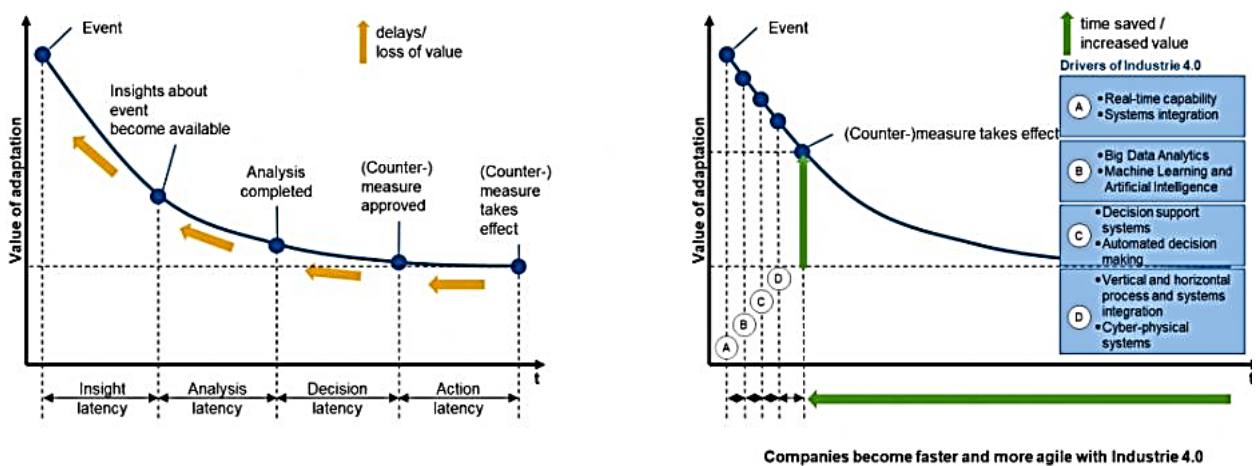
- *Insight phase*: this first phase identify the time necessary to realize that the event occurred
- *Analysis phase*: this phase represents the time useful for understanding what happen.
- *Decision phase*: it is the time to decide what we want to do about it.
- *Action phase*: which indicate the time to take measures to address the event.

More an event is critical and more is the time that goes from the identification of the event to its resolution increases. Indeed, as we can see in the graph on the left (Figure 17), the process in the event of an unexpected event is very slow, consequently generating a loss of value. On the other hand, however, we are witnessing the same situation experienced but from an organization that has developed Industry 4.0 practices internally, as we can see the time that goes from the moment of identification of the event to the final moment is very short, indicating

a speed of application.. This is because thanks to the implementation of 4.0 technologies, the organization becomes faster and more agile and allows a rapid response to these crisis situations, also generating an increase in value.

This graph, however, is based on theoretical assumptions that through the use of Big Data Analytics, Vertical and Horizontal Integration and Artificial Intelligence, it is possible to respond more quickly to a crisis situation but without any kind of given in support. In fact, it is true that technologies, especially in this crisis, have proved indispensable, but it is equally true that we need to analyse any critical issues that may exist.

FIGURE 17 REACTION TO UNPLANNED EVENTS



Source: European 4.0 Transformation center, 2020

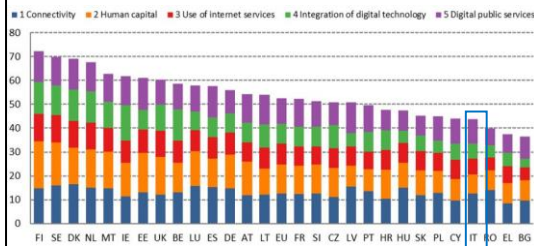
In general, as we saw in the previous chapter, an organization is considered resilient if it is able to flexibly adapt to changes; thanks to enabling technologies, production processes are more flexible and are able to respond quickly to changes. As we have seen for the case of Smart-Working, but not only, new technologies also guarantee the continuity of work, a fundamental characteristic for a resilient organization. Indeed, despite the crisis conditions, a correct use of technologies allows organizations to continue to carry out their work through the use of robots and autonomous and additive manufacturing. This way the organization can gain a competitive advantage over your competitors. To address the crisis, a resilient organization also relies on a diversified product portfolio. Product diversification can also be a guarantee, in this case, with adequate technologies. Highly technological production plants, in fact, give companies the possibility of creating different types of products; in this way the company manages to overcome the moment of crisis or even, by optimally exploiting its technological skills, an

organization can modify its production in favour of products that guarantee the continuity of the company even in times of crisis, for example, in the previous chapter in the case of adaptability we have seen companies that have managed to reconvert their production and to be able to do this within them have developed adequate technological capabilities. To maintain an advantage over competitors, it is also important to diversify the technologies used and IT systems.

BOX 1: INDUSTRY 4.0 IN ITALY

Up to this point, we have theoretically analysed what is the Industry 4.0, what are the benefits of Industry 4.0, its criticalities and what are the so-called enabling technologies and what is their impact in the world. But in Italy, at what point do we are in terms of digitization? How we can see from the graph below, at European level, Italy remain very low in the rankings indeed it holds the position number 25 out of 28 countries and has values below the European average. These data come from the Digital Economy and Society Index (DESI) that is a composite index that summarises relevant indicators on Europe's digital performance and tracks the evolution of EU Member States in digital competitiveness (European Commission, 2020)

Figure 1 Digital Economy and Society Index (DESI) 2020



Source: European Commission, 2020

At national level, the results of the digitized processes started are not so negative. Indeed, according to the results presented by the Politecnico di Milano, the results achieved by Italy in 2018 are very good and are expected to grow over the years. With the launch of the National Industry 4.0 Plan in 2017, indeed, investments in Industry 4.0 have increased. Indeed, how we can see from the graph (Figure 2) below from the 2017 to 2018 there has been an increase of investments in this market of the 35%, instead in the period between 2018 and 2019 the value of the Industry 4.0 market increased but slightly less than in the previous period (+22%) reaching 3.9 billion euros (Politecnico di Milano, 2019)

Figure 2 Market Value 4.0 Italy

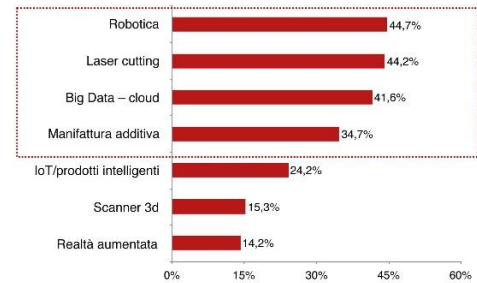


Source: Politecnico di Milano, 2020

According to the data of 2019, the most used technologies are the Industrial IoT, (+42% respect the previous year) and the Analytics, with an +39%. Cloud Manufacturing focuses on accessibility and collaboration in supply chain processes and records +27%. Additive Manufacturing (+34%) is consolidated thanks to production flexibility. Advanced human-machine interface applications in maintenance, product development and training processes are also growing (+20%), among these, 70% are augmented reality solutions and 30% virtual reality. Advanced Automation applications' grow of the 15% compared to the previous year. In addition, there is a 17% increase compared to 2018 in consulting and training activities for Industry 4.0 projects (Politecnico di

Milano, 2020). Based on the census of companies carried out by Istat in 2019, which involved a sample of 280,000 companies with more than three employees, it was shown that 77.5% of Italian companies use key digitization technologies or invest in this sector (Istat, 2019). The propensity to adopt digital technology increases as companies get bigger: indeed, for companies that have more than 500 people, we reach 97.1% (Istat, 2019). Small and medium-sized enterprises (SMEs) represent a very important factor for the Italian economy, indeed, according to Istat, SMEs realize about 68% of the total added value and employ 79% of the total employed. The Digital Manufacturing Laboratory of the University of Padua has therefore focused its attention on the digitization processes of SMEs, identifying the benefits and results obtained from the introduction of these technologies. On the basis of the "Second Industry 4.0 Report in Italian SMEs", the results of a sample of 1,020 manufacturing companies in the Made in Italy sector, present in Northern Italy and with a turnover in 2015 greater than 1 million euros, were recorded. The first relevant figure is that the share of companies that adopt at least one Industry 4.0 technology is about 18.6%. Therefore, only one in five companies appears to have invested in this direction and, by analysing the source, it is noted that these are companies with a turnover of about 15 million euros with an average of 58 employees and a production located on the national territory (Università degli Studi di Padova, 2018)

Figure 3 Use of Industry 4.0 technologies in SME



Source: Laboratorio Manifattura Digitale, Università degli Studi di Padova, 2018

In figure 3 the most used technologies by these companies have been analysed from the point of view. we note that the most used enabling technologies of industry 4.0 are: robotics, laser cutting, big data and analytics and finally additive manufacturing. The main reasons that push these companies to adopt these technologies are: the improvement of customer service (with a high or very high relevance for 75% of companies) followed by an increase in internal efficiency (65%). These needs find a good match in the benefits obtained ranging from an increase in internal efficiency (60%) and increased productivity (54%) to improve customer service (53%). At the same time, however, there are difficulties in adopting this path: in the first place a problem, that of skills, which is strongly felt by companies of all sizes, in small companies is often even more acute because, on the other hand, large companies are more attractive (in terms of career prospects) for highly sought-after professional figures, on the other hand, SMEs hardly have the necessary resources to activate significant training courses (as can happen in large ones) (Università degli Studi di Padova, 2018).

2.6 CONCLUSION

In this chapter, the theme of Industry 4.0 was explored, which today represents a very important Industrial Revolution based on cooperation between machines and humans. As we have seen, Industry 4.0 is represented by nine enabling technologies and the adoption of these technologies leads to the digitization of processes within an organization. Digitizing the company, however, means not only acquiring new technologies but activating a process of change that affects the management of the company, pursuing objectives of flexibility, speed, productivity, quality and greater competitiveness of its products. It can be said that Industry 4.0 does not only want to introduce new and more advanced technological equipment in companies, but also to combine different technologies already present in the company to integrate the factory system and the production chains involved in a connected system. The aim is therefore to combine technological changes with the resulting reorganization of work processes, destined to be distorted together with the markets of companies. In order to do this, as we have seen, the development of new skills and knowledge is required, combined with a greater level of involvement and participation of workers in production processes. The transformation from a traditional business to a smart business, however, encounters some challenges represented for example by the loss of jobs and resistance to change. Furthermore, for large companies, which have higher capital and know-how, it is easier to adopt these technologies unlike small companies which are forced in most cases to request these services from third parties.

During the pandemic generated by COVID-19, digitization proved to be a tool essentially in containing the spread of the virus, managing the crisis and mitigating its consequences also at an economic level. New digital technologies, such as Smart-Working and online sales, have allowed businesses, workers and consumers to continue interacting, thus avoiding the total paralysis of many essential activities and services.

For these reasons, the current crisis situation has led companies to accelerate the digitization processes and to focus more on those areas that have proved to be strategic in emergency management. In particular, the interest of companies in the adoption of digital solutions for an innovative organization of work and relationships with customers and suppliers is growing; the implementation of integrated digital networks also favoured by a greater diffusion of the cloud, the spread of high-speed Internet and the introduction of IoT technologies. From this information it follows, therefore, that the adoption of technologies is an essential factor for survival and becomes a key factor for achieving organizational resilience. As we saw in the chapter, this relationship between technology and resilience finds application from a theoretical point of view, without, however, finding any type of data among the authors cited.

In the next chapter, we will try to prove the relationship between technology and resilience from a practical point of view through interviews aimed at digitized companies in order to understand if the adoption of technologies has actually allowed organizations to have a competitive advantage.

CHAPTER 3: HOW DID THE DIGITALIZED COMPANIES REACT TO THE CRISIS? SOME CASE STUDIES

3.1 INTRODUCTION

In the previous chapters we have analysed from the theoretical point of view the concept of organizational resilience, understood as the ability of an organization to respond to a crisis situation, and the technologies of Industry 4.0 that lead to the digitalization of companies.

As we have seen, the current crisis situation has highlighted the need for companies to possess certain technological skills in order to overcome the crisis, identifying technology as a fundamental tool for overcoming the crisis. Resuming the study presented by Unioncamere (*Figure 1 Situation of Organization COVID-19 Emergency*) it emerged that companies that had already undertaken digitization plans, investing continuously in the areas of digital transformation, proved to be more resilient in dealing with the exceptional situation that hit the country (Unioncamere, 2020).

The aim of this thesis is to understand if there is in any way a relationship between resilience and technology, for this reason, through case studies of digitized companies in the national territory, we will try to understand how they reacted to this emergency situation and whether the adoption of previous technologies has allowed them to better face the crisis situation.

Before proceeding with the analysis of the results obtained, in the following paragraphs will be described the research method used and a brief description of the sample analysed.

3.2 METHOD OF ANALYSIS

Before proceeding with the discussion of the business cases examined, it is necessary to identify the method of analysis used. The method used to collect information was the interview, these interviews were administered to the companies being researched in the period of October / November 2020, as it represents the period following the recording of the first results after the

first wave of COVID-19. We have chosen to interview the owners of the companies, who generally correspond with the founder or with the son, as they represent the key figures for the digitization process.

Unlike the questionnaire, the interviews allow for greater interaction with the interviewee, ensuring that the questions are interpreted correctly (Della Porta, 2014). As we know we can have three types of interview: structured, semi-structured and unstructured. In this case, we decided to use the semi-structured interview, as it is a non-directive interview, because there are no pre-determined answers from which the interviewee must choose; the interviewee is therefore free to respond according to the contents and expressive methods he deems most suitable (Della Porta, 2014). This methodology provides a trace of the topics that must be addressed during the interview, this trace can be constituted by a list of topics or, as in our case, by a series of questions of a general nature on the subject being analysed. Although there is a trace, the conduct of the interview can vary on the basis of the answers given by the interviewee, for example it can develop arguments that arise spontaneously during the interview or it can anticipate some answers and therefore the interviewer must change the order of some questions. We can therefore say that this method allows a certain flexibility in the answers, guaranteeing a greater compression of the treated topic.

In the box below, we can identify the questions used for the interviews. As we can see, the questions refer to two different situations: the first part includes questions relating to when the company adopted the technologies, the reasons that pushed them, the type of technologies adopted and the advantages; while the second part, on the other hand, includes questions regarding the COVID-19 situation and the effects that the adoption of the technology has had. In this way we were able to have a complete vision of the company, analysing the steps that led them to be a digitized company, to then understand the effect that the technologies developed have had on the reaction of these companies to the current crisis.

Of course, these questions were guidelines for conducting the interviews, but in most cases the order was not followed as some topics were anticipated, leading to a change in the order of the questions, or dealing with unplanned topics; for this reason we can say that the interviews were also adapted according to the company that was interviewed, ensuring greater flexibility and more colloquiality with the interviewee.

BOX 2: INTERVIEW QUESTIONS

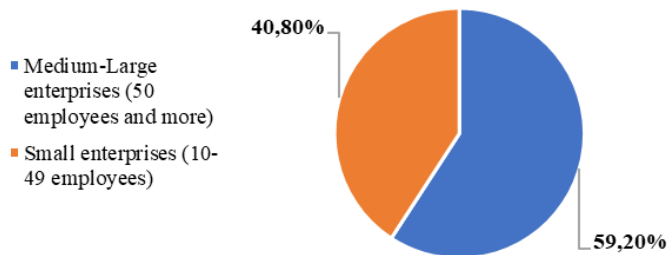
- As you are a digitized company, do you think you have a high, medium or low level of digitization?
- What are the most developed / used technologies within the company?
- How long have you been implementing these technologies and what was the motivation that prompted you to adopt these technologies?
- What were the positive affects you have obtained from investing in technology? Were they budgeted or were there unexpected or exceeding expectation? Were there any critical issues?
- During the COVID-19 situation, how did the company react? Have you continued to work? How much drop in turnover do you expect for the year?
- Have the technologies that you have adopted over time helped and / or are they helping you to cope with the situation that has arisen with COVID-19?
- Because of how you faced the crisis, do you think that the adoption of technologies has given you an advantage over your competitors?
- Are you planning further investments in digital? And if so, for which technologies?

3.3 BUSINESS CASES ANALYZED: SOME GENERAL INFORMATION

The interviews were carried out among four Veneto companies. We have chosen this region as it has a high concentration of manufacturing companies, representing a fundamental economic asset for our country (De Francesco, 2018) and, moreover, many of these are embarking on a digital transformation path. Indeed, according to the DESI (*Digital Economy and Social Index*) of 2019, Veneto is one of the nine best regions in the field of technology and digitalization with an average higher than the Italian one (European Commission, 2020).

According to a study conducted by Unioncamere in 2019, 44,5% of manufacturing companies in Veneto, with at least 10 employees, declared that they had adopted one or more enabling technologies of Industry 4.0. Of these, most are represented by large companies, indeed the medium-large companies (50 employees and more) that invest in digital are 59,2%, compared to 40,8% of small companies (10-49 employees) (Figure 18).

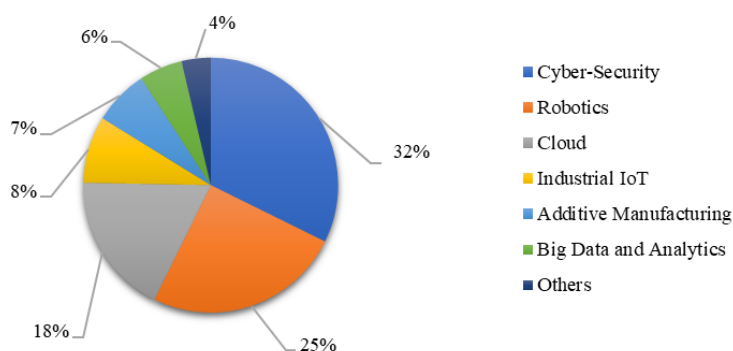
FIGURE 18 DIGITAL COMPANIES IN VENETO



Source: Unioncamere, 2019

Breaking down the data in relation to the sector to which the companies belong, it emerges that the adoption of technologies regards especially companies in the rubber and plastic; food, beverage and tobacco; and sectors of electrical and electronic machines (Unioncamere, 2019). The graph below (Figure 19) shows the technologies mainly adopted by these companies, in particular among the most used technologies we find: technologies related to IT security (32,3%), integrated robotics (25%) and cloud computing services (18%). On the other hand, the share of companies that have activated technologies for Industrial IoT (8.5%), additive manufacturing (7%) and Big data management and analysis (5.5%) is lower (Unioncamere, 2019)

FIGURE 19 TECHNOLOGIES ADOPTED BY DIGITAL COMPANIES



Source: Unioncamere, 2019

After having made this brief excursus on the situation in the region, let's focus on the companies under discussion.

The companies that we went to interview were: Better Silver, Bravo Spa, Ono Exponential Farming and Texa Spa. As we can see from the map (Figure 20), these are companies located respectively in the provinces of Vicenza, Verona and Treviso.

FIGURE 20 LOCATION OF THE CASE STUDY



Source: Author elaboration

These are both B2B and B2C companies active in different sectors, this will allow us to have a broader vision of the phenomenon of digitization within multiple sectors of the economy. The main economic characteristics are summarized in the following table (Table 3).

As we can see from these preliminary data, these are medium-large companies with a medium-high turnover.

It is important to underline that ONO EF despite registering sales of 0,00€, still generates positive EBITDA since in the financial statements are recorded in the Total Value of Production Increase in fixed assets and Other Revenues not specified by the Company.

TABLE 3 GENERAL CHARACTERISTICS OF THE CASE STUDY COMPANIES

COMPANY	FOUNDATION	INDUSTRY	REVENUES (2019)	EBITDA	ROI (%)	ROE (%)	ROS (%)	EMPLOYEES
BETTER SILVER	1977	Manufacture of jewellery and precious metal gold smithery or coated with precious metals	48.065.510,00 €	5.736.509,00 €	8,43	16,05	6,72	100
BRAVO SPA	1967	Manufacture of machinery for food, beverage processing	11.719.773,00 €	1.303.952,00 €	6,31	27,39	6,43	59
ONO EF	2018	Manufacture of industrial robots for multiple use	0,00 €	48.790,00 €	2,19	2,19	27,79	1
TEXA SPA	1992	Manufacture of electrical and electronic equipment for motor vehicles	117.864.781,00 €	23.697.024,00 €	41,08	45,94	19,74	497

Source: Author Elaboration

As we can see from the founding date, the sample features both outdated companies, and which therefore had to digitize themselves over time by applying technologies to products and / or production processes to increase efficiency; and younger companies, therefore born digital.

In the following paragraphs, we will analyse each company individually and through the company financial statements, the information collected on the companies' websites, and the interviews we will build empirical evidence. In particular, the paragraphs will be structured as follows: we will start with a brief description of the company history, we will move on to analyse the steps that led to digitization, identifying whether there are also economic advantages, and finally we will analyse the reaction to the current crisis situation.

After having analysed each company individually, we will develop a comparison between these cases that will allow us to identify if the digitalization of companies has been useful for these companies to face the crisis.

3.4 BETTER SILVER



3.4.1 Company Profile

Better Silver was born in 1977 from the idea of the current president Romano Bettinardi in a small garage in Bressanvido (VI), where the first products and skills that are the basis of the company's success were developed. Better Silver produces chains and jewellery, semi-finished and finished, in bronze and silver for wholesalers, shops and manufacturers. Better Silver's Mission is to "anticipate the market" to improve its competitiveness, guaranteeing maximum customer satisfaction, through the quality of the products and services provided, a wide range of offers, the guarantee of delivery times and fulfilment of orders, maximum transparency and availability in commercial relations. Technological and product innovation, teamwork carried out by professionals in the sector and customer satisfaction are the distinctive features that distinguish the Better Silver style. The company has 100 employees and is part of the Bettinardi Group, holding of the family of the same name that also controls Easy Silver and Rbs Exim. Better Silver mainly sells abroad, indeed most of its sales are generated in the approximately 90 countries to which it exports, while only 15% are sold in Italy.

Better Silver closed 2019 with a profit of € 2,956,519, slightly lower than the previous year (-11%). This decrease also affects the ROE which undergoes a decrease compared to the previous year, despite this, the level of ROE is still satisfactory and is equivalent to 16,05%. The return on investment (ROI²), on the other hand, corresponds to 8.43%, which represents the return on investments made in operational management. A high level of ROI is generally expected for organizations that invest in digital. As regards turnover, the company closed with a slight decrease compared to the previous year (-2.5%) and the ROS³, which represents the return on sales, was positive with a value of 6,72% also in this case the downward trend is confirmed compared to 2018. At a financial level, the company has a positive net financial position, it means that the company has a surplus of cash and cash equivalents over the debt.

² ROI: Return on Investments (Operating Income/Cost of Investment) *100

³ ROS: Return on Sales (Operating Income/Revenues) *100

After this brief description of the company and its economic situation in December 2019, let's move on to analyse the different steps of the company's digitalization.

3.4.2 Digital Strategy

Better Silver has always believed that digital is a fundamental tool for business development, helping it to be more efficient. This propensity, which has always been visible in the company, has accelerated over the last 10 years. According to Paolo Bettinardi, CFO of Better Silver:

“The company has always been ready to embrace new digital solutions and has worked hard in the digital field, we are committed and invested heavily in numerous digital projects, perhaps we could have done something less, nothing more and nothing before. We are ahead of our competitors and we invest around 10-15% of total investments in digital. Today on the market there are several digital solutions that can help companies, the problem is that the entrepreneur alone cannot know them all, so he needs "digital talents" who bring new ideas and propose cutting-edge digital solutions”.

The first decade of Better Silver's life was characterized by a strong ability to be able to satisfy the preferences of the market and thanks also to an increase in demand, the company expands and builds a large product catalogue and builds the first production plant. Its commercial network was defined thanks to the participation in numerous fairs dedicated to the orifice. Over time, Better Silver has managed to develop a strong reputation in the sector and consequently also came into contact with major brands such as Pandora and Swarovski, who were asking for a product on which to place their brand and ready to be placed at the inside their stores.

In the 2000s, a strong push was given both to production, thanks to the purchase of latest generation machinery for greater product differentiation, and to sales thanks to the company's entry into online sales channels.

In 2005 the external context began to change, the quantity of orders from wholesalers decreased, the price of silver was rising, the market began to demand more elaborate products and the number of substitutes on the market increased. This difficult situation brings to Better Silver the need to change and the first steps towards the digital world begin.

“At a certain point we realized that something had to change, starting from overcoming the figure of the intermediary that generated a great loss of value, both because we lost track of the product on the market since the company did not have direct contact with the customer, and because a product was sold at a lower price than the final value with which it was placed on the market. In addition, we wanted to be able to sell our products directly to stores, but it was difficult because they required minimal lots. The supply was not

very convenient and we were unable to achieve economies of scale. The shopkeepers continued to maintain strong relationships with intermediaries, so sales were also influenced by a relationship of trust between shopkeeper and wholesaler”.

In 2007 the company began to review its strategy and decided to equip itself with a channel for online sales, especially to be able to manage even small orders from stores. Thus, was born Silver Retail, the B2B website dedicated to the online sale of finished products for stores, managed by the subsidiary Easy Silver. In addition, this platform had the objective of capturing precisely that slice of the market on which the company was less present, that is, the national market. Over time, the project has evolved and many resources have been dedicated to build the structure, to have dedicated staff, the warehouse, to carry out the communication campaigns. Although the platform had numerous registered customers, about 13 thousand registered companies (of which 70% Italian companies and 30% European), it never achieved the desired results to allow it to grow in turnover and, moreover, management costs were very high. This experience has provided a new vision of the market, contributing to the creation of new knowledge within the company, necessary for future development. With the advent of the 2008 crisis, the dynamics in the market changed and at this moment the need arises to further diversify the offer, developing a new strategy aimed at attracting the attention of the big brands and opening up to other markets in response to a general crisis in the sector.

Between 2011 and 2013, following multiple changes in the market, the company embraces digitalization and new marketing and internationalization strategies.

“In recent years, Better Silver's commercial strategy has changed: on the one hand, the intention was born to develop a line under its own brand and sell it directly in the owned stores, as well as on the online platform, on the other hand the 'goal is to increasingly surpass the figure of the wholesaler and be able to become a supplier of new big brands, in addition to Pandora and Swarovski, and distribution chains (Stroili), thus overcoming the intermediate figures that generated significant losses in value”.

After several years of experience gained in the field thanks to the Silver-Retail platform and driven by the idea of presenting itself on the market directly with a finished product and its own brand, Better Silver enters the market with the Roma 1947 brand. Subsequently, an online platform also for the Rome brand, but this time no longer dedicated to B2B customers such as Silver-Retail, but to the B2C channel, for a male and female audience. In 2016 Better Silver worked with around 80 countries and compared to the early 2000s the composition of sales has also changed, no longer just companies and brands, but also the final consumer. Precisely this

change has led to a turnaround in business strategies, recognizing the need to outline a well-defined commercial action towards the final consumer and where to rethink the business model.

In 2017 the company had developed its own E-commerce platform for both the B2B channel and the B2C channel, through the Roma brand, a strategy focused on developing the online commercial network that we could consider in line with what is shown by the trends of the last years.

From 2018 the company decides to close Silver-Retail and to entrust the subsidiary Easy Silver, no longer with the management of online sales, but with the opening of a chain of stores for the sale of Roma 1947 brand products. While all the companies started to sell online, Better Silver decided to open a chain of its own stores. They are physical points of sale, located in cities with greater tourist influxes, such as Venice, Verona or Florence, in perfect made in Italy style, to make you live a real experience for the tourist who wants to take home a piece of Italy. The idea then is to push the tourist to visit the E-commerce platform and to make subsequent purchases via the web. Over time, awareness develops that online and offline sales are complementary to each other, in this sense, Better Silver is trying to create coordination between online and offline. Indeed, Paolo Bettinardi says that:

“It is not possible to focus only on one or the other mode of sale, but these must coexist: if the physical store manages to make consumers converge on the online channels, secularly the online channel can push the consumer to visit the store thanks to the support of social networks and targeted and geo-localized communication campaigns”.

Despite these investments for physical stores, within the stores we can find the application of digital solutions, one above all represented by big data. Indeed, the company needed to be able to control what was happening inside the store, for this reason, with the help of a supplier, a system was developed, interfaced directly with the management system, which allows you to collect information on consumers who enter in the store and analyse them in order to get to know the outlet market better. In real time, on a dashboard, even remotely, it is possible to know: number of receipts issued, amounts, consumer sex, nationality, age, date of purchase or visit to the store and many other information. Thanks to these data it is possible to make various arguments on the strategies to be implemented, for example knowing the nationality of the customer could be useful to understand which products are more attractive in certain countries.

We can therefore say that the physical store does not only cover the general function of contributing and generating turnover for the company, but represents a real container of information that allows to better understand the market and develop new strategies.

It is interesting to note how digital has at the same time brought the company back to more traditional sales logic and has brought innovation within the stores such as to make the collected data instrumental to future strategic choices, also and above all in terms of internationalization. In fact, Paolo Bettnerdi says that:

“Digitization is a necessary condition for internationalization. If today the company did not have the digital tools at its disposal, it could not think of working with certain realities. Without digitization, we could not continue to maintain leadership in the markets. The company has always tried to update itself on the existence of all those possible tools that can facilitate it”.

Thanks to digital, Better Silver shares its warehouse with its two main customers, Swarovski and Pandora, so they can from time to time calibrate their orders based on the stocks that are available at that time. In this sense, digital has enabled Better Silver to overcome the need to open a warehouse near the branches of the two customers.

Moreover, the production is carried out inside a 12,000sqm warehouse with more than 1.000 machines in order, if the company did not equip itself with the appropriate digital tools, it could not monitor production, know its status and receive data in real time. Machines and systems have been interfaced to communicate directly with the management system, both to have a control in real time, both to give an answer to the customer regarding the status of his order, and to make predictions.

As we can see from the graphs below (Figure 21), following a not particularly prosperous period in 2012, thanks to digital investments and new strategies, we see a constant trend in revenues and a growth in Return on Sales, indicating that the company is growing more than effectively.

FIGURE 21 BETTER SILVER TURNOVER AND ROS



Year	2011	2012	2013	2014	2015	2016	2017	2018	2019
Revenues/000	58.220,20 €	48.647,95 €	41.383,81 €	39.232,33 €	38.569,23 €	45.690,75 €	47.812,96 €	47.445,73 €	48.065,51 €



Year	2011	2012	2013	2014	2015	2016	2017	2018	2019
Return On Sales (ROS)	2,27%	-0,30%	0,87%	3,55%	2,64%	10,45%	10,93%	8,92%	6,72%

Source: Author's elaboration based on AIDA data

After having explained the steps that led the Better Silver Company to invest in digital over time, now we will deal with understanding how the company has reacted to the current crisis.

3.4.3 COVID-19 Reaction

As we have seen, the advantages obtained by Better Silver from the digital point of view are the result of investments made by the company over a period of time that had its greatest fulcrum in the period called by the company itself Digital Era between 2011 and 2013.

In this period of crisis, more than ever, for Better Silver digital has proved to be a fundamental tool for the company's survival, not only from a strategic point of view but also from an operational one.

For the company, the 2020 had started very well, indeed, thanks to a fair in Vicenza, the company had managed to obtain a large amount of orders, marking a + 25% at the end of February compared to the last year. Furthermore, the entry into the workforce of a new manager who came from a large multinational in the sector, accelerated the processes of change that were underway, especially in the strategic field but also from the operational point of view.

Unlike other businesses that have experienced the Lockdown period with some difficulties, Paolo Bettinardi stated that:

“We realized that Lockdown has provided us with the perfect opportunity to pursue our objectives and to initiate and implement many activities aimed at preparing us for tomorrow and becoming a stronger and more strategic partner for our customers.”.

In particular during this period, the CRM has been modified, making it more automated so that it is the CRM that guides all activities, and this new CRM will be ready by the mid-November. In addition, a new ROME 1947 E-commerce site will be launched, as thanks to the help of a Social Media Marketing, they realized that the site created in 2015 was a bit dated and, moreover, it was not easy to make purchases via the device. The new site will be launched by the end of November and the company hopes it will present the desired results that E-commerce has never been able to give.

To cope with this crisis situation, in addition to the implementation of the Smart-Working for the for staff, company has developed a virtual room developed in just two months between May and July. Through this room the company is able to carry out virtual fairs, very important for the sector, and meetings with customers, managing to keep the image quality high as the image for them that sells jewels represents a fundamental characteristic. The company has managed to put into practice quick solutions to the crisis situation thanks to the development of infrastructures over the years and therefore Better Silver has understood how digital has been a

fundamental tool in these times of difficulty. Indeed, the company has understood that a reference point in the company is necessary, that is, it is essential to have a person within the company who knows the needs of the company but who, at the same time, knows the innovation that exists outside.

When we talk about infrastructures, however, we are not referring only to information technology but also to cultural ones. Indeed, as reported by Paolo Bettinardi:

“The most difficult thing is to be able to create a mentality aimed at change, once you succeed in this everything is easier. Today, fortunately, people are very open to change and this attitude to the new is very developed”.

Of course, there was some resistance from the staff but today people in the company tend to be much more open to change. For example, a robot was introduced in the warehouse to be able to carry the products from one consecutive step to another, thus guaranteeing a reduction in waste of time and guaranteeing a faster process, but at the beginning this innovation was not living well because the work of the robot was carried out by a person, but after that even in the company they were no longer able to do without it, generating a sort of resistance to go back to what was there before the change. This means that the change has been effective for the firm. Again Paolo Bettinardi:

“The profitability of digital is not easy to verify. It takes an open mind that leads to the definition of the benefits. We can say, however, how many things would not have been possible without digital, how many lost sales and business we would have had if we had not made the journey of digitalization. For example, in September I managed to hold this fair thanks to the technologies developed, managing to be exhaustive, punctual, guaranteeing a 360 ° view of the product without having to go to the physical place. We will most likely carry this COVID-19 thing into the future, guaranteeing cost and time savings both for us as a company but also for the company. One thing, however, that must be weighed is the human aspect”.

Despite these precautions through the use of digital, there will still be a negative effect even if in the month of October just ended the values hovered around those of last year. Indeed, what was lost in March, April and May is no longer possible to recover, for this reason the company plans to close the year with a -26 / -27% compared to the previous year, while maintaining a positive EBTDA thus generating a profit.

Although the company does not sell a basic necessity, Paolo Bettinardi brings to light the behaviour of consumers:

“Consumer behaviour was different between the first and second waves. In fact, today there is a different awareness that affects consumer behaviour. This can be seen in the level of retail sales in the sector which, against all odds, have not declined. This is because on the part of the final consumer there is a desire to return to normal”.

One factor that emerges from this interview is the working condition. Indeed, thanks to digital, the company is working better, information's are easier to find and are available to everyone. Compared to its competitors, the company plans to widen the advantage towards them more and more.

For the future, the company is already starting to implement new digital solutions, including: the use of drones to transport products between the two production sites; a collaboration with H-Farm and the use of a 3D printer to create a resin chain, easily transformed into metal, which will lead to the customization of the product.

3.5 BRAVO SPA



3.5.1 Company Profile

The Bravo Spa was founded in 1967 by Genesio Bravo in Montebelluna Maggiore province of Vicenza. Today is one of the most important worldwide firm for the production of machines for ice-cream, pastry and chocolate shops and restaurants. Genesio Bravo in 1974 has revolutionized the way we conceive the ice-cream shop laboratory with the invention of Trittico, the first and only complete laboratory enclosed in just one machine, which in less than one square metre pasteurizes and batch freezes high quality artisan ice-cream. After more than 50 years Bravo continues to grow thanks to the continuity of the new generation. Turnover grows, the trademark repositions itself on the market, the sales network increases year by year and international branches spring up transforming Bravo into the solid and efficient international company which it is today. Bravo is a forerunner of trends not only in terms of technology but also and above all in terms of ideas and services for its customers. “We travel the world, explore new markets to identify trends, translate them into technology and bring them to your home”, this is the mission on which the company is based. The company grows so much that it also inaugurates foreign branches that transform Bravo into the international reality it is today. The branches present are: Bravo France with headquarters in Paris, Bravo Asia with headquarters in Singapore, Bravo North America with headquarters in Charlotte,

Bravo Deutschland with headquarters in Munich and Bravo Middle East with headquarters in Dubai. The whole group, considering Bravo Spa and its foreign subsidiaries, generates a turnover of around 15 million and employs just over 100 employees (in Italy there are 59 employees). Over time, the company has managed to create numerous partnerships with the best pastry and ice-cream interpreters, bringing its products into the kitchens of masters of art. Bravo Spa closed the 2019 with a turnover of 11.719.773 just a little lower than the previous year (-9%), with a ROS of 6,43%, this index is lower than the previous year. We are witnessing an increase in ROE which goes from 9.15% to 27.39%, this increase derives from the increase in profit that the company obtained in 2019. As regards the Return on Investments (ROI), also in this case we see a slight increase over the previous year. At a financial level, the company has a positive net financial position, it means that the company has a surplus of cash and cash equivalents over the debt.

After this brief summary of the company's distinctive information, let's move on to analyse in detail the digital investments made by the company over time.

3.6.2 Digital Strategy

Two factors that have always distinguished Bravo Spa from its competitors are innovation and internationalization.

For many years, the idea was that the machine could sell itself, its quality is so high that the first models produced still exist and resist. Initially only Italy and Germany were enough as markets, the Bravo grew on the thrust of its machine and on the wave of growth that the ice-cream parlour was experiencing. His son Giuseppe was immediately sent around the world to take care of the company's commercial affairs. During his long experience, Giuseppe realizes that machine sales were performing better abroad, rather than in Italy. The company's performance had dropped around the 2000s and the company name had been partially tainted by some negative references. With these words, Giuseppe Bravo tries to explain what Bravo Spa's problems were:

“The Bravo innovated the machines at such a speed that 5 new models were released in a year, Mr. Genesio wanted to anticipate the times, but the salesmen of the dealers could not keep up with all this innovation. So many customers decided to change companies. Not even brochures could keep up with so much innovation, new machines and old brochures. Too much innovation. The innovation did not take place as a result of the study of a new idea, but on the basis of some denied feedback collected during trade fairs”.

The technology developed by the company was excessively advanced for the target customers it was addressing and in 2004 his son Giuseppe, who returned to Italy after his experience abroad, comparing the performance of his company with those of the main competitor, realizes that even in Italy it was possible to sell this type of machines.

In this case, it was not a problem of technology, as it had already been sufficiently developed, the problem was to find a way to explain the machine to the ice-cream maker and the pastry chef. According to Giuseppe Bravo:

“The innovation of this machine brought with it the problem of making it understandable for the end user, this was the main limit to the sale of the machine. You couldn't go around the world explaining such a complicated machine. The paradox is that Bravo was far ahead in technology, but at the same time too far ahead for its customers. We were present abroad, we had the technology, only the way to communicate was missing, not so much the mechanics of the machine, but the way in which it had to be used to create the recipes”.

In 2004, a communication campaign began which aims to make the machine known to ice-cream parlours through emails, digital catalogues and video recipes. Since his first travels, Giuseppe Bravo has started making presentations, first on printed paper, then on CD in digital format, to show the customer how the machine works, so that anyone, through an image or a video, could learn to use it. In order to support customers from the moment they buy the machines and to be present in their business through assistance and training courses, the company decided to create the Trittico Club in 2005. This is a digital portal that includes all owners of the Trittico, in this way anyone who buys a Trittico will also receive the recipes and any owner can subscribe to the portal to ask questions and receive answers on the functioning of the Trittico and its potential. Over time, the company has also contracted some ice-cream makers who travel around Italy to explain how the machine works and teach the recipes.

Bravo Spa understood that it was necessary to be in constant direct contact with customers and the sales network was not enough to do so. In this way, it managed to build the success of the Trittico, which came only 40 years after its first introduction, thanks to the communication campaign that the company has implemented through digital tools. First with print media, then with video recipes on CD or through the use of the QR code printed on brochures, today through the web and YouTube channels, digital has been instrumental both in the marketing field, for the commercial part and to convince the customer to buy the machine, both in post-sales assistance. For a long time, Bravo stopped innovating its machine and began to release recipe videos to show the procedures to follow in using the Trittico for pastry chefs and ice-cream makers.

In 2009, in the midst of the financial crisis, following a sector study, the company identified two main critical issues that were affecting the world of artisanal ice-cream. The first was due to the fact that the same homemade ice-cream, once put in the freezer, due to the very low temperatures, became too hard to be eaten. The second criticality was due to competition with industrial stick ice-cream, a market segment that was growing very fast even in the years of the crisis. The survival of a company like Bravo necessarily depended on the success of artisan ice-cream parlours, which for the reasons set out above were not achieving the same performance. Customers had to be encouraged to consume larger quantities of artisanal ice-cream, and again Bravo turned to digital. In particular, the strategy used was to work in support of artisanal ice-cream parlour to improve communication. In particular, at each ice-cream parlour participating in the program, a small corner, showcase and television with video is created, plus a specific website for the ice-cream maker so that all the people in the district knew that that ice-cream parlour had a certain type of ice-cream. For the Bravo it was a radical change: moving from selling the machines to creating websites. With these words Giuseppe Bravo contextualizes all:

“At that time, we were not interested in improving the machines, because it was such a high-quality product that it did not need to be improved, but the important thing was to communicate its value”.

Between 2010 and 2011, when it was now understood that with digital you could do great things, Bravo Spa started using augmented reality, this would have been useful for explaining how the machine works, giving a vision of what it did the machine and to provide a better understanding of what it could do. However, augmented reality was still too advanced a technology for those times and the project was held back.

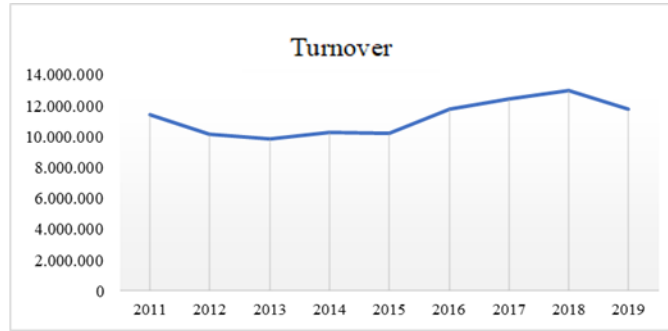
The company works exclusively with YouTube and the website that provides real-time information on new products and initiatives. To manage these advertising activities, a marketing office was no longer enough, so Bravo founded GSG Service, its own advertising agency that today also manages the Trittico Club. Over time, Bravo also involves the great masters of ice-cream in its communication activities, who physically go with the video recipes from the customer, or on the web answer questions. Today three people manage the social channels, highlighting the profiles of their customers, to give them visibility: video interviews, challengers and various activities to make the ice-cream maker the protagonist of Bravo's communication activities.

Between 2015 and 2016 Unconventional Gelato was launched, a short web-series where the protagonist is the ice-cream maker. In a short time, it has a great success and the cast are also brought to the fair. In a few years the company has changed its face, social networks have become almost more important than R&D, also because the machines are still very good.

Through the use of digital, the business model of Bravo Spa has changed, if in a first phase this was instrumental for marketing campaigns and increasing machine sales, today digital has also changed the origin of revenue flows.

With reference to this last point, the graph below (Figure 22) analyses the sales performance of Bravo Spa over the last few years. As we can see, the trend is constant over time, without particular peaks of decrease. In particular, starting from 2015 we are witnessing a slight growth in sales. Under the turnover graph, the trend of ROI (Return on Investment) was also analysed as the company has made various investments for, as we have seen above, digital communication and social media. As we can see, apart from 2013, we are seeing good levels of ROI, with growth also in this case starting from 2015. This means that the investments that have been made by the company have given a good return. It is right, however, to underline that not all the investments that are taken into consideration for this calculation are to be attributed to digital even if it is deductible that a large part of them refer to digital. In order to better analyse the return on digital investments, it would have been necessary to use the investments that the company made for marketing, but the distinction of investments was not present in the AIDA Report.

FIGURE 22 BRAVO SPA TURNOVER AND ROI



Year	2011	2012	2013	2014	2015	2016	2017	2018	2019
Reveues/000	11.387 €	10.128 €	9.839 €	10.264 €	10.204 €	11.771 €	12.400 €	12.935 €	11.720 €



Year	2011	2012	2013	2014	2015	2016	2017	2018	2019
Return On Investment (ROI)	9,89%	4,94%	0,02%	1,08%	2,59%	2,99%	7,82%	10,02%	6,31%

Source: Author's elaboration based on AIDA data

3.6.3 COVID-19 Reaction

As we have seen, Bravo Spa's investments in digital began a long time ago and have mainly focused on digital communication and Social Media.

The crisis caused by COVID-19 represented a very important challenge for the company, despite this, however, Bravo Spa did not stop and tried to react to this situation in the best possible way thanks also to the investments made during the time. Giuseppe Bravo describes the solutions adopted in this way:

“We have created a control room in the company to be connect with all departments of the company and with foreign branches, and with all external people of the company. In this way, thanks also to past investments in digital machine control, it was possible to stay in touch with customers”.

Through this technology, therefore, if a customer wants to buy a machine but is not 100% sure, through this mode he can connect and see all the features of the machine and have a 360 ° view of its use, the only missing factor is the tasting. An important aspect to underline is that all this cannot be developed if there has not been a digital path of the machines first, in fact without an adequate machine-network connection it would not have been possible to do so. Indeed, the company began developing these innovative systems calibrated on machines in 2018, highlighting the importance of these investments. Bravo's goal is to make a customer feel in Bravo even from miles away and, thanks to these technologies, he succeeded, in fact during the Lockdown the company managed to close a deal with an unknown dealer in Sydney without ever being there met, only thanks to the implementation of these technologies. According to Giuseppe Bravo:

“What interests us today is staying in touch beyond COVID-19, because the world will get bigger and bigger. Through this method it was possible to save several costs. Surely the COVID-19 forces us to use these technologies but not the COVID-19 that prompted us to implement them”.

One thing the company is very keen to specify is that if in the past there had been no investments in digital, today starting from zero would have been hard. Indeed, these investments have allowed them to develop innovative solutions quickly.

Another important aspect concerns the mentality. Indeed, differently from competitors who still have a closed mindset, Bravo Spa tries to create a work environment made up of people who have an open mind ready for change. Perhaps the hardest thing today is to find people who are mentally actualized at the moment. Although technology represents today, more than ever, a fundamental tool for survival, a factor that is missing is certainly the human presence.

Turning now to analysing the economic aspect, let's see how the health emergency represented a setback for the turnover of Bravo Spa. Indeed, despite the company being a company in the food and beverage sector and that, in the past crises, had it always been one of those sectors that had no problems, the crisis triggered by COVID-19 was particularly strong, as it mainly hit restaurants, bars, pastry shops and ice-cream parlours. For this reason, the company is grinding a -35% compared to 2019, even if the quarterly closure of September shows that the Bravo Spa company is not gaining, but at the same time it does not have a negative sign.

Two fundamental aspects that allowed Bravo to survive were: having branches abroad and digital. In fact, the presence of branches has allowed the company to earn, for example in the United States the branch is doing well, there were no blocks and people continued to buy and do business. Same thing in France, the first block imposed by Macron (the second will be harder) not having been very restrictive, allowed the French branch of Bravo to continue working. Therefore, the presence of a branch with foreign staff was fundamental. At the same time, however, digital was indispensable as it was the tool that allowed the company to stay in contact with the branches and be able to reach them virtually. This is how Giuseppe Bravo describes what happened:

“We have a manager in Shanghai but not being a demonstrator so there was the need to keep in touch with him. Through this technology we were able to connect to explain how the machines work so that he could explain it to the end customers”.

Investments in digital have certainly proved fundamental for Bravo Spa to resist and not suffer further losses compared to those they have obtained; but at the same time the presence of foreign branches has proved beneficial for companies. Above all, as regards the presence of foreign staff who guarantees a sort of safety towards the final consumer.

On this relationship between technology and the human side, Giuseppe Bravo says:

“Technology has certainly helped us, but it is impossible to think of removing the human aspect from sales. Technology helps us but maintaining the human relationship with the customer is essential”.

3.6 ONO EF



3.6.1 Company Profile

ONO Exponential Farming is a start-up founded in 2018 by Thomas Ambrosi, current owner and CEO of TOR.MEC Ambrosi Srl, a company active in the precision mechanics’ sector. The entrepreneur has patented a system of modular and mobile shelving, to be used both for factory work and vertical farming. Vision of the company is to “create a world where anyone can cultivate profitably practically everything, everywhere in the world.”

Being a newly established start-up, the company recorded 0 sales in 2019. Despite this, however, 2019 proved to be a fundamental year as Ono was able to implement the intentions it had set itself in 2018, raising capital and developing prototypes and starting to develop all those digital and marketing activities necessary for make the company known.

3.6.2 Digital Strategy

The business idea of ONO arises from the need to adopt a lean concept within the TOR.MEC production plant: an automated vertical warehouse. Unlike traditional storage systems, which require more time to pick up a component and operators are forced to travel long distances, the ONO system expects to obtain substantial advantages in terms of saving time and space. Currently, during the component assembly phase, each operator manually picks up the individual pieces from a shelf that runs along all the assembly phases, it means that each operator moves to pick up the component to be assembled in each phase. To make these activities more efficient, it was thought to introduce the automated vertical warehouse, but following a discussion with some consultants, it emerged that this type of warehouse did not allow to have a vision of what it contained inside, contrasting one of the principles of lean, visual management. Hence the idea of patenting a warehouse in which all the modules could move in all directions in order to reach the operator positioned in one of the assembly phases. These warehouses can move objects without people having to move to find and retrieve a component. Just select the component code and the warehouse will send the component to the station. Once the semi-finished product has been assembled, it will be repositioned on the shelf and ready to be "called" by the next operator. All this will take place through modules, separated from each other, but able to communicate with each other and recognize the operator's needs. In this way, through the union of skills and objectives of lean, a storage system was created not for the storage of semi-finished products but to facilitate the production phase, in particular the assembly. This type of solution combines the potential of artificial intelligence with the benefits of a modular structure. Here are the words reported by Thomas Ambrosi:

“Artificial intelligence captures data on production and assembly rates from a cloud system. The warehouse learns to recognize the movements that each individual component carries out during the assembly phase and with what timing. Thanks to intelligence, the warehouse makes each component available to the operator when it is needed, choosing the shortest path. The speed with which the component is available is guaranteed by a system of modular drawers, separated from each other but joined by a network cable that makes them communicate. Intelligence identifies a leader module that will take care of the transport of the components, in the event that this is excessively busy, intelligence identifies a new leader to ensure full availability of the component at all times”.

Artificial intelligence is able to manage the movement of components because, thanks to the data originally entered and those collected subsequently, it knows when a component must reach the operator's station. Furthermore, thanks to the management of the production cycle according to a Just-in-Time logic, the warehouse is also able to predict the production rhythms of the following days, this allows it to know which component will be used first and to position it as close as possible to the operator, leaving the parts for which immediate use is not expected at the bottom of the warehouse

The modular system guarantees speed, because the different shelves of the warehouse move knowing the needs of the operators and ensuring that they are available at the required time without the operator calling the drawer. There are already solutions in which the drawers move, but this happens through a single conveyor. Instead, the innovation of this idea lies in having modular drawers that have the ability to move independently.

From the idea of equipping the automated warehouse with artificial intelligence, through the use of machine learning, not only a new solution was born to bring inside the factories, but also a solution for vertical farming. This is a practice that is developing in the agricultural field in response to climate change, the use of pesticides, the consumption of soil, water and energy. Vertical farming uses a space that develops vertically to grow small crops. The plants are fed without the use of pesticides with water and LED light, alternating the hours of light and shade. Thomas Ambrosi has identified some critical issues in the current structures used for vertical farming:

“The problem of many vertical farming systems lies in their rigid structure, this does not allow adequate adjustments for the right quantities of water and light to be administered to the plants, and therefore leads to an excess or a defect in this feeding system for the plantation. In addition, certain high-altitude activities are carried out by people, such as harvesting or controlling growth, which involve safety concerns.”

From these problems, Thomas's intuition was born to apply the same solution used for the automated vertical warehouse to vertical farming as well. In this way it will be possible to move the shelves on which the crops have been arranged, in order to position them in a more suitable way to carry out irrigation, lighting and monitoring activities. It will no longer be necessary for the lighting and irrigation systems to run along the entire structure to reach all the plantations, but thanks to the system of mobile drawers, each shelf on which a specific plantation is placed will move to a specific sector, based on the treatment it needs.

Thanks to the system of mobile drawers, each shelf on which a specific plantation is placed, will move to a specific sector, based on the treatment it needs. This will reduce structural costs.

Indeed, the plants will receive water only when necessary, by moving the drawer to the area dedicated to irrigation. The LED lights will no longer have to be positioned along the entire structure, but only some parts will be dedicated to lighting, when the plantations do not need light they will be moved to an area where there are NO LED lights. Research has shown that using this system it will be possible to reduce the cost of the LED infrastructure by almost 30% and reduce energy consumption by 50%.

This could be a great revolution in the agricultural field, the grower will no longer have to have specific knowledge about the plant, but must be able to use the artificial intelligence software, to which all irrigation and lighting activities will be delegated.

This project was born from an international perspective, the operator could control several vertical farming around the world, directly remotely.

In this way, a company would be able to maintain proximity to the local market, thanks to the work carried out entirely by a central office.

3.6.3 COVID-19 Reaction

Since ONO EF is a start-up with a digital impact that was recently created, the current crisis situation has particularly affected the company's performance and its potential growth.

During the Lockdown period ONO EF remained stationary, and this led to an interruption of all the growth and research activities that the company had planned. Despite this, however, ONO EF has tried to continue with its work through Smart-Working and, moreover, has witnessed an acceleration of interest for their products from the Gulf countries, in particular Arabia and Middle Orinete. The motivation for this is explained by Thomas Ambrosi:

“We have seen an acceleration of interest in our products in these countries as, due to the lack of flights and transport to their countries, the supply of some products, especially vegetable ones, has decreased. For this reason, they realized the need to produce them locally, leading to accelerate the requests for these products”.

The acceleration of information on these products is also the result of investments made by the company not only to improve the machine system developed but also in digital marketing, which is useful for reaching both customers but above all suppliers. In addition to the Gulf countries, an important acceleration of interest in these products comes from Italy.

Unlike the Vertical Farming models proposed by competitors, which require the use of many people for control, the model presented by ONO EF can be managed completely remotely.

For this reason, we can say that ONO EF has digitized agriculture. All information relating to the growth or management of irrigation or lights, or the movement of plants, is carried out automatically by an autonomous system or in any case with the supervision of agronomists or technicians working outside the plant.

A digitization of this type in the COVID-19 context is very important, as it guarantees the reduction of time and continues to work even if there are mobility restrictions.

Although there has been an acceleration in the awareness of the usefulness of these systems especially in the latter period, in 2020 there were no sales, even if the company expects to generate revenues in 2021.

For the future the company plans further investments in digital, in fact it will try to develop platforms to make the machines autonomous, in fact through the use of artificial intelligence algorithms it will try to determine the growth trends of the plants and, through of mathematical rules, we will try to manage the light and feeding of plants. In this way the system will self-store keeping the values in line with the established ones.

Despite the few information that we were able to collect about the company and its reaction to COVID-19 due to its young constitution, we can still say that this type of solution is very useful in this period as, as there is no need for the intervention human, guarantees continuity even in adverse conditions.

3.7 TEXA SPA

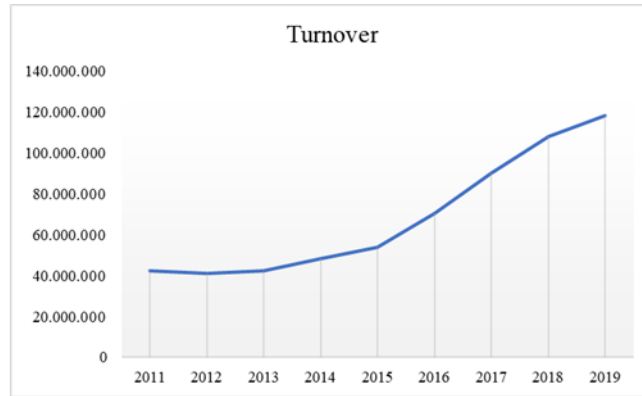


3.7.1 Company Profile

Texa was founded in 1992 by Bruno Vianello and his friend Manuele Cavalli. The company designs and manufactures multi-brand diagnostic tools, exhaust gas analyser's, air conditioning maintenance stations and remote diagnosis devices for cars, motorcycles, trucks, boats and agricultural vehicles. The head office and the only production plant, where the products are designed, engineered and built, are located in Monastier di Treviso. Texa is present all over the world through its commercial branches and its distribution network, employing about 640 people, of which 400 in the main office. From 2012 to 2017, the company had an exponential growth in revenues to reach 101 million in 2017, this growth is certainly due to the diagnosis and recharging systems for air conditioning, but the surge was mainly driven by Telemobility,

a sector in which the company entered 7-8 years ago, and Original Equipment Manufacturing (OEM), whose greatest results have been achieved in the last 3 years. Indeed, how we can see from the graph below (Figure 23), we are witnessing an exponential growth in sales, with the peak reached in 2019, with a turnover of 117.865.000 €.

FIGURE 23 TEXA SPA TURNOVER



Year	2011	2012	2013	2014	2015	2016	2017	2018	2019
Revenues /000	42.123 €	40.744 €	41.868 €	48.022 €	53.677 €	70.149 €	89.649 €	107.751 €	117.865 €

Source: Author's elaboration based on AIDA data

The main market of reference is the European one, which without considering Italy occupies a market share of 60%, while the market share of the non-European company is 13%.

The company is present in the world with some branches, including Germany, France, UK, US, Poland, Russia and Japan. Within these branches there are only service offices, as the production site remains in Italy.

After this brief description of the company, let's move on to analyse the digital investments made by the company.

3.7.2 Digital Strategy

At the end of the 1980s, great changes were taking place in the automotive sector and even cars began to have a significant number of electrical components, first of all the control unit. Mechanics, used to working with mechanical parts, were the first to notice that electronics had taken over but did not have the proper tools to repair cars and encountered difficulties in identifying problems related to the electrical components of cars. From the intuition of these issues, the two founders of Texa Spa decided to design tools that could help mechanics perform the new ECU diagnostics and could facilitate their role. The first handcrafted tools proved effective and in 1999 the company launched Axone 2000, which allows the translation of the information collected by the switchboards and makes them legible in simple language. Through a screen it is possible to read the technical data of the vehicle, carry out a global scan of the electrical system to identify problems and then make adjustments. The software also allows you to put thousands of customers in contact at the Texa headquarters by sending information and technical data in real time via the Internet. The experience accumulated with diagnostics for electrical control units makes the company understand that it is very strong in the garage equipment sector and that it has a distribution network that allowed it to sell other products as well. From here Texa decides to expand into other markets as well: that of exhaust gas analysis and that of recharging stations for air conditioning.

As pointed out by Dr. Marton, Texa's sales director, digital has allowed the company to address its offer on three main channels:

- *Garage equipment*, tools sold to workshops specializing in diagnostics for major automotive brands, the product is designed and manufactured by Texa and then sold to the workshops, these are about 70,000 worldwide;
- *Tele-mobility*, large companies that have a large fleet of machines, rental companies, telecommunications or postal services companies;
- *Original Equipment Manufacturing (OEM)*, the main customer is the large manufacturer and Texa enters into direct agreements with the car manufacturers to sell custom-made solutions based on a design established by the parent company.

The birth of diagnostic tools has been pushed more recently by the development of tele mobility. The companies that fall into this channel need to equip their operators with a vehicle and

therefore find themselves having to manage a large fleet of machines. These companies therefore immediately found a fundamental need for their business activity: that of having to monitor and know the health of their cars.

Texa was born in recent times, in response to the needs of a category of professionals, mechanics and perhaps Texa would never have been born if this need had not arisen. At the same time, the technology developed by the company has allowed the latter to be able to grasp the needs of new markets, such as that relating to air conditioning equipment and that of tele-mobility. Starting from the intuition of being able to equip mechanics with a tool capable of identifying a problem within an electrical system, today Texa has put on the market equipment that allows car monitoring to be carried out even remotely and to have predictive values on the state of the car's health, preventing any breakages through a predictive maintenance system, mechanics will be able to call the owner of the car back to the workshop to carry out the necessary maintenance. Texa tools allow you to switch from a traditional diagnosis, carried out in the workshop, to that carried out remotely, perhaps while the car is in motion. Many tele-mobility operators have seen numerous benefits for their business activities in Texa products, this has guaranteed Texa to expand its business perimeter.

In the 2000s, telephone connectivity enabled new solutions, the starting point for Texa was the idea of creating a device that could help the mechanic to identify a problem in the electrical system, but now, thanks to the internet, it is the way of offering new diagnostic solutions has also changed. An interesting case of IoT is the Texa CARE tool, created mainly for garage equipment but later extended to tele-mobility as well. It is a device installed on vehicles capable of interfacing automatically with the driver's smartphone and sending data to the mechanic's workshop, who can analyse them in real time from a tablet and know the situation of the vehicle, any anomalies and monitor the maintenance. So Dr. Marton explains how it works:

“The device introduced into the car produces data that are collected on a cloud platform. The big data and the connection allow to analyse in real time all the information coming from the cars, carrying out a mapping of the vehicle aimed at identifying possible faults, present and future”.

Initially, Texa had decided to manage the cloud on its servers, but with the growth in volumes it chose to entrust the management to external suppliers who had the appropriate skills to manage the infrastructure, while the company preferred to remain focused on production of devices.

Texa products quickly invaded the market, unlike other solutions that have had a slower diffusion, as explained by Dr. Marton:

“The Texa product offers a greater number of services than the classic black boxes installed by insurance companies, which are unable to make a preventive diagnosis. The product is also easier to deploy than other IoT solutions installed in order to increase connectivity: some of the most recent connected vehicles cost up to 50 thousand euros. A Texa device, which allows a minimum of connectivity, is certainly easier to procure and purchase, because it costs less and manages to achieve exceptional results in terms of user satisfaction, be it a mechanic, a motorist, or a fleet manager”.

Technological innovation has led the company to enter new sales channels and has enabled important collaborations with some important international brands.

Compared to other innovations, Texa products were immediately welcomed with success by mechanics, in some cases the risk is to encounter resistance from those who are used to carrying out a job following very traditional logic, instead the product Texa was appreciated by many professionals for making their job easier, but it was also appreciated by the owners of the machines who were able to intervene promptly on their cars.

However, as well as many other realities, Texa encountered difficulties in finding personnel who had the right digital skills. For this reason, they decided to carry out training programs for recent graduates and young people from technical institutes. But even mechanics often do not have the adequate digital skills to be able to use Texa products. To address this problem, the TEXAEDU project was launched, a division entirely dedicated to training.

3.7.3 COVID-19 Reaction

As we have seen, Texa Spa was born to provide a new product to its customers with a digital imprint. Thanks to the type of product offered and the investments in digital, we will see how the company reacted to the crisis generated by COVID-19.

At a time when Italy was observed by other European countries as a country at risk against COVID-19, perhaps the first among European countries, the company had to take raw materials, as in February there have been a series of above-average requests due to customer concern about production stoppage.

Texa Spa was one of the first companies in their area to close production for a few days, quickly inserting a large number of workers into Smart-Working. In reference to this, Dr. Marton explains:

“Technology is fundamental and also the activities that independently from COVID-19 we had carried out in previous years as part of our risk management processes (activity of configuring a secure remote system) so that through the VPNs our people could work quietly from home with the company's knowledge that external hacker attacks were protected by secure systems. This had been done well before the time of COVID-19, it was not a situation that had 100% coverage, there had been an additional effort in the period between early and late March”.

The company, therefore, experimented with new ways of working, which made it possible not to slow down the arrival of materials and supplies already planned and not to suspend Research and Development activities

Unlike other companies, Texa Spa achieved good results during COVID-19, so much so that it expects to close 2020 with a few percentage points less than last year. Among the three sectors to guarantee the highest volume of business was the Garage Equipment, a sector which generally generates 75% of the turnover against the other two sectors (Tele-Mobility and OEM) which generate 30%. The second and third sectors, being linked to the registration of new vehicles, which have suffered a sharp decline due to COVID-19, have been penalized, unlike the first sector as Dr. Morton explains:

“In a situation where, public transport has become dangerous, people have rearranged themselves to move more by car. And all the slowdown in trade and the movements of people also to go and see new cars and buy them in dealerships and in addition the uncertainty of families to buy a durable good such as mobile cars, has led people not to buy new cars and invest in car repairs. For this reason, the performances of the garage sector equally reached good numbers”.

Furthermore, during this period the company has strengthened its call center services to increase proximity to customers, guaranteeing in-person technical assistance. Furthermore, 70% of the training courses provided by Texa with the TEXA EDU service in 2/3 months are converted into training courses delivered digitally.

Also, from the product point of view, the Texa company has introduced some innovations, in fact in July, following the needs of consumers, ER2SUN, an ozone-based sanitizer, was introduced.

Also, in this case, the need emerges to have made investments in digital before the emergency, as it allowed the company to develop quick solutions that otherwise would not have existed.

3.8 COMPARISON OF COMPANIES COVID-19 REACTION

After having analysed each company individually, and having identified how the company has provided the COVID-19 situation, let's go and make a comparison of the cases. The table below (Table 4) summarizes some of the main information that we have dealt with in the previous paragraphs by companies. In particular, we highlighted: when the company began to adopt digitization processes; the technologies adopted; the reasons that prompted them to adopt the technologies; new technologies implemented during the current crisis situation; benefits that the adoption of technology has given for the survival of the company and, finally, any critical issues that have emerged.

TABLE 4 COMPARISON CASE STUDY COMPANIES

Company	BETTER SILVER	BRAVO SPA	ONO EF	TEXA
Start year of digitization	2011	2004	Born Digital	1992
Type of Technology	<ul style="list-style-type: none"> • E-commerce • Big Data 	<ul style="list-style-type: none"> • Digital Communication • Social Media 	<ul style="list-style-type: none"> • Big Data • Machine Learning 	<ul style="list-style-type: none"> • Big Data • IoT
Purpose of Digital	Overcoming a difficult moment in the sector and getting to know the customer better	Communication and marketing to make their products known	Machine Learning applied to the vertical warehouse	It was born digital to satisfy a customer need
Actions Taken During COVID-19	<ul style="list-style-type: none"> • Implementation of a Virtual Room for making fair and meeting (Augmented Reality) • Smart-Working 	<ul style="list-style-type: none"> • Implementation of a Digital Room (Augmented Reality) • Smart-Working 	<ul style="list-style-type: none"> • Smart-Working • Digital Marketing 	<ul style="list-style-type: none"> • Smart-Working • Enhancement of the call centre • Online training activities • Product innovation
Effect of technology on the company's survival	<ul style="list-style-type: none"> • Respond quickly to changes • Open minded • Ease of finding information, better working conditions 	<ul style="list-style-type: none"> • Respond quickly to changes • Advantage over competitors • Possibility of keeping in touch with foreign branches 	<ul style="list-style-type: none"> • Acceleration of interest • Ability to manage remotely compared to other vertical farms 	<ul style="list-style-type: none"> • Respond quickly to changes • Increased demand for products
Criticalities emerged	<ul style="list-style-type: none"> • Loss of the human aspect • Need to have a point of reference in the company who knows the company's needs and new innovations 	<ul style="list-style-type: none"> • Loss of the human aspect 		

Source: Author Elaboration

As can be seen, companies have reacted proactively and reactively to this situation of crisis, indeed, through a series of concurrent actions, they have been able to develop and implement solutions to try to overcome this crisis situation. This ability of companies to cope with sudden events after they manifest themselves in a reactive way represents, as we have seen, one of the fundamental capabilities that Ducken (2019) defines for an organization to be considered resilient. The main solutions they have adopted to provide for this situation of crisis have all been technological solutions, since as we have seen, the crisis that has hit our country was a crisis that has accelerated the processes of digitization. In this case, a first advantage of these companies is already evident, as being all four companies that had already developed investments in technology, it can be deduced that they found themselves in an advantageous position compared to other companies. Among the main solutions adopted we find the Smart-Working, adopted by all four companies, confirming the Istat (2020) data of the report *“Situazioni e prospettive delle aziende nell’emergenza sanitaria Covid-19”*, according to which Smart-Working was the most useful technology to companies to ensure continuity.

Moreover, Better Silver and Bravo Spa have introduced non-invasive augmented reality tools so as to be able to hold meetings and fairs, which are very important for Better Silver, with high image quality, making the customers feel as if they were in the company. Indeed, through this non-invasive augmented reality, the company, through the use of monitors and cameras, gives the customer a unique experience in a virtual environment that allows him to interact with each other. Texa, on the other hand, in addition to Smart-Working, has introduced other solutions, for example it has enhanced the call-centre service to reduce the gap with the final consumer and, moreover, it has transported 70% of the contents of the refresher courses held by company on online platforms. As for ONO EF, on the other hand, being a digital start-up established two years ago, compared to the other three companies, it has not implemented many new solutions to deal with the crisis situation, in fact we find Smart-Working and Digital Marketing, this latter continuation of the project started in 2019. Despite this, however, ONO has witnessed an acceleration of interest in its products, in which thanks to the automation of these products, they are very important during the Lockdown.

As we can see, one aspect that has guaranteed the companies under consideration to continue their business thanks to the development of new technological solutions is represented by having made investments in digital in the past. Indeed, from the interviews it emerged from all four companies that all the solutions that were developed could be implemented because there was already a good basis. This confirms what was reported by the Unioncamere study (2020) according to which companies that had already invested in digital have found themselves in an

advantageous position compared to other companies. This is because they are innovative companies, which set no limits and which are motivated to continuously field new solutions. Given that we have seen that innovation is one of the four fundamental drivers that allows us to define a resilient organization, we can say that, on the base of this point, these companies tend to consider themselves resilient.

Another important aspect that relates to having invested in digital over time is speed. Indeed, as we can see from Table 4, one effect that technology has had in ensuring the survival of companies is the speed with which companies have responded to changes. As has been widely discussed, the speed of response to changes by companies is a fundamental characteristic especially in crisis situations. In this case, we see that the companies examined, thanks to past investments in digital, were able to give rapid responses to changes, introducing new solutions in a short time, ensuring business continuity. This demonstration confirms the study presented by Morisse in collaboration with Deloitte (2017), according to which companies that have invested in digital are more inclined to respond more quickly to new market needs in the event of a crisis. Indeed, as reported in *Figure 17: Reaction to unplanned events*, it can be confirmed that companies that have invested in digital are able to be faster and more agile even in the event of unexpected events, as in this case it was COVID-19. As we know, speed is also a factor that allows us to determine whether an organization is resilient or not and generally, as we have seen, the greater the speed of response to the crisis, the greater the level of resilience of companies. In this case, we can say that given that the analysed companies were able to implement innovative and technological solutions in a short time, we can say that, even in this respect, they are resilient companies.

A fundamental role, however, was not only played by technological infrastructures, but also by culture. As we have seen in the literature, organizational culture is an important aspect of building a resilient organization. Sharing certain values, indeed, makes it possible to build a cohesive work environment that is able to overcome crisis situations. In this case, on the basis of the interviews, the need emerges to create a work environment characterized by people who have an open mind ready for change. Indeed, as reported by Better Silver and Bravo Spa, the presence in the company of personnel with these characteristics allows us to respond more quickly to the crisis situation. This could relate to the model presented by Lengnick-Hall and Beck (2005), according to which resilience within an organization must also depend on the people who operate within it. It is also true, however, that to ensure that their workers are resilient and open to change, there must be a leader who reflects these characteristics, and, we

can say, that the managers who manage these companies interviewed are the first to assert these values of resilience and innovation by pushing their workers towards these values and creating a corporate culture based on them. Of course, as evidenced by both companies, there has been some resistance over time for these innovations, but ultimately most of the company managed to adjust to the line of thinking.

One of the advantages that we have analysed of using technologies is the increase in productivity. In this case, given the particularity of the crisis, the interviews revealed that despite investments in digital, companies expect to close 2020 with several percentage points less. Despite this, however, they continue to record better results than their competitors who do not have their same degree of digitization. An exception of the group is represented by Texa, which, thanks to the type of product it offers to the market, has registered an increase in demand.

A disadvantage highlighted by the companies during the interviews but which had not been discussed in the literature cited above is represented by the loss of human contact. The companies examined, indeed, stated that although the technologies have allowed him to keep in touch with customers and with foreign branches, they have suffered from the lack of the human factor which in most of the times represents the key factor that allows to close a deal.

Comparing the results that emerged from the empirical analysis with those present in the literature, it emerges that in the companies interviewed the contribution of the technologies of Industry 4.0 was fundamental to guarantee the survival of the company and establish that there is a positive relationship between technology and resilience. This is partly due to the fact that the analysed companies have developed various digital investments over time.

In this way, the companies interviewed were able to react quickly to the initial shock, implementing technological solutions quickly, reducing the impact gap and the recovery gap that the shock can bring to the organization, leading companies to obtain an advantage over other companies.

Based on the above, we can identify three propositions:

Proposition 1: Companies that adopted digital technologies are able to respond quickly to changes

The fact of having already implemented technological solutions as well as giving an advantage for the development of other technologies would seem to make it possible to respond more quickly to the new needs arising from the crisis.

This could give the possibility of being able to obtain a consistent competitive advantage over those competitors who are instead unprepared from a technological point of view and consequently increase the gap by acquiring more prominence in the market.

This was supported by the companies analysed which, from their experiences it emerged that they responded quickly (within a couple of months in most cases) to the new needs due to the crisis.

This could also translate into an ability of organizations to be more resilient which allows them to adapt better and more quickly to the changing environment.

Proposition 2: Companies that have adopted digital technologies for a long time are able to develop new solutions to ensure survival

An element related to the first proposition is the adoption of technologies over time. Indeed, from the analysis carried out in the paper, the importance of adopting a digital strategy seems to be a key element for companies.

From the analysis carried out, the adoption of a strategy of this type would seem to allow companies to develop a technological background that is able to provide them with the tools and skills necessary to develop new technologies based on technologies already developed internally, in order to respond to the particular crisis situation that they face.

Indeed, a digitization process, as we have been able to see, involves a fairly long implementation period that usually exceeds one year and that in any case at the beginning of the process does not allow for full knowledge and awareness of the technology adopted. Having, on the other hand, already behind a technological history consolidated over the years with a stratification of knowledge allows us to be able to think out of the box to identify the best possible technological response, which also goes towards developing a more sophisticated and innovative technology.

Therefore, the fact of having developed these technologies in advance would seem to represent a sort of inestimable treasure in terms of skills that allow companies to obtain an effective crisis response strategy.

Preposition 3: An organizational culture based on change and innovation allows the development of a dynamic organization

The last element identified is how the spread of an organizational culture based on change and innovations can positively impact the contribution that the workforce can make in responding to the crisis.

An organizational culture focused on the acceptance of change and the presence of technological innovation it would seem to lead to staff with a more open mind and more inclined to accept these new innovative solutions.

All this makes us think that there must therefore be a positive correlation between the technological implementation and the acceptance of this by the workers, because without a clear awareness of the potential benefits that technology can bring to the company even the best possible digital strategy cannot it would make it possible to exit the crisis situation without its complete acceptance by the workers.

We could therefore conclude that the survival of an organization in the face of a crisis depends not only on technological development, but also and above all on people's ability to understand its importance by accepting it and not hindering it and understanding that this technology would allow them to increase their skills.

3.9 CONCLUSION

The purpose of this thesis was to investigate whether digitalization can actually help companies overcome a crisis situation, in particular the crisis situation that we are experiencing. Although there is a wide literature regarding both Industry 4.0 and Resilience, few studies have dealt with the relationship that exists between the two. Consequently, my intent was to contribute to the integration of these issues, which in the last period following the COVID-19 emergency, have become increasingly important.

Through the literature it has been possible to analyse the concept of Organizational Resilience, which as we have extensively discussed in the course of the paper, can be defined as the ability of companies to respond to a crisis situation. The crisis experienced has identified technology as a fundamental factor for survival, leading to an acceleration of the digitization processes. For this reason, we have analysed in detail the enabling technologies of Industry 4.0, its advantages and disadvantages, trying to find studies that could correlate Resilience and Technology.

To verify the existence of a positive relationship between technologies and resilience, there has been analysed some real cases. In particular, between October and November 2020 a series of interviews were carried out with four Veneto companies that have pursued digital investments over time. The companies that have been interviewed are: Better Silver, Bravo Spa, ONO EF and Texa Spa. These are companies that presented different nature, corporate maturity and type of digitization.

From these interviews it was possible to draw interesting conclusions relating to the effects that the crisis has had on these digitized companies.

Before proceeding with the results of the analysis, it is appropriate to focus on a fundamental point. In the literature we have seen that the post-crisis phase can have a Bounce Back perspective or a Bounce Forward perspective. In this case, given the particularity of the crisis situation, it will be necessary to adopt a Bounce Forward perspective as this perspective, as we have seen, requires a high level of adaptability and the post-crisis performance will have to be superior to the pre-crisis situation as the KSF needed to overcome the crisis are different from the pre-crisis ones.

From the analysis carried out, it emerged that for these four companies analysed there was a positive relationship between resilience and technology. Indeed, thanks to the investments made over time, companies have been able to respond quickly with innovative solutions to the crisis situation. This speed of adoption of new solutions can be translated into the speed that these companies have to respond to changes and adapt to the situation they are experiencing; this translates into a resilient factor for the organization by identifying a first positive relationship between the two concepts.

Thanks to investments in digital, companies have shown themselves to be more open to change ready to implement new cutting-edge solutions. In this case we have seen that two fundamental aspects come into play which are Organizational Culture and Innovation: indeed, Innovation is one of the drivers that allows to develop resilience, so the more you are inclined to invest in new solutions, the greater it will be considered resilient; as regards the Organizational Culture, which is also a driver of resilience, it allows to create a work environment ready to face emergencies thanks also to the open-mindedness given by technology.

However, the analysis also brought to light some disadvantages of adopting the technology, the most important of which is the loss of human contact. Indeed, if on the one hand technology has allowed these companies to respond quickly and efficiently to the new challenges of the market guaranteeing survival, on the other hand it has led to the loss of the human relationship which is one of the most important factors, and in some cases the decisive factor, for closing the business.

By comparing the results obtained from the empirical analysis and those of the literature, we can affirm that technology has proved to be a fundamental tool for dealing with the crisis, especially useful for already digitized companies, which are in an advantageous position compared to competitors and companies not digitized.

Indeed, digitized companies have been able to reduce the necessary recovery time and increase their competitive advantage.

It is important to underline, however, that the analysis that was carried out was based on qualitative data, in order to have a more complete view on the reaction of companies to the COVID-19 crisis with perhaps even some quantitative evidence, it will be necessary to wait a few years.

On the basis of this we have however been able to identify three general propositions that represent starting points, to be verified empirically, to support the objective of the paper.

The fundamental elements that would seem to help companies to emerge from crisis situations are: the presence of an already consolidated technological strategy in the company which would represent a starting point for developing new solutions; the speed with which thanks to technology it would be possible to respond in a timely manner to new needs with new solutions; and the presence of an organizational culture based on the acceptance of change and innovation by the workforce that would allow the development of a dynamic and proactive company climate.

BIBLIOGRAFY

- Adamik, A., & Nowicki, M. (2018). Preparedness of companies for digital transformation and creating a competitive advantage in the age of Industry 4.0. *Proceedings of the International Conference on Business Excellence* (pp. 10-24). Organizational Problems Industry 4.0
- Aguilar, F. J. (1967). *Scanning the business environment*. New York: Macmillan.
- Ansoff, I. H. (1975). Managing strategic surprise by response to weak signals. *California Management Review* Vol. 28 No. 2, 21-33.
- Barton, L. (2001). *Crisis in Organization II*. South-Western College Pub.
- Blunck, E., & al., e. (2017). Industry 4.0- An opportunity to realize sustainable manufacturing and its potential for a circular economy. *International Economic Meeting*, (pp. 644-661). Dubrovnik.
- Boin, A. (2009). The new world of crisis and crisis management: implications for policymaking. *Review of Policy Research* Vol. 26 No. 4, 367-377.
- Bonekamp, L., & al., e. (2015). Consequences of Industry 4.0 on human labour and work organisation. *Journal of Business and Media Psychology* Vol. 6 No. 1, 33-40.
- Bowonder, B., & Linstone, H. (1987). Notes on the Bhopal Accident: Risk Analysis and Multiple Perspectives. *Technological Forecasting and Social Change*, 183-202.
- Brettel, M., & al., e. (2014). How Virtualization, Decentralization and Network Building Change the Manufacturing Landscape: An Industry 4.0 Perspective. *International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering*.
- Bruno, F. (2020, May 5). *Resilienza e innovazione: le tecnologie abilitanti di Industria 4.0 come stimolo per la ripresa*. Retrieved from InnovationPost: <https://www.innovationpost.it/2020/04/27/resilienza-e-innovazione-le-tecnologie-abilitanti-di-industria-4-0-come-stimolo-per-la-ripresa/>
- Buch, G., Cugno, M., & Castagnoli, R. (2018). Smart Factory performance and Industry 4.0. *University of Turin*.
- Bundy, J. e. (2016). Crisis and crisis management: integration, interpretation and research development. *Journal of Management* Vol. 20 No. 10, 1-32.
- Carli, A. (2020, March 24). *Mascherine e respiratori, ecco le fabbriche che si riconvertono*. Retrieved from Il Sole24Ore: <https://www.ilsole24ore.com/art/da-miroglio-menarini-fabbriche-che-si-riconvertono-contro-coronavirus-ADLIFdD>
- Carli, A. (2020, March 24). *Mascherine e respiratori, ecco le fabbriche che si riconvertono*. Retrieved from Il Sole24Ore: <https://www.ilsole24ore.com/art/da-miroglio-menarini-fabbriche-che-si-riconvertono-contro-coronavirus-ADLIFdD>
- Catalan, C., & Robert, B. (2011). Evaluation of organizational resilience: application in Quebec. *École Polytechnique de Montréal*.

-
- Cervelli, R. (2020, April 2). *Danieli e Covid-19: progettisti al lavoro da casa per la business continuity*. Retrieved from NetworkDigital360: <https://www.zerounoweb.it/smart-working/danieli-e-covid-19-progettisti-al-lavoro-da-casa-per-la-business-continuity/>
- Ciriaco, T. (2020, April 6). *Lotta al Covid-19, Dallara e ospedale di Parma insieme*. Retrieved from La Repubblica: https://www.repubblica.it/motori/sezioni/attualita/2020/04/06/news/lotta_al_covid-19_dallara_e_ospedale_di_parma_insieme-253269859/
- Coombs, W. T. (2006). The protective powers of crisis response strategies: Managing reputational asset during a crisis. *Journal of Promotion Management Vol. 12*, 241-260.
- Dadson, B. (2015). *Planning for a More Resilient Future: A Guide to Regional Approaches*. University of Missouri Institute of Public Policy/National Association of Development Organizations Research Foundation.
- Dalla Porta, D. (2014). *L'intervista qualitativa*. Gius.Laterza & Figli Spa.
- Dalziell, E., & McManus, S. (2004). Resilience, Vulnerability, and Adaptive Capacity: Implications for System Performance. *Resilience, Vulnerability, and Adaptive Capacity: Implications for System Performance*. Stoos, Switzerland.
- Darkow, P. M. (2018). Beyond “bouncing back”: Towards an integral, capability-based understanding of organizational resilience. *Journal of Contingencies and Crisis Management Vol. 27 No. 2*, 145-155.
- Duchek, S. (2019). Organizational resilience: a capability-based conceptualization. *Business Research Vol. 13*, 215-246.
- Dutton, H. W. (2014). Putting Things to Work: Social and Policy challenges for the Internet of things. *Industry and Public Sector Management Vol. 16 No. 3*, 1-21.
- Elerdini, B. (2020, June 19). *L'innovazione digitale è la cura per uscire dall'ibernazione indotta dal Covid-19*. Retrieved from InnovationPost: <https://www.innovationpost.it/2020/06/19/innovazione-digitale-e-la-cura-per-uscire-dallibernazione-indotta-dal-covid-19/>
- Foray, D. (2006). *New Frontiers in the Economics of Innovation and New Technology*. Cheltenham, UK: Edward Elgar.
- Fourgous, B., & Roux-Dufort, C. (1998). Crises: Events or Processes? *Hazards and Sustainability Conference*, (pp. 98-71). Durham, UK.
- Fulco, I., La Sala, A., & Loia, F. (2019). The role of technology for building resilience thinking in corporate governance. *University of Rome – La Sapienza, Italy*.
- Gabanelli, M., & Querzè, R. (2020, March 15). *Coronavirus, smartworking obbligatorio per tutti ma ad 11 milioni di italiani manca la connessione*. Retrieved from Corriere Della Sera: <https://www.corriere.it/dataroom-milena-gabanelli/coronavirus-smartworking-connessione-oltre-11-milioni-italiani-senza/deb45d24-66e8-11ea-a26c-9a66211caeeeva.shtml>
- Garcia, P. (2020, April 8). *Contro il Covid-19, il ruolo determinante della digitalizzazione*. Retrieved from IlSole24Ore: <https://www.ilsole24ore.com/art/contro-covid-19-ruolo-determinante-digitalizzazione-ADj0r2I>
-

-
- Gerino, C. (2020, July 11). *eCommerce, crescita nel 2020 prevista al +26 per cento*. Retrieved from La Repubblica: https://www.repubblica.it/economia/2020/07/11/news/ecommerce_crescita_nel_2020_prevista_al_26_per_cento-261225752/#:~:text=Accelera%20la%20crescita%20degli%20acquisti,B2c%20del%20Politecnico%20di%20Milano.
- Greenough, E. (2016, June 7). *Executives call industrial IoT initiatives critical for success*. Retrieved from Business Insider: <https://www.businessinsider.com/executives-call-industrial-iot-initiatives-critical-for-success-2016-6?IR=T>
- Henry, D., & Ramirez-Marquez, J. (2012). Generic Metrics and Quantitative Approaches for System Resilience as a Function of Time. *Reliability Engineering System Safety Vol. 99*, 114-122.
- Herman, B. D. (2015). *Digital depression: Information technology and economic crisis*. University of Illinois Press: Urbana .
- Hermann, C. F. (1963). Some consequences of crisis which limit the viability of organizations. *Administrative Science Quarterly Vol. 8*, 61-82.
- Hermann, M. (2015). Design Principles for Industries 4.0 Scenarios: A literature Review.
- Hillison, D. (2009). *Managing Risk in Projects*. Gower Publishing, Ltd.
- Hiltunen, E. (2008). Good Sources of Weak Signals: A Global Study of Where Futurists Look For Weak Signals. *Journal of Futures Studies Vol. 12*, 21-44.
- Hirsch, P., & Levin, D. Z. (1999). Umbrella advocates versus validity police: a life-cycle model. *Organization Science Vol. 10 No. 2*, 199-212.
- Hirsch-Kreinsen, H. (2016). Digitization of industrial work: development paths and prospects. *Journal for Labour Market Research Vol. 49*, 1-14.
- Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics Vol. 4*, 1-23.
- Hollnagel, E., & al, e. (2006). *The functional response of predators to prey density and its role in minery and population regulation*. Ashgate UK.
- Home, J. F., & Orr, J. E. (1998). Assessing behaviors that create resilient organizations. *Employment Relations Today Vol. 24 No. 4*, 29-35.
- ISTAT. (2020, June 15). Retrieved from <https://www.istat.it/it/files/2020/06/Imprese-durante-Covid-19.pdf>
- ISTAT. (2020, 7 October). *Commercio al dettaglio* . Retrieved from https://www.istat.it/it/files//2020/10/CS_Commercio_al_dettaglio_0820.pdf
- ISTAT. (2020, June 15). *Situazioni e prospettive delle impres nell'emergenza sanitaria COVID-19*. Retrieved from <https://www.istat.it/it/files//2020/06/Imprese-durante-Covid-19.pdf>
- James, E. H. (2011). Crisis management: informing a new leadership research agenda. *The Academy of Management Annals Vol. 5 No. 1*, 455-493.
-

-
- Kagermann, H., & al., e. (2013). *Recommendations for Implementing the Strategic Initiative INDUSTRIE 4.0: Securing the Future of German*. Frankfurt: Final Report of the Industrie 4.0 Working Group.
- Kiel, D., & al., e. (2017). The Impact of the Industrial Internet of Things on Established Business Models. *International Association for Management of Technology Conference*. Orlando, Florida.
- Koronis, E., & al., e. (2012). Introducing Corporate Reputation Continuity To Support Organizational Resilience Against Crisis. *Journal of Applied Business Research Vol. 28 No. 2*, 283-290.
- Kucera, D., & al., e. (2018). New automation technologies and job creation and destruction dynamics. *International Labour Office*.
- Lee, J., & al., e. (2014). Service innovation and smart analytics for Industry 4.0. *Procedia CIRP Vol. 16*, 3-8.
- Lengnick-Hall, C. A., & Beck, T. E. (2005). Adaptive fit versus robust transformation: How organizations respond to environmental change. *Journal of Management Vol. 31*, 738-757.
- Lengnick-Hall, C. A., & Beck, T. E. (2011). Developing a capacity for organizational resilience through strategic-human resource management. *Human resource management Review Vol. 21 No. 3*, 243-255.
- Lepak, D. P. (2007). Value creation and value capture: a multilevel perspective. *The Academy of Management Review Vol. 32 No. 1*.
- Longo, M. (2020, July 28). *Investire in digitale, priorità prima e dopo l'emergenza*. Retrieved from Inno3: innovazione, informazione, incontro: <https://inno3.it/2020/07/28/investire-in-digitale-priorita-prima-e-dopo-lemergenza/>
- Madni, A. M., & Jackson, S. (2009). Towards a conceptual framework for resilience engineering. *IEEE Systems Journal Vol. 3*, 181-191.
- Magnani, M. (2020, September 9). *Covid, l'importanza di apprendere e adattarsi*. Retrieved from Il Sole24Ore: <https://www.ilsole24ore.com/art/covid-l-importanza-apprendere-e-adattarsi-ADXtB3n>
- Mallak, L. A. (1998). Measuring resilience in health care provider organizations. *Health Manpower Management Vol. 24*, 148-152.
- Marigonda, S. (2020, September 9). *Come adottare il paradigma Industria 4.0 nella ripresa post-pandemia*. Retrieved from IndustrieQuattroPuntoZero: <https://www.industriequattropuntozero.it/2020/09/09/come-adottare-il-paradigma-industria-4-0-nella-ripresa-post-pandemia/>
- McGrath, M. (2020, May 4). *COVID-19 May Trigger A Technology Revolution*. Retrieved from Seeking Alpha: <https://seekingalpha.com/article/4342772-covidminus-19-may-trigger-technology-revolution>
- McKinsey&Company. (2011, May 1). *Big data: The next frontier for innovation, competition, and productivity*. Retrieved from <https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/big-data-the-next-frontier-for-innovation>
-

-
- McKinsey&Company. (2015, April 1). *Industry 4.0: How to navigate digitization of the manufacturing sector*. Retrieved from <https://www.mckinsey.com/business-functions/operations/our-insights/industry-four-point-o-how-to-navigae-the-digitization-of-the-manufacturing-sector#>
- McKinsey&Company. (2020). *How COVID-19 has pushed companies over the technology tipping point-and trasformed business forever*. Retrieved from <https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever>
- McKinsey&Company. (2020). *Risk, resilience, and rebalancing in global value chains*. Retrieved from <https://www.mckinsey.com/~//media/McKinsey/Business%20Functions/Operations/Our%20Insights/Risk%20resilience%20and%20rebalancing%20in%20global%20value%20chains/Risk-resilience-and-rebalancing-in-global-value-chains-full-report-vH.pdf>
- Meyer, A. D. (1982). How ideologies supplant formal structures and shape responses to environment. *Journal of Management Studies Vol. 19*, 45-61.
- Mincuzzi, A. (2020, April 25). *Con il coronavirus Bezos (Amazon) guadagna altri 25 miliardi, più del Pil dell'Honduras*. Retrieved from Il Sole24Ore: <https://angelomincuzzi.blog.ilsole24ore.com/2020/04/25/coronavirus-bezos-amazon-guadagna-altri-25-miliardi-piu-del-pil-dellhonduras/>
- Monostori, L. (2014). Cyber-physical Production Systems: Roots, Expectations and R&D Challenges. *Procedia CIRP Vol. 17*, 9-13.
- Morisse, M., & Prigge, C. (2017). Design of a Business Resilience Model for Industry 4.0. *Manufactures, AMCIS*.
- Müller, J. M., & al., e. (2018). Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0. . *Technological Forecasting and Social Change Vol. 132*, 2-17.
- Muller, J., & al., e. (2017). Sustainable Industrial Value creation: Benefits and Challenges of Industry 4.0. *International Journal Innovation Management Vol. 21*.
- Muller, J., & al., e. (2018). What drives the implementation of Industry 4.0? The role of Opportunities and challenges in the context of sustainability. *Sustainability Vol. 10 No.1*.
- Nagy, J., & al., e. (2018). The Role and Impact of Industry 4.0 and the Internet of Things on the Business Strategy of the Value Chain—The Case of Hungary. *Sustainability Vol. 10*.
- Nelson, R. R., & Winter, S. G. (1982). An evolutionary theory of economic change. *Harvard University Press*.
- Ozgun, E., Devanandham, H., & Sauser, B. (2010). Perspectives on measuring enterprise resilience. *Systems Conference*.
- Pauchant, T. C., & Miroff, I. I. (1992). *Transforming the Crisis-Prone Organization: Preventing Individual, Organizational and Environmental Tragedies*. San Francisco:: Jossey Bass.
-

-
- Pearson, C. M., & Clair, J. A. (1998). Reframing Crisis Management. *The Academy of Management Review Vol. 23 No. 1*, 59-76.
- Pellissier, R. (2011). A study of strategic intelligence as a strategic management tool in the long-term insurance industry in South Africa. *European Business Review Vol. 23 No. 6*, 609-631.
- Pendolini, E. (2020, August 8). *Lavoro, il futuro nel Veneziano sarà ancora smart. In 15 mila da casa anche dopo il Covid, questa è la previsione*. Retrieved from Il Mattino Di Padova: <https://mattinopadova.gelocal.it/regione/2020/08/08/news/lavoro-il-futuro-sara-ancora-smart-in-15-mila-da-casa-anche-dopo-il-covid-1.39173650>
- Pompei, F. (2020, April 27). *Leadership resiliente ai tempi del Covid-19*. Retrieved from Deloitte: <https://www2.deloitte.com/it/it/blog/italy/2020/leadership-resiliente---fabio-pompei.html>
- Porter, M. E., & al., e. (2014). How smart, connected products are transforming competition. *Harvard Business Review Vol. 92 No. 11*, 64-88.
- Portinaro, A., & Di Maggio, A. (2020, September 21). *Commercio tradizionale ed eCommerce, come sono cambiati con il Coronavirus*. Retrieved from NetworkDigital360: <https://www.pagamentidigitali.it/ecommerce/commercio-tradizionale-ed-ecommerce-come-sono-cambiati-con-il-coronavirus/>
- Reeves, M. (2020, July 2). *A Guide to Building a More Resilient Business*. Retrieved from Harvard Buinsess Review: <https://hbr.org/2020/07/a-guide-to-building-a-more-resilient-business>
- Reilly, A. H. (1993). Preparing for the worst: the process of effective crisis management. *Industrial & Environmental Crisis Quarterly Vol. 7 No. 2*, 115-143.
- Riccio, S. (2020, September 8). *Boom delle vendite online. Adesso il food made in Italy punta sulla rete*. Retrieved from La Stampa: <https://www.lastampa.it/economia/2020/09/08/news/boom-delle-vendite-online-adesso-il-food-made-in-italy-punta-sulla-rete-1.39282557>
- Robb, D. (2000). Building resilient organizations. *OD Practitioner Vol. 32*, 27-32.
- Robert, B. (2010). Organizational Resilience- Concepts and evaluation Method . *Press de l'ècole polytechnique de Montreal*.
- Rose, A., & Liao, S.-Y. (2005). Modeling Regional Economic Resilience to Disasters: A Computable General Equilibrium Analysis of Water Service Disruptions. *Journal of Regional Science Vol. 45 No. 1*.
- Rudtsch, V., & al., e. (2014). Pattern-based Business Model Development for Cyber-Physical Production Systems. *Procedia CIRP Vol. 25*, 313-319.
- Rüßmann, M., & al., e. (2015, April 9). *Industry 4.0: the future of productivity and growth in manufacturing industries*. Retrieved from Boston Consulting Group: https://www.bcg.com/it-it/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries
-

-
- Schmid, R. F., & al., e. (2014). A meta-analysis of blended learning and technology use in higher education: From the general to the applied. *Journal of Computing in Higher Education Vol. 26 No. 1*.
- Schmidt, R., & al., e. (2015). Industry 4.0-potentials for creatinf smart-products: empirical research results. *In Business Information Systems*, 16-27.
- Shrivastava, P. (1987). Crisis Communications. *Industrial Crisis Quarterly Vol. 1 No. 2*.
- Shrivastava, P. (1995). The role of corporations in achieving ecological sustainability. *The Academy of management review Vol. 20 No. 4*, 936-960.
- Singer, J. (2015). Practice Innovation through Technology in the Digital Age: A Grand Challenge for Social Work. *Grand Challenge 9: Harness Technology for Social Good*.
- Sironi, C. (2018, November 20). *Resistenza al cambiamento: nell'era digitale è la vera sfida per chi fa Hr*. Retrieved from Il Sole24Ore:
https://www.ilsole24ore.com/art/resistenza-cambiamento-nell-era-digitale-e-vera-sfida-chi-fa-hr--AEQijuLG?refresh_ce=1
- Somers, S. (2009). Measuring resilience potential: An adaptive strategy for organizational crisis planning. *Journal of Contingencies and Crisis Management Vol. 17*, 12-23.
- Sony, M. (2020). Pros and cons of implementing Industry 4.0 for the organizations: a review and synthesis of evidence. *Production & Manufacturing Reserch, Vol. 8 No. 1*, 244-272.
- Sony, M., & Naik, S. (2019). Critical factors for the successful implementation of Industry 4.0: A systematic review and proposed theoretical model. *Technology in Society Vol. 61*.
- Sutcliffe, K. M., & Vogues, T. J. (2003). Organizing for resilience. *Positive organizational scholarship*, 94-110.
- Tunisini, A., & al., e. (2014). *Economia e Management delle imprese: strategie e strumenti per la competitività e la gestione aziendale*. Milano: Hoepli Editore.
- Unioncamere. (2020, July 22). *Dossier Excelsior Covid-19, un approfondimento sulla situazione delle imprese dopo l'emergenza sanitaria e sulle prospettive di ripresa*. Retrieved from Unioncamere:
<https://www.unioncamere.gov.it/P42A4519C189S123/dossier-excelsior-covid-19--un-approfondimento-sulla-situazione-delle-imprese-dopo-l-emergenza-sanitaria-e-sulle-prospettive-di-ripresa.htm>
- Vala, L. J., & Campanella, T. J. (2004). The resilient city: how modern cities recover from disaster. *Oxford University Press*.
- Venzin, M., & Perotti, G. B. (2014). *Resilience. Sette principi per una gestione aziendale sana e prudente*. EGEA.
- Vogus, T. J., & Sutcliffe, K. M. (2007). Organizational Resilience: Towards a Theory and Research Agenda. *Proceedings of the IEEE International Conference on Systems, Man and Cybernetics*. Montréal, Canada.

-
- Volpe, C. (2020, May 7). *stat presenta i dati di marzo: crescono e-commerce e supermercati*. Retrieved from Starting Finance: <https://www.startingfinance.com/news/istat-dati-marzo-e-commerce-supermercati-alimentare/>
- Wang, L., Torngren, M., & Onori, M. (2015). Current status and advancement of cyber-physical systems in manufacturing. *Journal of Manufacturing Systems Vol. 37 No. 2*, 571-527.
- Wang, Y., & al., e. (2017). Industry 4.0: a way from mass customization to mass personalization production . *Advanced in Manufacturing Vol. 5* , 311-320.
- Waschull, S., & al., e. (2017). Impact of Technology on Work: Technical Functionalities that Give Rise to New Job Designs in Industry 4.0. *IFIP Advances in Information and Communication Technology*.
- Watanabe, C. (2004). Resilience as a source of survival strategy for high-technology firms experiencing megacompetition. *Technovation Vol. 24 No. 2*, 139-152.
- Weick, K. E. (1993). The collapse of sensemaking in organizations: the Mann Gulch disaster. *Administrative science quarterly Vol. 38 No. 4*, 628-652.
- Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (1999). Organizing for high reliability: Processes of collective mindfulness. *Research in organizational behavior* , 81-123.
- Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of sensemaking. *Organization Science Vol. 16*, 409-421.
- Westrum, R. (2006). Typology of Resilience Situations. *Resilience Engineerng: Concepts and Precepts* , 55-66.
- Wildavsky, A. (1991). *Searching for safety*. New Brunswick: Transaction Publishers.
- Williams, T. A., & al., e. (2017). Organizational response to adversity: fusing crisis management and resilience research streams. *Academy of Management Annal Vol. 11 No. 2*, 733-769.
- Williams, T. A., & Sheperd, D. (2016). Bulding Resilience or providing sustance: different paths of emergent ventures in the aftermath of the Haiti earthquake. *Academy of Management Journal Vol. 59 No. 6*, 2069-2102.
- Xu, L., & Duan, L. (2018). Big Data for Cyber Phisical systems in Industry 4.0: a survey. *Enterprise Information Systems Vol. 13 No. 2*, 148-196.
- Xu, M. (2018). The Fourth Industrial Revolution: Opportunities and Challenges. *International Journal of Financial Research Vol. 9 No. 2*, 90-94.

WEBOGRAPHY

<https://www2.deloitte.com/it/it/pages/about-deloitte/articles/the-perseverance-of-resilient-leadership---deloitte-italy---abou.html> [Last Access: 27/10/2020]

<https://www2.deloitte.com/it/it/blog/italy/2020/leadership-resiliente---fabio-pompei.html>
[Last Access: 27/10/2020]

https://www2.deloitte.com/content/dam/Deloitte/it/Documents/strategy/PrivateBrochure/COVID-19_cambio%20di%20paradigma_Deloitte%20Private.pdf [Last Access: 29/10/2020]

<https://www.texa.it/> [Last Access: 09/11/2020]

<https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf> [Last Access: 16/10/2020]

<https://www.osservatori.net/it/ricerche/osservatori-attivi/ecommerce-b2c> [Last Access: 10/10/2020]

https://www.mise.gov.it/images/stories/documenti/Slide_transizione_22giugno2020.pdf [Last Access: 18/09/2020]

<https://www.mise.gov.it/images/stories/documenti/Rapporto-MiSE-MetI40.pdf> [Last Access: 18/09/2020]

https://www.mise.gov.it/images/stories/documenti/guida_industria_40.pdf [Last Access: 18/09/2020]

https://www.mise.gov.it/images/stories/documenti/2017_01_16_Industria_40_Italiano.pdf
[Last Access: 18/9/2020]

<https://www.focusindustria40.com/resilienza-e-digitalizzazione/> [Last Access: 27/10/2020]

<https://www.bravo.it/> [Last Access: 06/11/2020]

<https://www.bettersilver.it/it> [Last Access: 06/11/2020]

<https://www.bcg.com/press/21june2017-gaining-robotics-advantage> [Last Access: 16/10/2020]

<https://www.bcg.com/it-it/publications/2020/resilience-more-important-than-efficiency> [Last Access: 20/10/2020]

<https://www.bcg.com/it-it/publications/2020/digital-path-to-business-resilience> [Last Access: 20/10/2020]

<https://www.bcg.com/it-it/capabilities/operations/embracing-industry-4.0-rediscovering-growth> [Last Access: 16/10/2020]

https://www.bcg.com/it/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries [Last Access: 16/10/2020]

https://www.accenture.com/_acnmedia/PDF-128/Accenture-Tech-Vision-COVID-19-2020-CH.pdf [Last Access: 26/10/2020]

<https://onoexponentialfarming.com/contact> [Last Access: 08/11/2020]

<https://idexe.com/> [Last Access: 28/10/2020]

<https://home.kpmg/it/it/home/insights/2019/06/global-ceo-outlook-2019.html> [Last Access: 23/10/2020]

<https://forbes.it/2020/02/21/coronavirus-in-italia-come-stanno-rispondendo-nostre-imprese/> [Last Access: 26/04/2020]

<https://economia.unipd.it/LMD/laboratorio-manifattura-digitale> [Last Access: 15/09/2020]

https://ec.europa.eu/italy/news/20200611_nuova_relazione_della_commissione_europea_sulla_resilienza_digitale_it [Last Access: 26/08/2020]

<https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20190121-1> [Last Access: 16/10/2020]

<https://e4tc.rwth-campus.com/> [Last Access: 20/10/2020]

https://aida.bvdinfo.com/Search.QuickSearch.serv?_CID=1&context=212NIOOUA3SIY50 [Last Access: 12/11/2020]

http://www3.weforum.org/docs/WEF_Critical_Frontier_Leveraging_Technology_Combat_COVID_19_2020.pdf [Last Access: 28/10/2020]

http://www.ven.camcom.it/userfiles/ID652_comsta432019_digitalizzazione.pdf [Last Access: 01/11/2020]

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