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"THE ROLE OF DIGITAL SERVITIZATION IN MITIGATING THE IMPACTS OF COVID-19 PANDEMIC: THE CASE OF ITALIAN MANUFACTURING COMPANIES"

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INTRODUCTION

The main object of the thesis work involves the theme of digital servitization and how the combination of services and digital technologies can help manufacturing companies to react even in the face of health emergencies such as the Covid-19, thus building their own path towards the new normal. In order to understand how all of this is feasible, we will start from chapter 1 where the analysis of the reference literature, according to the theme of servitization, is provided, including some basic definitions and concepts regarding this issue. Further words will be spent on the evolution that the servitization phenomena has had within the manufacturing context, where services were initially considered as a necessary evil. In doing so, we will also define the main drivers able to push industrial enterprises to rely and invest on services and, on the other hand, we will look at the main challenges that manufacturers may face while moving into the service business. Such a discussion, finds in the concept of "service-paradox" a major hurdle to be overcome while transitioning to services, since firms may not get the expected returns from such shift. Indeed, different organizational, structural and even procedural aspects have to be adapted and addressed while transitioning from a product-centric orientation to a service one, in order to gain a favorable momentum. However, in this issue, we highlight how a proper combination of market-oriented service development, together with coordination and transparent procedures, can act as key enablers for a firm in supporting the successful implementation of a service strategy, thus avoiding to get stuck in the abovementioned paradox. Once made, such premises will be an important basis to introduce the resources and capabilities needed to perform a successful service transition and how a firm could leverage on them in order to gain a differentiation or cost advantage with respect to other players. In the conclusive part of this chapter, languages involving the concept of hybrid offerings will be provided, with particular attention on four categories of industrial services namely: product life-cycle services, asset efficiency services, process support services and process delegation services.

In chapter 2 we introduce the digital transformation process in manufacturing, starting from the concept of Industry 4.0. Languages are provided in an attempt to define the relationship between servitization and digital transformation and the main innovative trajectories that manufacturers can undertake, are envisaged. In this context, the role of digital technologies, in providing value by firms to their customers, is also highlighted. However, as in the case of transitioning to services, also the digital transformation process requires a series of aspects to be addressed by those industrial realities aiming to be successful. Further languages are provided with respect to how digital technologies that are shaping the service business – in particular the Internet of Things, Cloud Computing and Predictive analytics – are influencing

how manufacturers pursue their service-led growth strategies, thus unlocking new possibilities and opportunities. As consequence, the combination of Industry 4.0 enabling technologies, together with services, creates room for new and innovative business models, over which companies can build up a profitable service strategy. Initially, we will define how manufacturers shall organize themselves in order to undertake said strategy, then three main business models will be introduced namely: availability provider, performance provider and equipment provider. Lastly, service-led growth strategies will be analyzed from an ecosystem perspective, in which collaboration and cooperation by customers are key factors for manufacturers aiming to provide advanced services, such as pay-per-use and outcome-based-contracts. In the last paragraph of chapter 2, the definitions, concepts and features, envisaged in the previous sections, will yield to an analysis regarding the role of services in turbulent times. Here, the aim is to define why manufacturers rely on services and service-led growth strategies, thus implementing increasing customer-oriented business models. For this reason, the discussion starts from the role of services during the industry life-cycle, provided that this is not a crisis per se, it still constitutes an important basis in order to look at how services behave in case of uncertainty or in case of introduction of new technologies. Such premises will found a further expression when the impacts suffered by both products and services, during the 2008-2009 collapse, will be discussed. Indeed, the differences in terms of impacts occurring between trades in products and trades in services will be introduced in an attempt to demonstrate why services where more resilient with respect to product trades. Finally, the role of advanced services will be analyzed in two different sectors: automotive and printing. The goal here is to define why the former cannot afford to make result-oriented offerings in spite of the latter which is, instead, considered to be a forerunner in the adoption and implementation of servitization. This latter aspect will be the basis for a further analysis – discussed in chapter 3rd – since a gap has been envisaged in the literature and thus two additional interviews have been performed, in an attempt to provide a complete picture of the issue.

The thesis work concludes in chapter 3, where evidences from the research activity carried out are provided. In particular, the discussion starts from describing the adopted methodology and continues through an explanation concerning the main research goals. On such occasion, differences arising between Covid-19 and other major outbreaks will be introduced and discussed. The following sections, instead, aims at giving a greater overview regarding the pandemic and highlights previous researches on the matter. To address this issue, two different thematic will be covered: firstly, the research activity born through the collaboration between ASAP SMF and DT-Lab will be discussed; secondly, the main results arising from the instant papers will be highlighted. Such a thematic will be an important basis for the introduction of

the research carried out together with DT-Lab. In this sense, we will firstly look at the challenges arisen by the interviews carried out, then we will represent and discuss the data from the empirical analysis, who were collected through an extensive survey. Finally, an in-depth analysis regarding the degree of servitization in sectors as printing and automotive will be provided. The reason for performing such an analysis lies into the literature review made in Chapter 2, where differences arose between these two industries. In particular, we will determine which is the actual state – in terms of services and technologies – of such industries, which are the direction in which they are moving and how the business models being implemented can be transferred also to other industries.

1. The servitization within manufacturing companies

Introduction

The first chapter aims to give a general overview regarding the servitization topic. To address this goal, we will begin by giving some basic definitions and concepts as stated in literature and then move on to the evolution of this theme. Especially this latter aspect is important to have a comprehensive overview regarding why manufacturing and product-centric companies have, over the time, increased their engagement with the servitization process, since services were initially seen as a necessary evil by all of these entrepreneurial realities. However, the increasingly competition and sometimes stagnation of industries has pushed many companies to rely and invest on services as a way for achieving differentiation and, at the same time, escape from commoditization.

For this reason, we will go through the different drivers that, according to the main body of literature, are able to push firms towards a servitization strategy. Although, as we will see, the transition from products to services is not a simple pathway for many different companies that may get stuck in such shift due to the many challenges that these are called to face. For this reason, we will also define the deservitization and service paradox phenomena and provide languages regarding how it is possible to overcome such hurdles and be successful in the transition from producer to service provider.

The second paragraph, instead, aims at giving a complete overview regarding the resources and capabilities needed by companies on their way for the servitization pathway, especially with respect to how these shall be developed and in which directions can be oriented to successful apply the transition from products to solutions. Indeed, the successful combination of resources and capabilities unlocks the possibility for manufacturing companies to design the so-called hybrid offerings.

The third paragraph is entirely dedicated to service-led growth strategies and hybrid offerings, to be developed by manufacturing companies. Indeed, we will go through the four main categories of solutions that can be developed by suppliers (PLS, AES, PSS, PDS), underlying the resources and capabilities needed to successfully engage with such hybrid offerings and explaining how such trajectories can bring companies to gain a positional advantage in their value chains.

1.1. Servitization: definitions and concepts

In order to gain a comprehensive analysis regarding the servitization phenomena it is important to start from the very basic distinction between products and services. The product nomenclature is typically better understood by manufacturers, who produce, store, advertise,

transport, and sold products (e.g. car, bicycle, plane). In other words, a "product" is the core offering of the firm (Cusamano, et al., 2006). Whereas a service is an economic activity which does not result in the ownership of tangible assets (Baines, et al, 2009) and thus enables product companies to assist the promotion of the core product or to enhance it.

This last definition creates room for looking at the intrinsic relationship occurring between products and services as a form of complementary assets (Teece 1986), where two activities are complementary when, an increase in one, raises the marginal return of the other (Brandenburger and Nalebuff, 1996). According to Cusamano, however, such complementarity does not require that products must exist before services as it actually happens within the software industry, where firms offer services to learn the user requirements before developing a standardized product. Therefore, the relationship between products and services has implications for companies both from an economic standpoint, where services have been linked to longer term and more stable sources of revenue, that may be able to protect firms from economic downturns (Quinn, 1992) or periods of commoditization. In addition, from a strategical standpoint since services often require different labor-intensive capabilities, the integration of products and services can make imitations by competitors more difficult (Heskett et al., 1997).

1.1.1. Defining servitization

The topic of servitization resulted in a large interest both from an academic standpoint as well as from an industrial point of view. However, as highlighted by Kowalkowski et. al (2017), despite the extensive literature associated with this now-mature discipline, there is no broad-based consensus on the core concepts and definitions deployed by servitization scholars.

For such reasons, we will go through some of the main and most widely adopted definitions regarding servitization, which enable to have a better comprehension about such discipline (see: Table 1).

In particular, Vandermerwe and Rada (1988) were the first to define the servitization phenomena as "the increased offering of fuller market packages or 'bundles' of customer focused combinations of goods, services, support, self-service and knowledge in order to add value to core product offerings". According to such definition, "services are performed and not produced and are essentially intangible", while servitization is "a more holistic approach by managers to their businesses and their customers problems. […] [The managers are] looking at their customers' needs as a whole, moving from the old and outdated focus on goods or services to integrated 'bundles' or systems, as they are sometimes referred to, with services in the lead role".

As shown in Table 1, there are other definitions regarding servitization, the majority of which do agree with the concept introduced by Vandermerwe and Rada, thus based on the delivery of product-based services. As we can notice, one slight deviation is proposed by Lewis et al. (2004), who refers to the idea of a functional product, which, according to Tukker (2004), is a specific PSS offering. Such last aspect, generates similarities between the two communities (PSS and servitization) as both converge towards a common conclusion, where manufacturing companies should be focusing on selling integrated solutions or PSS, reason for which (Baines et al., 2009) defines servitization as: "the innovation of an organizations capabilities and processes to better create mutual value through a shift from selling product to sell PSS".

Author	Definition of servitization
Vandermerwe and Rada (1988)	"Market packages or 'bundles' of customer-focussed combinations of goods, services, support, self-service and knowledge"
Desmet *et al.* (2003)	"A trend in which manufacturing firms adopt more and more service components in their offerings"
Tellus Institute (1999)	"The emergence of product-based services which blur the distinction between manufacturing and traditional service sector activities"
Verstrepen and van Den Berg (1999)	"Adding extra service components to core products"
Robinson *et al.* (2002)	"An integrated bundle of both goods and services"
Lewis *et al.* (2004)	"Any strategy that seeks to change the way in which a product functionality is delivered to its markets"
Ward and Graves (2005)	"Increasing the range of services offered by a manufacturer"
Ren and Gregory (2007)	"A change process wherein manufacturing companies embrace service orientation and/or develop more and better services, with the aim to satisfy customer's needs, achieve competitive advantages and enhance firm performance"

Table 1 – *Definitions of servitization (Baines et al., 2009)*

1.1.1.1. The evolution of servitization

There is little evidence in literature regarding the evolution of servitization within the manufacturing scenario, though, as pointed out by Baines et al. (2009), after the 1988 there has been a growing number of papers involving servitization in operations, services and business fields. Also in this case, Vandermerwe and Rada (1988) were the first that tried to describe the evolutionary pathway made by firms on the journey for servitizing their businesses. According to their findings, originally companies were divided into goods or services businesses. Such trend, changed soon after the technological development which made obvious that most companies needed both goods and services; such aspect was particularly evident for manufacturers operating within the computer industry, where products and services started to be inseparable. This journey, concluded into a stage where services dominate and firms offer 'bundles' consisting of "customer-focused combination of goods, services, support, self-service, and knowledge".

Although servitization as a phenomena started to be studied in the 1990s, Davies et al. (2006), argued that pioneering applications originated in the 1960s with the introduction of the so-called "selling systems". Therefore, with the evolution of servitization the boundaries between products and services became slimmer, as many manufacturing companies have moved into services.

1.1.1.2. Drivers of servitization

Initially, services were seen as a necessary evil in the context of marketing strategies by managers of manufacturing companies (Wise and Baumgartner, 1999; Gebauer and Friedli, 2005; Gebauer et al., 2006), where the main part of total value creation was considered to stem from physical goods, and services were assumed purely as an add-on to products (Gebauer and Friedli, 2005).

Nonetheless, the provision of services has now turned into a conscious and explicit strategy with services becoming a main differentiation factor, in a totally integrated products and service offering (Baines et al., 2009). Recently, the value proposition often includes services as fundamental value-added activities (Vandermerwe and Rada,1988; Quinn et al., 1990; Gebauer et al., 2006) and reduces the product to be just a part of the offering (Oliva and Kallenberg, 2003; Gebauer et al., 2006), reason for which some companies have found this to be a most effective way to open the door to future business (Wise and Baumgartner, 1999). That is why, many authors in the management literature (Bowen et al., 1991; Gadiesh and Gilbert, 1998; Quinn et al., 1990; Wise and Baumgartner, 1999) are suggesting to product manufacturers to integrate services in their core product offerings.

Thus, the literature suggests three drivers able to push companies towards a servitization strategy (Mathe and Shapiro, 1993; Mathieu, 2001b; Oliva and Kallenberg, 2003; Gebauer and Friedli, 2005; Gebauer et al., 2006; Gebauer and Fleisch, 2007).

- Financial

The majority of the literature mention the main financial drivers to be higher profit margins and stability of income (Wise and Baumgartner, 1999; Gebauer and Friedli, 2005). According to Wise and Baumgartner (1999), for manufacturers with high-installed product bases (e.g. automotives, locomotives, aerospace), service revenues can be one or two orders of magnitude greater than the new product sale, a concept upon which Slack (2005) agrees and states that in these sectors higher revenue potential often exists. Likewise, Sawhney et al. (2004) identifies companies that were successful in following such approach (e.g. GE, IBM, Siemens and Hewlett Packard) and achieved stable revenues from services despite significant drops in sales. Furthermore, Ward and Graves (2005) emphasize that the increased life-cycle of many modern

complex products, like aircrafts, is pushing the most significant revenues downstream towards in-service support. These product-service combinations tend to be less sensitive to price-based competition (Malleret, 2006), and so tends to provide higher levels of profitability in comparison to offering the physical product alone (Frambach et al., 1997). Conclusively, product-service sales tends to be counter-cyclical or more resistant to the economic cycles that affect investments and goods purchase (Oliva and Kallenberg, 2003; Gebauer and Fleisch, 2007). This can help secure and regular income and balance the effects of mature markets and unfavorable economic cycles (Brax, 2005; Malleret 2006).

- Strategic

The literature frequently refers to strategic drivers that are largely concerned with gaining a competitive advantage (Baines et al., 2009). These, use service elements to differentiate manufacturing offerings and so provide important competitive opportunities (Frambach et al., 1997; Mathieu, 2001b; Gebauer and Fleisch, 2007). Competitive advantages achieved through services are often more suitable since, being less visible and more labor dependent, services are more difficult to be imitated (Oliva and Kallenberg, 2003; Gebauer and Friedli, 2005; Gebauer et al., 2006). On the other hand, many authors (Coyne, 1989; Frambach et al., 1997; Mathieu, 2001b; Gebauer and Fleish, 2007) reflect on the increased commoditization of the markets, where differentiating strategies based on product innovation, technological superiority or low prices, are becoming incredibly difficult to maintain. Indeed, Frambach et al. (1997) argue that the value-add of services can enhance the customer value up to the point where homogeneous physical products are perceived as customized, which, in turn, increase barriers to competitors (Mathieu, 2001b).

- Marketing

Marketing opportunities are generally understood as the use of services for selling more products (Mathe and Shapiro, 1993; Gebauer et al., 2006; Gebauer and Fleisch, 2007). The service component is well known to influence the purchasing decision and assessing its importance has been a lasting in tradition in marketing literature (Mathieu, 2001b; Gebauer and Fleisch, 2007). This is especially true in B2B or industrial markets where customers are described as increasingly demanding for services (Vandermerwe and Rada,1988; Oliva and Kallenberg, 2003; Auramo and Ala-Risku, 2005; Slack, 2005). The reasons for these are pressures to create more flexible firms, narrower definitions of core competencies and higher technological complexity, and these often lead to increasing pressures to outsource services (Lewis et al., 2004; Auramo and Ala-Risku, 2005; Slack, 2005). Furthermore, according to both

Vandermerwe and Rada (1988) and Correa at al. (2007), services are also claimed to create customer loyalty up to the point where the latter becomes dependent on the supplier. Finally, by offering services, companies gain insights into their customers' needs and are enabled to develop more tailored offerings (Baines et al., 2009).

1.1.1.3. Challenges in the adoption of servitization

Many authors agree upon the fact that the adoption of servitization brings with it significant cultural and corporate challenges (Vandermerwe and Rada, 1988; Wise and Baumgartner, 1999; Oliva and Kallenberg, 2003; Brax, 2005; Slack, 2005).

In particular, according to Slack (2005) the design of services is significantly different to the design of products since, by their nature, services are fuzzy and difficult to define. This may discourage companies from expanding the service dimension, particularly because they need to take account of competition outside the usual domain, from unexpected rivals, including their own suppliers, distributors and customers (Vandermerwe and Rada, 1988; Mathieu, 2001b; Oliva and Kallenberg, 2003).

Therefore, manufacturers that decide on a service-oriented strategy have to adapt the necessary organizational structures and processes (Mathieu, 2001b; Gebauer and Friedli, 2005; Oliva and Kallenberg, 2003; Gebauer and Fleisch, 2007). Here, as pointed out by Wise and Baumgartner (1999), there are challenges in defining the organizational strategy necessary to support the customer allegiance, required to deliver a combination of product and services. In addition, attempting to transform a traditional manufacturer to the required organizational strategy for effective servitization sets-up particular challenges (Baines et al., 2009). As the matter of fact, Mathieu (2001a, b) pointed out that the service culture is specific and different from the traditional manufacturing culture and a shift of corporate mindset is necessary to take on services and prioritize their development with respect to more traditional sources of competitive advantage (Coyne, 1989; Oliva and Kallenberg, 2003; Slack, 2005). Such shift in mindset, according to Foote et al. (2001), will require significant changes to long-standing practices and attitudes, for example through abandoning their product-centric structure in order to become more customer-centric (Windahl and Lakemond, 2006).

However, in implementing these changes, companies are likely to meet resistance from areas, within the organization, where the service strategy is not understood or because of a fear of infra-structural changes (Mathieu, 2001b). For these reasons, Baines et al. (2009), believes that creating a service-oriented environment and finding the right people for the service dimension is key to succeed.

1.1.2. The deservitization phenomena

Despite the large interest in the servitization phenomena shown by authors, companies and industries, it is also important to define what the deservitization phenomena is and why manufacturing companies engage with it.

In a price-competitive market, a company may decide to reduce or curtail service provision if uneconomical (Kowalkowski et al., 2017), indeed Rangan and Bowman (1992) referred to this kind of voluntary service dilution as a service compression strategy. As demonstrated by Cusamano et al. (2015), the evolution in the computer industry, highlighted that many large manufacturers continuously pursue both service infusion and service dilution initiatives (see: Figure 1) and, as pointed out by Kowalkwski et al., (2017), such dynamics are not confined to service flows from one actor to another [upstream and downstream], but also depend on factors as innovation, maturity, and competence.

Valtakoski (2017) views the deservitization phenomena as a special case of the computer industry evolution, which, during the 1980s, was characterized by a lower technological uncertainty that translated into a higher technological diffusion, prompting firms to deservitize. According to Spohrer (2017), in parallel with service growth, companies face a related technological change defined as the "cognitive" phase of the current digital transformation of the industry and the global economy, informed by advances in artificial intelligence. This is also known as the Industrial Internet, the Internet of Things or Industry 4.0, technologies able to facilitate the decoupling of machine software from hardware across the socio-technical industry system and enable fuller utilization of product data in combination with other data.

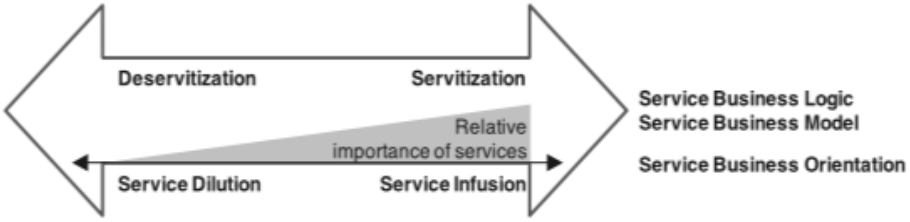

Figure 1 – *Service growth and reduction processes: two continua (Kowalkowski et al., 2017)*

These increasingly autonomous systems and self-aware, predictive and reactive machines communicate seamlessly with each other and with human actors, offering immense opportunities for service growth and driving new service innovation, such as cognition-as-a-service, as well as enabling more viable service systems (Kowalkowski et al., 2017). As pointed out by Spring and Arujo (2017) such technologies are coevolving with new opportunities to move from linear industrial processes to "circular economy" principles; at the same time, as

happened in the past for the Computer industry, many established services are likely to be negatively affected and even replaced.

1.1.3. Overcoming the service paradox

As we have seen in the previous paragraphs, there are many aspects to be addressed on the pathway for servitizing a business. In such a scenario, many authors have studied the adoption of servitization by companies based on case study work (Wise and Baumgartner, 1999; Mont, 2001; Miller et al., 2002; Oliva and Kallenberg, 2003; Mathe and Stuadacher, 2004; Davies, 2004; Davies et al., 2006a, b).

Baines et al (2009) summarized key examples of companies moving to exploit downstream opportunities from services (see Table 2). There are four categories that can be envisaged (Wise and Baumgartner, 1999): embedded services which allow traditional downstream services to be built into the product (e.g. Honeywell's AIMS for in-flight monitoring of engine systems); comprehensive services such as those offered by GE around its product markets (e.g. GE capital's financing activities); integrated solutions where companies look beyond their traditional product base to assess the overall needs of customers (e.g. Nokia's move to network-infrastructure solutions); and finally distribution control as the one used by Coca-Cola to grab shelf space in its high-volume low-margin supermarket segment.

However, as pointed out by Baines et al (2009), while the Table 2 summarizes cases of leading practice, it also highlights the limited nature of exemplars in this field. Such last aspect creates room regarding the fact that many companies involved in the transition into services, did not get the expected correspondingly high returns (Coyne, 1989; Neely, 2007). Such phenomenon is known as "service paradox", a term coined by Gebauer et al. (2005), whose observations and studies demonstrated that most companies found it extremely difficult to exploit successfully the financial potential of an extended service business. According to their analysis, many manufacturing companies got stuck in the "service paradox", thus failing to meet the intended objectives and the reasons for such failures are tied with some cognitive factors, able to limit extended service offerings.

Firstly, Gebauer et al. (2005), define as a cognitive phenomenon the overemphasis on obvious and tangible characteristics, a concept based on Kahneman et al. (1982) findings, whereby a manager argued: "Unfortunately, we have repeatedly been shown to pay undue attention to conspicuous and tangible aspects of business. We always believed our products could be differentiated from those of competitors through enhanced features, functionality, reliability, and suitability for current and latent customer needs. Entirely new products were another way of strengthening our competitive position. Products are simply more obvious than

services. We would, therefore, normally prefer to invest resources in products instead of investing resources in extending the service business".

Organisation	Description	Source
Alstom	Maintenance, upgrade and operation of trains and signalling systems	Davies (2004)
ABB	Turnkey solutions in power generation	Miller *et al.* (2002)
Ericsson	Turnkey solutions to design, build and operate mobile phone networks	Davies (2004)
Nokia	Nokia's network-infrastructure solutions, providing network equipment and service to carriers	Wise and Baumgartner (1999) Davies *et al.* (2006a, b)
Thales	Pilot training and simulator-building management	Davies (2004)
Rolls-Royce	"Power by the Hour" guaranteed flying hours for aero engines	Howells (2000)
Xerox International	Document management services. Guaranteed fixed price per copy	Mont (2001)
WS Atkins	System integration services and outsourcing solutions	Davies (2004)

Table 2 - *Industrial examples of servitization (Baines et al., 2009)*

The second cognitive factor able, according to the authors, to limit the investments in services is represented by the failure to recognize the economic potential of an extended service business, since managers may not believe in its economic potential. (Oliva and Kallenberg, 2003).

The third and most significant cognitive factor, able to limit the extended service offerings, is the risk aversion of managers within manufacturing companies. Indeed, the authors point out that managers typically prefer the less risky outcomes of investing resources into products, rather than relying on investing on uncertain outcomes tied to investments in services. According to Gebauer et al. (2005), such a risk is at first internal, since providing highly customized services, that require a high intensity customer relationship, consequently requires a different set of capabilities. Secondly, the risk related to providing services in manufacturing is also related to external factors, because services often support core activities and help maximize all processes associated with the supplier's product. The supplier, thus, acquires an intimate knowledge of the customer's operations. Therefore, if we combine such cognitive factors than we would end up having an explanation regarding why an extended service business often fails to achieve a sustainable momentum in manufacturing companies. In the following paragraph we will examine how it is possible to overcome the "service paradox" thus adopting an effective service strategy.

1.1.4. The transition from product manufacturer to service provider

As discussed in the previous paragraphs, the transition pathway from product manufacturer to service provider constitutes a major managerial challenge. Services require organizational

principles, structures and processes new to the product manufacturer. Not only are new capabilities, metrics and incentives needed, but also the emphasis of the business model changes from transaction to relationship-based. Developing this new set of capabilities will necessarily divert financial and managerial resources from manufacturing and new product development, the traditional sources of competitive advantage for the organization (Oliva and Kallenberg, 2003).

In order to extend the service business is, at first, important to start a market-oriented service development, especially with respect to the identification of the customer needs that, according to De Brentani et al. (2001), constitutes an indispensable prerequisite for developing new and successful services. Gaining knowledge regarding the customer's needs will enable a company to develop services able to fulfil those needs and avoid that the firm will fail in offering and designing services. As stated by Gebauer et al. (2005), in conjunction with the market orientation, a systematically coordinated and transparent procedure supports the successful development of new service products, since, typically, manufacturing companies have a clearly defined product development process, but they lack a sufficiently defined service development process, as found in traditional service companies. The service-development process shall be carried out precisely and shall be aligned with corporate goals in order to be effective and successful.

A proper combination between market-orientation and service-development would enable a company to offer a different service, although the expansion of service offerings should start with product-related services, whose aim is to ensure the proper functioning of the product or customer use of and access to it (transportation, documentation, inspection, repair, maintenance and spare parts). Being successful in providing such services could enable a company to further develop its service offerings, for instance through expanding over the customer support services such as process-oriented engineering, spare parts management and managing customer maintenance functions. Furthermore, according to Mathieu (2001), differently from product-related services, the customer support services enable the supplier to explore how services support particular client initiatives and advance the mission of customer organization. According to Oliva and Kallenberg (2003), once the company is able to provide both product-related and customer support services the effect is twofold, since the former changes the focus of the value proposition from ensuring the proper functioning of the product and effectiveness within the customer process, while the latter brings to change the focus of customer interaction from transition to a relationship basis. This last aspect, according to Gebauer et al. (2005), is directly related to the necessary organizational arrangement, which, in other words, is represented by the relationship marketing.

As pointed out by Grönroos (1998), the general focus of relationship marketing is on building relationships with customers, thus making possible to establish an ongoing relationship and make services "tangible". Furthermore, relationship marketing must be implemented at three different dimensions: (i) external marketing, directed towards making promises able to build positive customer expectations and bring the company to sell solution rather than products; (ii) internal marketing, refers to "enabling promises"; (iii) interactive marketing, consisting in the management of the previous forms. Especially the latter, is fundamental in order to ensure a proper communication between the customer and the service organization as well as train and empower sales people and service technicians so that they can offer services actively (Bowen and Lawler, 1998).

The correct and complete combination of a market-oriented service development, an extended service offering and a relationship marketing, must be based on a clear service strategy (Quinn et al., 1990). Indeed, both Gebauer et al., (2005) and Bowen et al. (1989), found that successful transition companies where those having a clear service strategy, able to encourage companies to make appropriate organizational arrangements and resource allocation, as well as being aligned with the corporate strategy. According to Mintzberg and Waters (1985), when implementing a service strategy, all successful companies go through two phases. In the first phase, a service strategy can be interpreted as an evolving strategy for manufacturing companies, because the strategy was not deliberate or explicit. The services offered were just an add-on to the product and a marketing tool in the context of a marketing strategy for core products. In the case of services as an add-on, profits and revenue are generated mainly through core products and the contribution of services is quite low in terms of revenue, profit and customer satisfaction. In the second phase, instead, there is a clear intention to increase the total value creation through services, therefore it constitutes a deliberate strategy.

Lastly, according to Gebauer et al (2005), in order to implement a successful and deliberate service strategy, there are three fundamental requirements. Firstly, the successful companies realized that a successful service strategy cannot be developed without a comprehensive understanding of the market in terms of customer needs, market potential and future service trends. Successful companies build a network of sales, technical staff and external experts, such as market research departments, which systematically collect and record current and future customer needs. Secondly, once the information which is relevant to the strategy has been collected, all areas of the company affected by service strategy are involved in the development process. The successful companies thus integrate all organizational components and increase acceptance of the strategy and commitment to it. Thirdly, it seems important for the entire procedure (strategy analysis, development, implementation and monitoring) to be systematic

and transparent. It should be considered as a non-linear process, a circular operation incorporating frequent feedback loops.

Conclusively, in order to achieve an expansion in terms of service offerings it is also possible to establish a separate service organization. Indeed, according to Schendel and Hofer (1979), the first step in the strategic management process is the formulation of a set of goals for the service organization. The priorities accorded to the various goals will determine both how goal conflicts will be resolved and the nature of the goal hierarchy that will be used in formulating, evaluating and implementing strategy. The service organization in manufacturing companies must operate like a professional service organization using such performance measures as customer satisfaction, employee satisfaction and business success (Heskett et al., 1997). In such a context, both Gebauer et al (2005) and Oliva and Kallenberg (2003) observed that firms, which are successful in increasing service revenue, ran decentralized service organizations with profit-and-loss responsibility. The successful companies do not merely quantify targets for their service organization, they also break goals down to the level of individual employees. They link goal achievement to an incentive system. Such a breakdown of the service strategy demonstrates how individual goals contribute to the overall corporate goal.

1.2. Relevance of the firm's resources and capabilities in the servitization pathway

As highlighted in the previous paragraphs, the servitization pathway undertaken by manufacturing companies is made up by many different challenges. In particular, such realities have to understand how to properly leverage unique resources and build distinctive capabilities in order to come up with successful offerings, able to create value for their customers. As we have seen, manufacturing companies who moved to services and solutions had the aim of solidify their positions within highly competitive markets and grow their revenues and margins.

However, organizations achieve competitive advantages predominantly by developing and deploying resources and capabilities (Peteraf, 1993). The former do not grant a competitive advantage per se, rather these must be translated into capabilities, indeed an organizational capability is a firm's capacity to deploy resources for a desired end result (Helfat and Lieberman, 2002). Furthermore, according to Ulaga and Reinartz (2011), if an organization is able to create sources of competitive advantage, than it may translate them either into a better position with respect to competitors or be able to differentiate vis-à-vis competitors. In the next paragraphs we will examine which are the unique resources that goods-focused manufactures need to leverage in order to build key capabilities and so deliver successful hybrid offerings.

1.2.1. Unique resources

It is better to precise that a firm's resources are a stock of available factors owned or controlled by the firm (Amit and Schoemaker, 1993) and, as it is easy to understand, manufacturing companies have a different stock of relevant resources compared with pure service firms (Bharadwaj, Varadarajan and Fahy, 1993). In this context, an important research was carried out by Ulaga and Reinartz (2011) regarding which are the most critical manufacturer-specific resources and these can be classified into four different categories.

- *Installed base product usage and process data*.

According to Wise and Baumgartner (1999), the installed base goods represent a unique assets for most manufacturing firms, meaning that if a firm is able to deliver services to its installed base – through maintenance and repair agreements for instance – than it can collect product usage and customer process data. In such context, the increasing importance of smart technologies has improved the manufacturer's access to strategic customer data (Rijsdijk, Hultink, and Diamantopoulos 2007). Furthermore, according to Watson et al. (2002), goods are increasingly equipped with information and communication technologies and form extensions of networks. Hence, it comes easy to understand that in a networked world, manufacturers have the control over a unique resource in terms of product usage and process data in the installed base. This last aspect is also confirmed by the research carried out by Ulaga and Reinartz (2011), where most of the firms participating stated that having access to the customer data is a unique asset able to provide differentiation within a competitive market.

- *Product development and manufacturing assets.*

Differently from pure service providers, manufacturing companies typically hold a stock of unique assets, both tangible and intangible, that are implied for developing and producing goods. Therefore, it is important for a manufacturer to leverage its goods-oriented resources for the development of hybrid offerings. In this sense, according to Markides and Williamson (1996), knowledge and resource spillovers likely help firms exploit synergies between manufacturing and services. This aspect is confirmed by the research by Ulaga and Reinartz (2011) where a tire manufacturer developed a new tire casing that allowed it to regroove and re-tread it more often than its competitors could. Therefore, customers' trucks could go thousands of miles more with the vendor's tiles than with any other competitive tire. This last aspect resembles that manufacturing firms may enjoy a unique position, in which they can

exploit specific resources thus being able to reach a competitive advantage over direct competitors and pure service providers in developing superior hybrid offerings.

- *Product sales force and distribution network.*

In the business-to-business context, typically firms invest in direct sales organizations or decide to work with some channel intermediaries to cover sales territories, an aspect confirm by the research of Ulaga and Reinartz (2011), where a participating manufacturer generated the 90% of its sales through a network of more than 2000 exclusive and independent distributors.

- *Field service organization*

Many manufacturing companies make investments into field organizations to deliver and install goods, as well as servicing their installed base. The aim behind such an investment is to come up with a field service network, able to increase both the margins and profits of the manufacturing company through providing after-sales services as well as gaining an opportunity to develop new and more complex hybrid offerings.

The above mentioned categories represent unique resources that goods-oriented manufacturers might own, since these are critical for building distinctive capabilities that can enable a company to come up with the development of successful hybrid offerings.

1.2.2. Distinctive capabilities

According to Amit and Schoemaker (1993) capabilities refer to a firm's capacity to deploy its resources. Such definition, indeed, fits particularly good with the distinctive capabilities envisaged by Ulaga and Reinartz (2011) in their research, which can be classified into five main categories.

- *Service-related data processing and interpretation capability.*

Such set of capabilities refer to the manufacturer capacity to analyze and interpret product usage and customer process data from an installed base, using advanced monitoring and communication technologies, and then utilize those data to develop hybrid offerings that allow customers to achieve productivity gains and/or cost reductions (Ulaga and Reinartz, 2011). As we have previously mentioned, product usage and process data derived from an installed base represent potential unique assets for manufacturers (Allmendinger and Lombreglia, 2005). However, the activity of collecting strategic customer data alone is not sufficient, indeed manufacturing companies shall also estimate how to translate these data into sources of revenues and/or opportunities to provide existing offerings at lower costs. An explicative example in this sense is the one provided by Ulaga and Reinartz (2011) where an

industrial equipment manufacturer had installed dozens of electricity meters in commercial buildings to monitor customers' energy consumption. Through using its unique data access, the manufacturer developed specific capabilities for analyzing energy consumption, which became the basis for distinctive skills in facility management. As a consequence, the company achieved an ideal position to provide energy efficiency consulting services to business customers, which became a new source of revenue generation for the firm. The vendor also gained a competitive edge over pure service providers, consulting firms, or even power utilities, because customers highly valued its ability to analyze data and provide new insights for better building management, which flowed from its previously installed base of electricity meters. Other authors, especially those belonging to the marketing literature, refer to such core capabilities as customer-centricity (Shah et al., 2006), customer intimacy (Treacy and Wiersema, 1993) and customer orientation (Olsen, Slater, and Hult, 2005). It seems quite obvious that the real challenge from the supplier's perspective is to determine how to use data in order to provide value to the customer's bottom line.

- *Execution risk assessment and mitigation capability.*

In this issue, and according to Ulaga and Reinartz (2011), risk refers to uncertainty about whether contractually agreed-on outcomes of hybrid offerings will be achieved and to design and implement safeguarding mechanisms to meet performance commitments, while still maintaining internal profit targets. Therefore, execution risk assessment and mitigation skills are critical to gain the proper degree of equilibrium between the design of competitive priced hybrid offerings and maintaining the internal profit targets. This means that manufacturers, typically, face the risk of getting committed to outcomes they cannot deliver or that can be achieved via unforeseen resources. However, manufacturers that participated to the research carried out by Ulaga and Reinartz (2011) suggested three different approaches to managing execution risks when designing and delivering hybrid offers. The first approach, and most likely to fail, involves manufacturers setting price buffers into their agreements to safeguard the contract's profitability. Typically, such approach translates into the instance where a manufacturing company, asked to undertake contractual performance commitments, raises the price for delivering such offer which, in turn, translates into that company to be priced out of the market. The second approach, entailing a higher degree of success, consists into sharing the risk among different accounts, thus redistributing the risk across a broader base. Lastly, several firms prefer to rely on their risk evaluation skills (in-depth analyses and understanding of archival contract performance data). Undoubtedly, companies able to develop such execution

and mitigation risk capabilities are able to gain differentiation advantages with respect to competitors.

- *Design-to-service capability.*

The authors define design-to-service capabilities as the manufacturer's capacity to develop a hybrid offering such that its tangible and intangible elements interact synergistically to tap its full differentiation and/or cost reduction potential. Indeed, another challenge to be addresses, on the pathway for developing hybrid offerings, is where such offerings embody products and services that synergistically interact for value creation. This means that, while companies carry out innovative activities that are product-related, they have also to think in service terms. The reason is that a company designing a new product, with the aim of unlocking a new service opportunity as well, can reach a competitive advantage: at first because, in this way, the company will go to the market with innovative and new hybrid offerings, thus gaining differentiation advantages; secondly, design-to-service capabilities would enable the manufacturing company to seek for opportunities in terms of cost reduction (for instance by retrofitting its products the manufacturer can enable its service technicians to perform first-level maintenance remotely, thus reducing the number of costly on-site interventions).

- *Hybrid offering sales capability.*

The authors Ulaga and Reinartz define hybrid offering sales capabilities as the manufacturer's capacity to reach key decision makers in the customer organization, coordinate key contacts in the customer and vendor firms, sell hybrid offering value through specific documentation and communication tools, and align the sales force with both the field organization and channel partners to increase hybrid offering revenues. Furthermore, as clearly pointed out by Dubinsky and Rudelius (1980), the selling techniques vary for goods and services, which is something over which Ulaga and Reinartz agree. Indeed, at the time of selling goods, manufacturers attempt to meet customer-defined specifications, while in presence of hybrid offerings the selling process is rarely well defined from the beginning, since these even require a strong customer involvement and co-creation. Such differences translate also over sales people involved in hybrid offerings, who must have proper skills to move beyond their usual comfort zone and engage with different actors both in the vendor and customer's firms. It is worth to summarize such issue arguing that hybrid offering sales require managers to switch from selling product to selling value. This last aspect highlights the difference between pure service providers and hybrid offering suppliers who, typically, face the challenge of infusing the hybrid offering sales into an already consolidated sales model. Moreover, hybrid

offering sellers, typically, engage with channel intermediaries to sell their offerings, thus it is important to ensure that sales initiatives are aligned with the goals of their distribution network.

- *Hybrid offering deployment capability.*

The authors define service deployment capability as a goods manufacturer's capacity to rely on flexible offering platforms that can standardize hybrid offering production and delivery processes, while also safeguarding its ability to adapt to individual customers' needs. At very last, it is important to strike a balance between ensuring efficiency and effectiveness in hybrid offering production and delivery processes. Ulaga and Reinartz (2011) found that several managers named a supplier's willingness to take a production-line approach to operations as a prerequisite for the efficient execution of hybrid offerings. According to their findings, this approach comprises three elements: repeatability and economies of scale of hybrid offerings, modularity of service elements within hybrid offerings, and proactive management of delivery costs. In terms of economies of scale, one respondent referred to a manufacturer's understanding of a hybrid offering's life-cycle as necessary for achieving economies of scale through standardization. However, recent research has suggested that an excessive focus on cost reduction actually reduces service revenue generation (Rust and Huang 2009), which implies that manufacturers must also seek effectiveness through flexibility in their customer interface. The concepts proposed in the previous paragraphs (unique resources and distinctive capabilities) are summarized in the following figure:

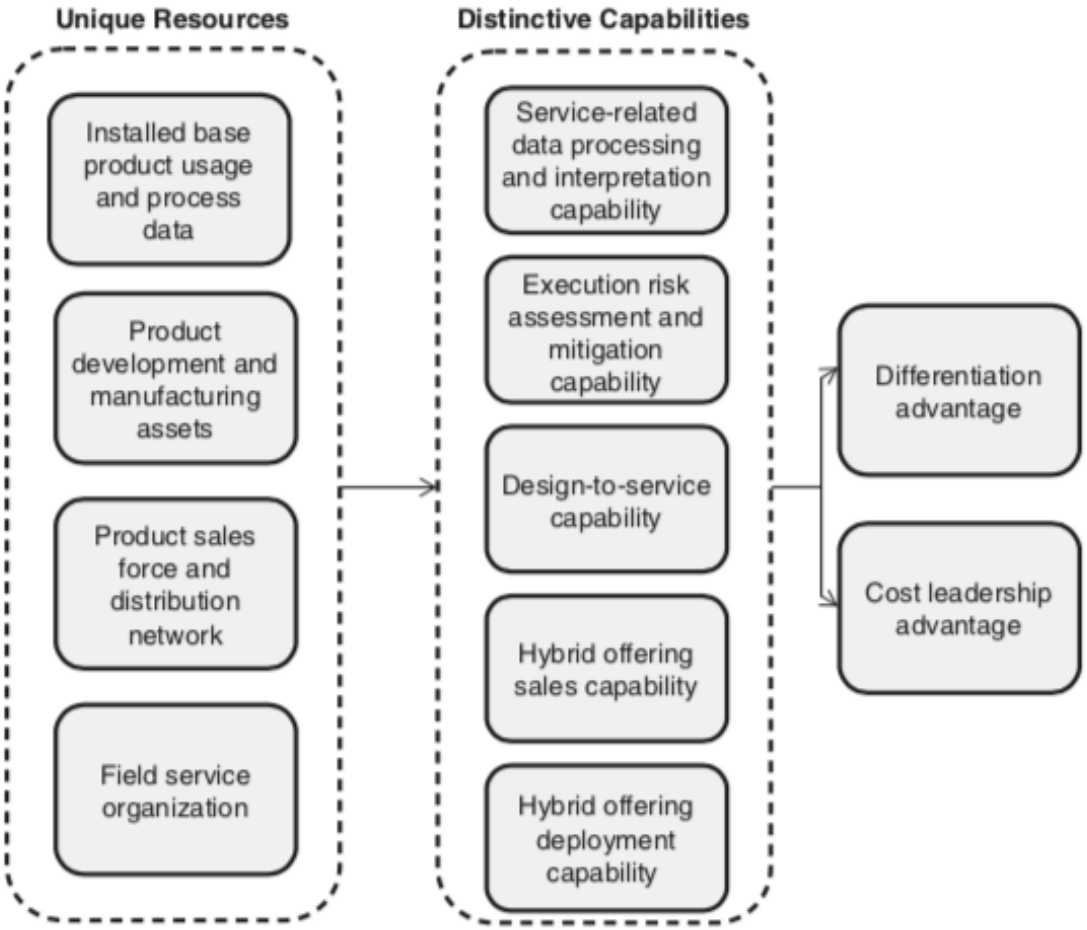

Figure 2 - *Manufacturer-Specific Resources and Capabilities for Successful Hybrid Offerings (Ulaga and Reinartz, 2011).*

1.2.3. Generate successful hybrid offerings

Before going into the main classes of industrial services for hybrid offerings, it is worth to precise that the capabilities described in the previous paragraph can be developed internally or externally, meaning that companies have to determine this aspect in order to be successful. According to Davies (2004), the decision regarding how to develop service-related capabilities is similar to the 'make or buy' question. Such issue has been addressed by Paiola et al. (2013), where we have that, when considering the move from products to solutions, companies favoring the internal development of capabilities have the advantage of being in control of all service and product components embraced by the solution. This is beneficial for the integration of all components, since it limits inter-organizational coordination efforts and, according to Nordin (2008), it contributes to create a competitive advantage to the firm. However, internal development tends to extend the number of capabilities, making it more difficult for the company to specialize in particular capabilities, and/or may be achieved at higher costs compared to that of sourcing from the market.

With respect to the external development of capabilities, Davies et al. (2007) and Neely (2008) suggests that it is advantageous, since it is time efficient and avoids excessively high fixed costs, which is very attractive, as companies are uncertain whether or not to apply the move towards solutions will be successful and the internal costs of developing services might simply outweigh the benefits. Furthermore, according to Paiola et al. (2013) relying on the external development of capabilities enables companies to specialize their existing set of capabilities (or core competence) further and can also take advantage of the superior resources offered by selected external specialists in developing service components. Finally, relying on external partners makes it easier to revert to previous products and service components if entering the solution business does not provide the expected results. The main disadvantages of external development, however, are the loss of control over the service components with the risk of opportunistic behavior by business partners, as well as the cost of co-ordination efforts. However, as pointed out by Kowalkowski et al. (2011b), firms may adopt a contingent approach, i.e. external or internal factors besides the ones pointed out above may affect the choice about capability development. Although, such factors may contrast each other, leading to the need to balance opposite influences (Nordin, 2005).

1.3. Industrial services for hybrid offerings: cost leadership and differentiation advantages

In the previous paragraphs we have seen that services greatly vary in terms of characteristics, resources and capabilities needed, as well as key success factors required. All of these aspects must be met before launching an offering into the market, otherwise it will not be successful and rather could generate losses. In this sense, according to Kowalkowski and Ulaga (2017) managers often mistakenly view business-to-business services as a homogeneous set of offerings and activities and thus may fail.

Therefore, in terms of service-led growth, it is important to determine which are the services a company can develop and how it should grow such services over the time. According to this topic, Kowalkowski and Ulaga (2017) proposed a classification of business-to-business services which is based on two different dimensions: at first, it is important to determine whether the service is oriented toward the supplier's product or it is directed at the customer's activities and processes. Secondly, it is important to determine the nature of the value proposition and, especially, if it is input-based (perform a deed) or output-bases (achieve specific performances).

The combination of these dimensions allowed the authors to come up with four categories of offerings that we will introduce in the next paragraphs. Furthermore, when developing a

service-growth strategy, companies shall decide both on the success factors needed in each of the following categories (see: Table 3) as well as in which service category they are willing to begin and grow.

Nature of the Value Proposition	Service Recipient: Service Oriented Toward the Supplier's Good	Service Recipient: Service Oriented Toward the Customer's Process
Supplier's promise to perform a deed (input-based)	**1. Product Life-Cycle Services (PLS)** *Definition* •Services to facilitate the customer's access to the supplier's good and ensure its proper functioning during all stages of the life cycle *Examples* •Delivery of industrial cables •Inspection of an ATM machine •Regrooving of an industrial tire •Recycling of a power transformer *Primary Distinctive Capabilities* •Hybrid offering deployment capability •Design-to-service capability *Main Underlying Resources* •Field service organization •Product development and manufacturing assets	**3. Process Support Services (PSS)** *Definition* •Services to assist customers in improving their own business processes *Examples* •Energy efficiency audit for a commercial building •Logistics consulting for material-handling processes in a warehouse *Primary Distinctive Capabilities* •Service-related data processing and interpretation capability •Hybrid offering deployment capability •Hybrid offering sales capability *Main Underlying Resources* •Installed base product usage and process data •Field service organization •Product sales force and distribution network
Supplier's promise to achieve performance (output-based)	**2. Asset Efficiency Services (AES)** *Definition* •Services to achieve productivity gains from assets invested by customers *Examples* •Remote monitoring of a jet engine •Welding robot software customization *Primary Distinctive Capabilities* •Service-related data processing and interpretation capability •Execution risk assessment and mitigation capabilities •Hybrid offering sales capabilities *Main Underlying Resources* •Installed base product usage and process data •Product development and manufacturing assets	**4. Process Delegation Services (PDS)** *Definition* •Services to perform processes on behalf of the customers *Examples* •Tire fleet management on behalf of a trucking company •Gas and chemicals supply management for a semi-conductor manufacturer *Primary Distinctive Capabilities* •Service-related data processing and interpretation capability •Execution risk assessment and mitigation capabilities •Design-to-service capability •Hybrid offering sales capabilities •Hybrid offering deployment capability *Main Underlying Resources* •Installed base product usage and process data •Product development and manufacturing assets •Product sales force and distribution network •Field service organization

Table 3 - Classification Scheme of Industrial Services for Hybrid Offerings (Ulaga and Reinartz, 2011)

1.3.1. Product life-cycle services

In the business-to-business field any manufacturer can, potentially, be considered to be in the service business. The reason is that, in order to sell products to other business customers, the firm may also have to offer a basic set of services.

Therefore, Ulaga and Reinartz (2011) defined the Product Lifecycle Services as the range of services that facilitate the customer's access to the manufacturer's good and ensure its proper functioning during all stages of its life cycle, whether before, during, or after its sale, such as the delivery of industrial cables to a customer's construction site, installation of a high-voltage

circuit breaker, inspection of an ATM, or recycling of a power transformer. PLS are directly attached to goods meaning also that customers typically perceive them as "must haves" (Kowalkwoski and Ulaga, 2017). This last characteristic is emblematic since it resembles that a customer may express a low willingness to pay for such services and this makes also difficult to differentiate them among different suppliers. Although, services falling into the product-lifecycle category are crucial for building the vendor's reputation as a competent service provider, meaning that an efficient supply of such offerings would generate trust over the provider's firm.

However, the above mentioned nature of PLS implies another important behavior undertaken by vendor's companies. Commonly, companies who engage with PLS are not able to price them and ask no price for such offerings. As a result, companies are tempted to make an "all-inclusive" offer thus hiding the service component. Such incorrect and unprofitable behavior can be adjusted in different ways, for instance through providing PLS at lower prices with respect to other competitors, where cost reduction could be achieved through standardizing such offerings effectively and efficiently, as well as reducing the delivery costs. Conclusively, a company able to provide PLS solutions into an efficient and profitable way can further grow through developing additional and more complex offerings, aimed at assisting the customer to improve his/her asset productivity.

1.3.2. Asset efficiency services

As just mentioned, a company willing to grow beyond product lifecycle services could engage with new service offerings like the asset efficiency services. These can be defined as the range of range of services suppliers provide to achieve productivity gains from assets invested by customers (Ulaga and Reinartz, 2011). In order to gain a comprehensive understanding regarding the differences between PLS and AES, it is worth noticing that even if these latter are tied and designed around a specific product sold, there is still a difference regarding the value proposition embodied by AES offerings. A company delivering them is committed and focused on achieving specific performances or outcomes which, instead, is not the case of PLS.

Such difference in the value proposition between PLS and AES typically translates into different resources and capabilities needed to successfully design, deploy and sell such services. Indeed, companies aiming to sell AES successfully are those able to collect customer usage and product data (see paragraph 1.2.1) and, mainly, have developed distinctive risk mitigation skills (see paragraph 1.2.2.). Due to the nature of AES offerings, they are not perceived as "must-haves" by customers – as PLS instead are – rather they represent a strong source of differentiation for the company providing them. Such second difference, further suggests that

customers are aware of the nature of AES offerings, as it is something that goes beyond the normal equipment functioning, which translates into a higher willingness to pay expressed by the customer.

Although the customer has a higher willingness to pay for such offerings, since the proposed value is higher with respect to PLS offerings, it is still important for the supplier to persuasively communicate the benefits of productivity gains in a proactive manner (Kowalkowski and Ulaga, 2017). The concept of proactivity exposed in this issue is particularly important since it enables us to draw up some commonalities between AES and post-sales services. Indeed, according to Challagalla, Venkatesh and Kohli (2009), there are two forms of proactive post sales service – proactive prevention and proactive education – which directly relate to the notion of AES. According to the authors, proactive prevention "refers to a supplier proactively initiating efforts to detect problems that may be imminent for a customer and taking action to avert them", whereas proactive education "refers to a supplier initiating effort to educate customers on how they can derive greater utility from its products". Conclusively, in order to successfully deliver asset efficiency services, manufacturers are asked to develop strong service-related data processing and interpretation capabilities together with a proper degree of risk assessment and mitigation skills.

1.3.3. Process support services

Another possible trajectory in terms of service-led growth is represented by the so-called process support services. Such offerings are no longer tied to the manufacturer's product, rather they are designed upon the customer's processes, indeed Ulaga and Reinartz (2011) define such offerings as the range of services a manufacturer provides to assist customers in improving their own business processes. In this sense, an example is provided by Kowalkowski and Ulaga (2017) where Schneider Electric of France, a global specialist in energy management, can provide expertise in the field of energy management in commercial buildings. By capturing and analyzing data from instruments installed in the customer's premises that measure energy consumption, the company has a distinct competitive advantage over third parties or power utilities when commercializing such consulting services. Such example is explicative regarding the nature of PSS, where manufacturers are often pushed to develop such offerings, regardless of the underlying equipment, indeed Ulaga and Reinartz (2011) referred to a forklift truck manufacturer able to offer warehouse optimization and logistic consulting to its customers without selling its own material-handling equipment to that client. Such examples underline that PSS offerings are able to address a different value proposition, where the supplier leverages

on its unique resources and distinctive competences to support customers in optimizing their processes or specific stages thereof.

Due to the nature of process support services, it is better to precise that the supplier delivering such offerings is not committed to reach any outcome or specific performance on behalf of its customers. Notwithstanding this latter aspect, suppliers that are able to provide PSS have typically the ambition of proceeding to a complete hybrid offering, which is something we will go through in the next paragraph.

As we have seen, PSS are offerings designed upon the customer's contexts and needs and thus embody a strong differentiation factor at the disposal of the supplier. In this sense, Ulaga and Reinartz (2011) make an explicative example of industrial gases that are typically standardized and commoditized. However, the gas manufacturer's unique knowledge about how to apply gases in the customer's processes can heavily differentiate the supplier in a competitive scenario. Combining the nature of PSS offerings with the skills, resources and capabilities required by a supplier to provide these solutions, is important also to reason in terms of the customer's willingness to pay. In presence of the above mentioned solutions, the customer has typically a higher willingness to pay with respect to both PSS and AES, and this is due to the value perceived and the nature of the offering which is highly customized. As consequence, in force of the factors analyzed so far, we can argue that manufacturers aiming at becoming successful in the development of process support services, heavily need to leverage their service-related data processing and interpretation capabilities. In this way, a supplier would be able to gain in-depth knowledge of the customer's processes which, overall, would translate into better analyses regarding complex processes and assist the customer's personnel in achieving prospective improvements. In addition, PSS solutions require further changes in the supplier's organization, that are basically tied to its selling approach and organization, since such solutions require the interaction of different people involved in the customer's firm and thus different sales argument may be needed. One solution to achieve this latter aspect could be a direct sales approach, whereby the service supplier no longer relies on channel intermediaries.

1.3.4. Process delegation services

Firms across markets are increasingly interested in venturing into the fourth category of solutions envisaged by Ulaga and Reinartz (2011): the process delegation services. These are defined by the authors as combinations of goods and activities that a supplier integrates in order to perform processes on behalf of customers, such as fly-by-the-hour agreements for commercial jet engines, and total gas supply management for a semi-conductor plant. Starting from their definition, PDS offerings share a common aspect with PSS solutions since both are

tied to the customer's processes. Although, in presence of process delegation services the supplier makes an additional step in the value proposition, since he/she is committed to achieve specific outcome or performances on behalf of the customer. We can sum up this issue arguing that, while process support services are designed over an input-based approach, process delegation services are, instead, designed over an output-based approach, where the supplier is directly responsible for achieving specific performance thresholds or outcomes.

If we take into account all of the factors envisaged so far, than we can clearly state that process delegation services are the most complex type of hybrid offerings to be delivered by a supplier. Such complexity mainly derives from the nature of these solutions, which require integration between goods and service elements into hybrid offerings. As consequence, the degree of customization embodied by such solutions is typically higher than the other categories envisaged so far, which require a higher degree of customer involvement.

The combination of a high complexity, customization and even the customer involvement, suggests that process delegations services are typically developed within a co-creation context between the supplier and customer, which requires frequent interaction, joint implementation and information flow among the parties involved; this latter aspect, in turn, resembles that the interests of the actors involved must be aligned. Furthermore, Ulaga and Reinartz (2011) found that in all the PDS agreements, customers required that the suppliers assume some level (or all) of the process outcome risk. Risk transfer represents one of the main motivations for customers to enter into such complex agreements. Finally, in line with the notion of risk transfer, the PDS involves complex gain-sharing agreements, which translates into the need for coming up with new key performance indicators in order to price such solutions.

The above mentioned factors suggest that few companies, typically leaders, have all the resources and capabilities needed to supply these kind of offerings. This latter aspect was also confirmed by Tuli, Kohli, and Bharadwaj (2007) who argued that suppliers need unique skills to define requirements; customize, integrate, and deploy offers; and provide post-deployment support in such complex arrangements.

1.3.5. Positional advantage

In this last paragraph we want to expose how a manufacturer's deployment of capabilities affects its positional advantage (see Table 4) since superior resources and capabilities enable a firm to execute activities along the value chain, either at a lower cost or in a way that leads to differentiation (Day and Wensley 1988).

Service Capability	PLS	AES	PSS	PDS
Service-related data processing and interpretation capability	Cost advantage	Differentiation advantage	Differentiation advantage	Differentiation advantage
Execution risk assessment and mitigation capability	—	Differentiation advantage	—	Differentiation advantage
Design-to-service capability	Cost advantage	Differentiation advantage	Differentiation advantage	Differentiation advantage
Hybrid offering sales capability	Differentiation advantage	Differentiation advantage	Differentiation advantage	Differentiation advantage
Hybrid offering deployment capability	Cost advantage	Cost advantage	Cost advantage	Cost advantage

Table 4 - *Summary of Proposed Effects of Service Capabilities on Positional Advantage (Ulaga and Reinartz, 2011)*

According to the classification we made in paragraph 1.2.2., we will start from the service-related data processing and interpretation capabilities. With respect to the product life-cycle services, such skills will enable the manufacturer to gain a cost advantage, since the service delivery costs will be lower. Indeed, having access to the customer's data will enable the supplier company to better analyze the variations in the consumption patterns of the customer. In terms of assets efficiency services, instead, a supplier able to better collect, analyze and interpret strategic product usage and process data can sell new value-added services able to improve the customer's assets productivity. In this context, a manufacturer of jet engines able to analyze and interpret data regarding its installed base through the remote condition monitoring can avoid the customer to face problems or unwanted risks which, in turn, would enable the manufacturer to reach a differentiation advantage.

As far as process support services are concerned, service-related data processing and interpretation capabilities would enable the supplier to develop and sell new value-added services that can better assist the customer in gaining productivity improvements and cost reduction. As consequence, the service provider would benefit from an important differentiation advantage with respect to other competitors or third parties. Conclusively, with respect to solutions such as process delegation services, service-related data processing and interpretation skills are mandatory for a supplier aiming to perform processes on behalf of its customers. Indeed, such skills are a fundamental prerequisite for companies falling into the PDS category. Also in this case, the supplier would be able to exploit a differentiation advantage with respect to its competitors, which arises mainly from both the nature of the solutions offered (PDS) and for the skills and capabilities developed over the time.

The reasoning in terms of execution risk assessment and mitigation capabilities creates room for evaluating their impact within an input-based (perform a deed) or output-based (achieve performance thresholds) value proposition. It is worth noticing that in cases where the supplier is committed to achieve specific performances, risk assessment and mitigation capabilities are quite mandatory to be developed. The reason is that customers would perceive

a higher value in presence of a supplier committed to reach a specific outcome, since they would be enabled to outsource activities that were previously performed internally. However, companies able to develop strong risk assessment and mitigation skills can achieve differentiation advantages both in terms of asset efficiency services as well as process delegation services.

Moving to the design-to-service capabilities, Ulaga and Reinartz (2011) believe that a supplier able to develop such skills distinctively can gain positional advantages. The nature of their thought is twofold: firstly, the manufacturer will bring new hybrid offerings to the market and thus will gain differentiation with respect to competitors and, secondly, it could re-design its offerings and achieve delivery cost reductions. Especially in the PLS category, the development of design-to-service capabilities would enable the manufacturer to deliver its offerings in a more cost-efficient way. With respect to solutions such as AES, PSS or PDS, manufacturers would leverage on design-to-service capabilities in order to differentiate their hybrid offerings that, under the customer's standpoint makes sense, since the vendor's legitimacy is more important for customer acceptance. In this sense, authors such as Rao, Chandy, and Prabhu (2008) find that innovations based on scientific legitimacy are more likely to succeed.

With respect to the hybrid offering sales capabilities we can argue that traditional product-centric companies tend to consider services a "necessary evil" (Reinartz and Ulaga 2008), and product salespeople often are tempted to give away services for free to secure a product sale. Such lack of skills to sell services translates into a missed opportunity to make further revenues. For this reason, and especially with respect to suppliers involved in AES, PSS and PDS solutions, it is crucial for the manufacturer to develop a sales force able to sell both products and services as well as align its sales efforts with those of channel intermediaries, and invest in service sales documentation and communication tools should contribute to a differentiation advantage (Ulaga and Reinartz, 2011). In terms of product lifecycle services, the hybrid offering sales capabilities shall be destined to invert the trend of services given away for free and rather move to a free-to-fee model.

Lastly, the hybrid offering deployment capabilities shall be developed to deliver the value proposition at a minimum cost. This is possible when the company achieves economies of scale and repeatability in their service offerings as well as a proactive service delivery cost management.

2. Digital servitization

Introduction

In this chapter we will start from looking at the digital transformation process within manufacturing industry. In doing so, firstly we will go through the concept of Industry 4.0, defining two different perspectives: macro and micro. Then, we will define how servitization is connected with the Industry 4.0 concept and which are the main innovative trajectories that manufacturing companies can undertake, thus transforming themselves in the way in which business activities are carried out. The role and types of digital technologies will be further analyzed, defining how these are shaping industries and how enable manufacturers to create value into a new way. In the final part of paragraph one, languages regarding the drivers pushing manufacturers to rely on digital transformation will be provided, concluding the first section with a discussion regarding which are the success factors able to make the digital transformation process successful within an industrial scenario.

The second paragraph, instead, aims at defining how digital technologies are changing the service business. In this sense, we will look at three main technologies (IoT, Cloud computing, Predictive analytics) that, according to the literature, have a major influence on manufacturers and on their likelihood to embrace service-led growth strategies. Further languages will be provided regarding how the abovementioned technologies are opening a world of opportunities to those industrial realities actually competing into fast-changing environments. However, the final part of paragraph two aims at underlying how such transition is not something to be applied "over the night", since a number of different capabilities have to be developed by manufacturers in order to effectively digitalize their business practices and propose new value to their customers.

In paragraph 2.3, we take all the consideration made in the previous sections to look at how enabling technologies have changed the service business, enabling manufacturers to come up with new and different business models. Such a discussion, will develop starting from how manufacturers shall organize themselves if aiming to move onto the digital servitization pathway. Once discussed, we will go through different services trajectories that manufacturers can walk, thus coming up with three main business models (availability provider, performance provider, equipment provider). However, in the conclusive sections we will also suggest that there are many pathways through which manufacturers can proceed, thus pursuing their service-led growth strategy. For this reason, the issue will be analyzed from an ecosystem perspective whereby manufacturers, engaging with the delivery of advanced services, have increasingly to collaborate and cooperate with both customers and partners in order to design better offerings and fulfil the customer's needs. The conclusive part of this chapter proposes two different

business models namely: pay-per-use contracts and outcome-based contracts. Languages will be spent in an attempt to define how these two configurations enable manufacturers to create value through solutions.

Conclusively, a discussion regarding the role of services and service-led growth strategies in turbulent times – defining why manufacturers rely on these offerings and implement more customer-oriented business models – is provided, starting from the role of services in comparison with the industry life-cycle. Here, we will go through three main phases, each with different characteristics and competitive implications. Accordingly, we will look at which services may occur during the ferment, transitional or mature stage of an industry, explaining also why some services may prevail on others. The languages provided in this section will constitute the basis for moving into more complex scenarios such as the financial crisis of 2008. Indeed, we will define how uncertainties and negative impacts brought by the financial collapse have dramatically hit a number of different sectors, thus opening the doors for a worldwide economic downturn. In the last two sections of this chapter, we will look at the role of services and the adoption of servitization logics within 2 different sectors. Initially, the discussion will involve the European automotive industry that, according to literature, was one of the sectors to be mostly and negatively hit after the financial crisis of 2008-2009. In the conclusive part of this chapter, languages will be provided regarding the evolutionary path made by the photocopier industry, where successful enterprises were even able to enter into more result-oriented and relationship-based offerings, thus redesigning their business models. The example of the photocopier industry is important in demonstrating how manufacturers facing uncertainties, increasing digitalization, commoditization and demand saturation, can rely on services not only to survive but also to differentiate themselves into fast-pace scenarios.

2.1. The digital transformation process in manufacturing companies

Digital transformation – the use of technology to radically improve performance or reach of enterprises (Westerman et al., 2011) – assumed a rising relevance for companies worldwide since, in all industries, business leaders are using digital technologies – such as social media, mobile, analytics or embedded devices – to enable major business improvements. According to Fritzgerald et al. (2014), the improvements brought by digital transformation translate into a different customer experience, which can lead to the creation of new business models. However, the digital transformation process is not only related to a new technological usage or implementation, rather it requires alignment to the organization and the environment (Matt et al., 2015). Thus, companies aiming at performing such cross-functional change are asked to

develop a digital transformation strategy, in order to meet the prospective goals. In line with this latter aspect, many authors in literature (Bharadwaj et al., 2013; Hess et al., 2016; Schwab, 2017) confirm the challenging nature of coming up with integration and alignment while developing a digital transformation strategy. Many companies, especially those from industrial branches, are still struggling with new technologies, meaning that to transform the business towards DT, it is necessary to understand the value of the technical impact on resources, courses of action and objectives, which form a strategy (Chandler, 1962). In order to have a comprehensive overview regarding the digital transformation phenomena and its relationship with servitization, it is worth starting from the Industry 4.0 concept analyzed in the following paragraph.

2.1.1. The Industry 4.0 paradigm: micro and macro perspectives

The industrial value creation, in the early industrialized countries, is currently shaped by the development towards the fourth stage of industrialization, the so-called Industry 4.0 (Stock and Seliger, 2016). Such a development, as suggested by Kagermann et al. (2013), follows the third industrial revolution which started in the early 1970s and was based on electronics and information technologies, for realizing a high level of automation in manufacturing. The development through Industry 4.0 has had significant impacts towards manufacturing companies, especially with respect to the establishment of smart products, smart services, smart factories as well as the implementation of technologies belonging to the Internet of Things (IoT) and Industrial Internet of Things (IIoT).

Regarding the paradigm of Industry 4.0, it is mainly composed by three different aspects. The first pertains the horizontal integration across the entire value creation network, which describes the cross-company and company-internal intelligent cross-linking and digitalization of value creation modules, throughout the value chain of a product life cycle and between value chains of adjoining product life cycles (Dorst, 2015). The second aspect refers to the end-to-end engineering across the entire product lifecycle that, in turn, describes the intelligent cross-linking and digitalization throughout all phases of the product lifecycle (from the raw material acquisition to manufacturing system, product use, and the product end of life). Finally, we have vertical integration and networked manufacturing systems that, according to Dorst (2015), describes the intelligent cross-linking and digitalization within the different aggregation and hierarchical levels of a value creation module, from manufacturing stations via manufacturing cells, lines and factories, also integrating the associated value chain activities such as marketing and sales or technology development.

The combination of the concepts expressed so far enables us to gain two different perspectives regarding the topic of Industry 4.0. Starting from the macro perspective (see Figure 3), it covers both the horizontal integration and the end-to-end dimensions previously discussed, with some differences. Indeed, the horizontal integration, according to a macro perspective, is characterized by different value-creation modules that, according to Seliger (2007), are defined as the interplay of different value creation factors i.e., equipment, human, organization, process and product. Furthermore, Stock and Seliger (2016) suggest that the value creation modules, represented in their highest level of aggregation by factories, are cross-linked throughout the complete value chain of a product life cycle as well as with value creation modules in value chains of adjoining product life cycles. This linkage, leads to an intelligent network of value creation modules covering the value chains of different product life cycles. This intelligent network provides an environment for new and innovative business models and thus it is currently leading to a change in business models. On the other hand, the end-to-end engineering, as represented in the macro perspective, consists into the cross-linking of stakeholders, products and equipment along the product life cycle, beginning with the raw material acquisition phase and ending with the end-of-life phase. Such lifecycle consists of the raw material acquisition phase, the manufacturing phase – containing the product development, the engineering of the related manufacturing system and the manufacturing of the product – the use and service phase, the end-of-life phase - containing reuse, remanufacturing, recycling, recovery and disposal - as well as the transport between all phases (Stock and Seliger, 2016). In such a context, companies that are engaging with smart data will evolve to the so-called smart factories and, according to the Smart Data Innovation Lab, smart data arises by expediently structuring information from big data, which then can be used for knowledge advances and decision making throughout the product life cycle. In addition, manufacturing companies, thanks to the Cyber-Physical System,s generate smart products able to self-organize the manufacturing processes and the flow throughout the factory in a decentralized manner by interchanging smart data with the CPS (Kletti, 2015).

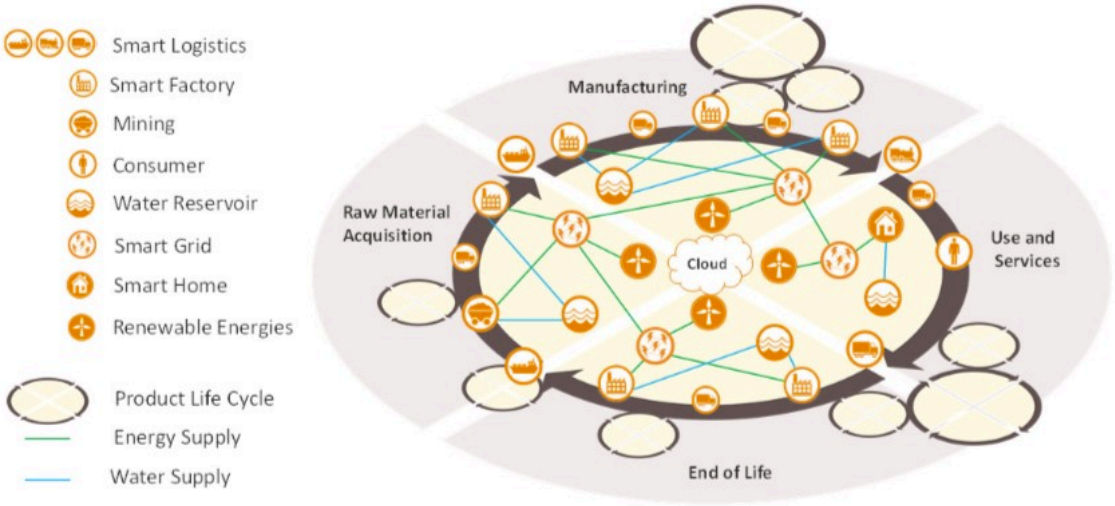

Figure 3 - Opportunities of Sustainable Manufacturing in Industry 4.0; macro perspective (Stock and Seliger, 2016)

It is also possible to look at the concept of Industry 4.0 from a micro perspective (see Figure 4). Under such a standpoint, the horizontal integration is characterized by the cross-linked value creation modules along the material flow of the smart factory, also integrating the smart logistic. In this context, both the inbound and outbound logistics will be characterized by agile transport equipment, able to react at the occurrence of unforeseen events. All transport equipment is interchanging smart data with the value creation modules in order to realize a decentralized coordination of supplies and products with the transport systems (Stock and Seliger, 2016), where identification systems (QR codes) enable a wireless identification of all the materials in the value chain. In terms of vertical integration, instead, the micro perspective highlights the intelligent cross-linking of the value creation factors (products, equipment and human). In this case, Porter (1985) also suggested that the networking, throughout the different aggregation levels, also includes the cross-linking of the value creation modules with the different value chain activities, like marketing and sales, service, procurement. Finally, the usage of smart data enables to quickly react to eventual changes tied to the product, humans or processes, thus bringing to a quick response in case of shocks.

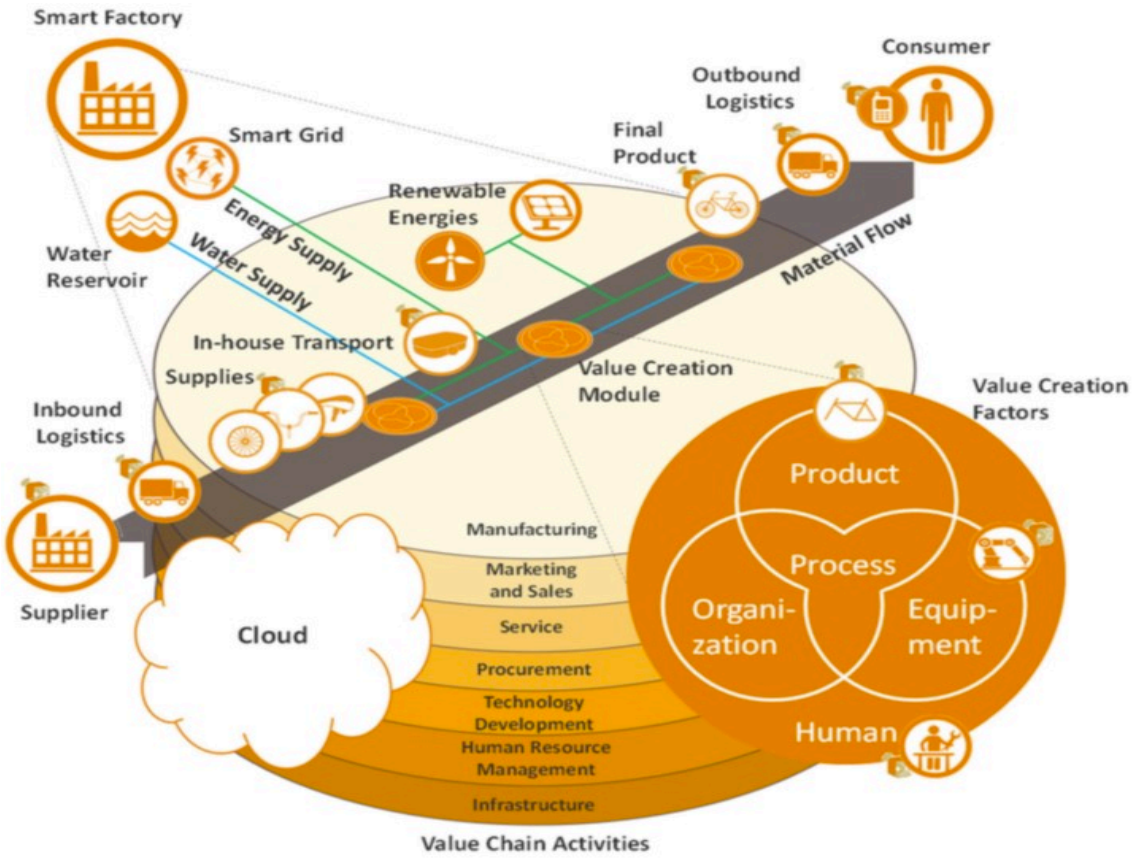

Figure 4 - Opportunities of Sustainable Manufacturing in Industry 4.0; micro perspective (Stock and Seliger, 2016)

2.1.2. The connection between servitization and Industry 4.0

The general overview regarding the Industry 4.0 made in the previous paragraph creates room for looking at its relationship with the servitization topic. As we have seen, industries have dramatically changed the way of carrying out their businesses activities, how they create value for customers and also the way in which products are developed, manufactured and delivered (Gersch and Goeke, 2007). Within such evolutionary stage, the servitization and Industry 4.0 phenomena have created attention both by the academic and entrepreneurial worlds, challenging the business models of product firms. However, it is worth noticing that such phenomena are quite different each other. Indeed, Dosi (1982), states that servitization is predominantly related to the demand-pull innovation trajectory, which resembles something that we already mentioned in chapter one. Due to an increasing competition, stagnation and commoditization industries have changed, thus moving from product consumption to a result-oriented demand and, as stated by Enkel and Gassmann (2010), the consequence is that customers are expecting to receive additional services to improve the experience they make when getting in touch with such products. Such change resulted in the servitization strategy of product firms.

A different matter is, instead, represented by Industry 4.0 where we can clearly refer to a technology-push innovation approach, since it comes from the direct competitors inside the product firms' own industry (Dosi, 1982). Here, thanks to the connectivity platforms offered by the Industrial internet, many industries are facing a transformation, where devices and products can be interconnected or networked in order to quickly meet the market changes (Wei et al., 2017). Further differences between servitization and Industry 4.0 can be envisaged since, as stated by Frank et al. (2019), these were born from different research fields – the first from management and the latter from engineering and computer science – and, therefore, for a long time the literature treated these issues as stand-alone areas, one focused on the customer value and the other focused on the manufacturing process value.

Apart from the differences just mentioned, both servitization and Industry 4.0 have implications in terms of competition, reason for which authors (Ardolino et al., 2017; Belvedere et al., 2013; Coreynen et al., 2017; Kamp et al., 2017; Vendrell-Herrero et al., 2017) started to be focalized on the connections between such topics trying to determine how demand-pull and technology-push factors are tied and correlated. According to Frank et al. (2019), servitization and Industry 4.0 can be correlated starting from the concept of business model innovation. On the one hand, several manufacturing companies are innovating their business models following a service-driven orientation (Martinez et al., 2017), therefore there is a common understanding that servitization brings strategic and competitive benefits for companies adopting this form of business model innovation (Ayala et al., 2018). On the other hand, the digitization of companies implies changes that exceed their own frontiers, requiring product firms to change the way they interact with external actors and customers (Porter and Heppelmann, 2014). Furthermore, the technologies tied to the concept of Industry 4.0 – IoT and big data analytics – not only enable companies to better understand what value means for customers, by obtaining a significant amount of data associated to their behavior and product usage (Porter and Heppelmann, 2014), but also allow firms to better deliver value to their customers, by rapidly integrating the external information of demand with their internal processes and new customers' needs, with more agile product and service development processes (Frank et al., 2019). This translates into the fact that Industry 4.0 reflects a new industrial scenario demanding transformation and innovation in the current industrial business model, as interoperability, virtualization, decentralization, real time capabilities, service orientation and modularity become imperative (Saldivar et al., 2015).

The abovementioned features about servitization and Industry 4.0, together with their relationship with the business model innovation perspective, are an important basis to evaluate how and when such fields converge. Therefore, in line with Frank et al. (2019), two different business model innovation can be envisaged (see Figure 5): (i) digitalization level, which

considers the levels of implementation of Industry 4.0-related technologies and, therefore, it follows a technology-push innovation trajectory, resulting in value added mainly for the company's internal processes (e.g. cost reduction, flexibility and productivity) and (ii) servitization level, which considers the relevance of servitization in the company, based on different types of service offerings and levels of service dominance in the product firm BMI, which follows a demand-pull innovation trajectory where the value proposition is focused on the customers (e.g. market expansion and customer loyalty). Such a distinction enabled the authors to come up with a specific framework, where three main categories of digitalization intensities are envisaged, based on their purpose for the service offering of product firms (see: Figure 6).

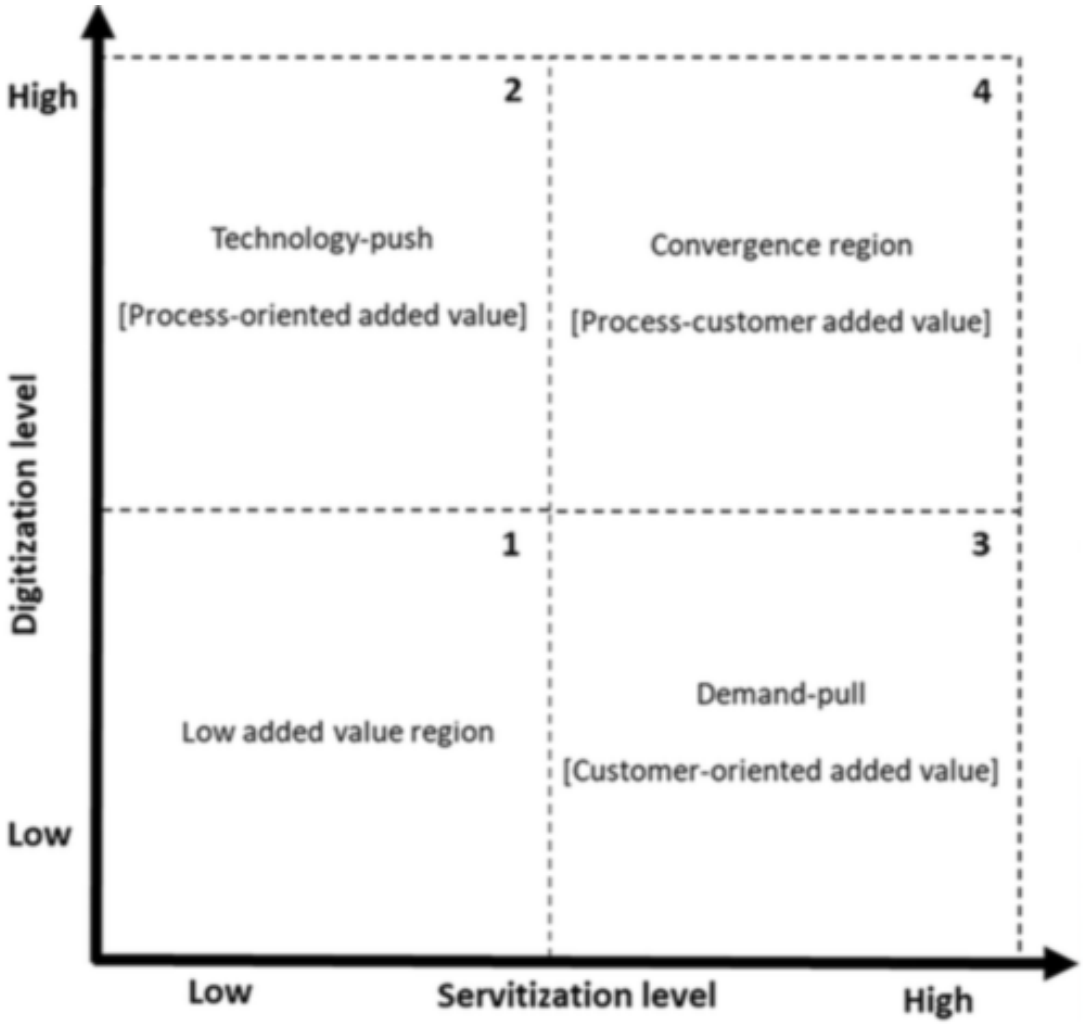

Figure 5 – *Innovation trajectories for Industry 4.0 and Servitization (Frank et al., 2019)*

The first level – manual services – considers low levels of digital technologies for service offering, therefore here digital technologies are used as support to create customers database or manage them with CRM only, meaning that services are manually delivered. The second level – digital services – comprises the use of digital tools to deliver different service offerings to the customer, meaning that technologies – apps, cloud computing and embedded

software – are used to provide the service itself, adding value to the service solution that customers are receiving (Frank et al., 2019). However, both in presence of manual and digital services the BMI falls under a customer-oriented added value type. Lastly, the highest level of digitalization envisaged by the authors – Industry 4.0 related services – considers high-tech services able to provide value for both customers and companies' internal processes, which translates into the fact that this is the only level of digitalization for servitization that compiles with the proposed concept of Industry 4.0: "new industrial maturity stage of product firms, based on the connectivity provided by the industrial Internet of things, where the companies' products and process are interconnected and integrated to achieve higher value for both customers and the companies' internal processes" (Frank et al., 2019). For the abovementioned reasons, such third innovation trajectory of the product firm falls in the fourth quadrant (see: Figure 5) where a convergence between process and customer added value is found.

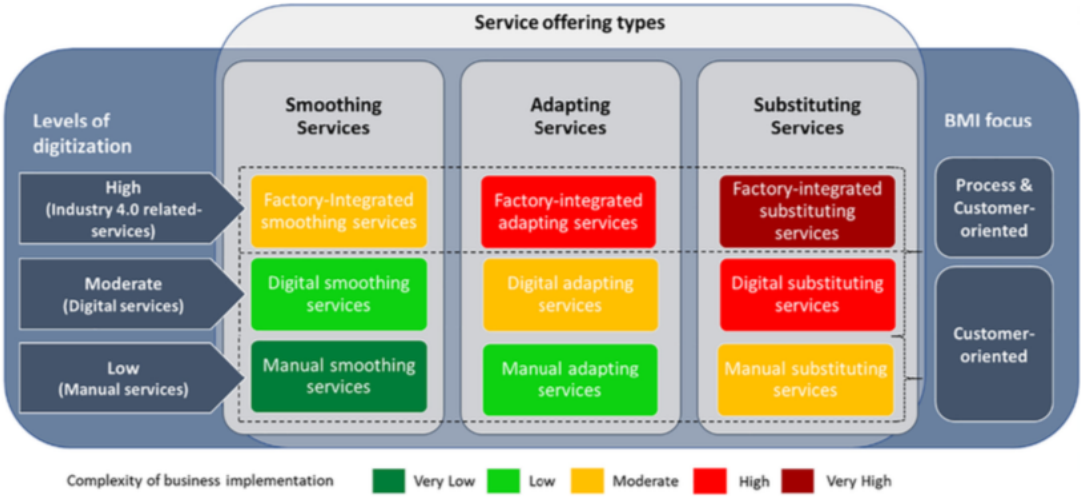

Figure 6 – Conceptual framework for Servitization and Industry 4.0 convergence (Frank et al., 2019)

2.1.3. Enabling technologies shaping the industrial scenario

After having defined the characteristics and correlations between servitization and Industry 4.0, it is now the time to engage with the main technologies that are transforming the industrial scenario, a matter that will be further analyzed in the paragraph 2.2. Different languages have been provided regarding this topic, though one of the most important contribution is given by Olivier Scalabre (Boston Consulting Group, 2016), whose classification consists of nine main technologies (see: Figure 7).

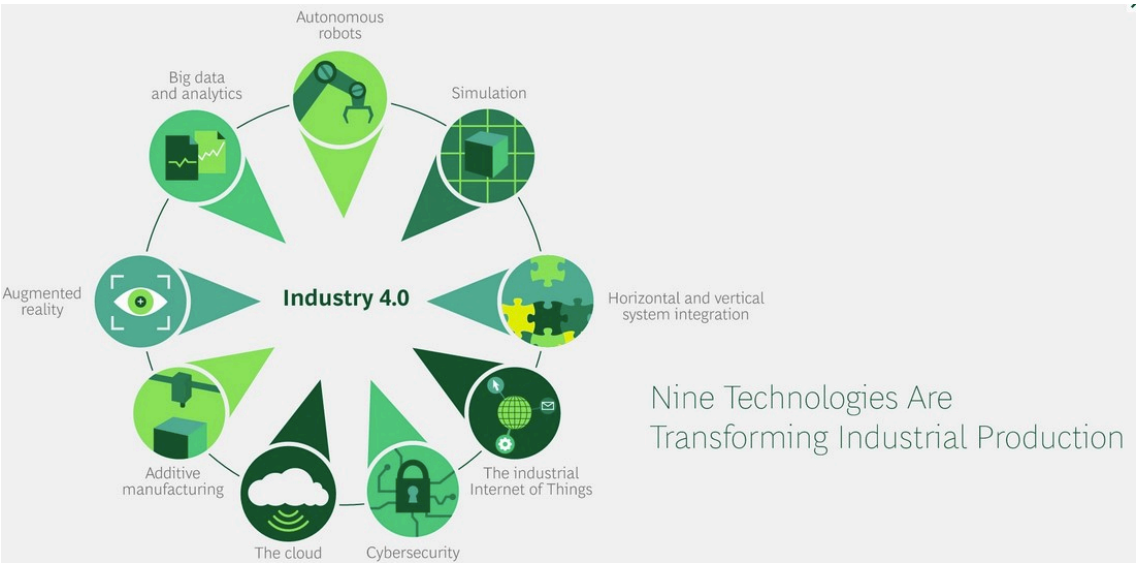

Figure 7 – *Enabling technologies of Industry 4.0 (Scalabre, 2016)*

1. *Big Data and Analytics*

Nowadays, a huge amount of data is produced from different sources, such as customers and industries (production equipment and systems as well as enterprise) and arise from many different sources. Within a competitive and industrialized scenario, the matter involving Big Data is one of the most important for executives and their decision-making choices. Not surprisingly, successful companies heavily rely on the collection and analysis of such flow of data, in order to make strategical decisions and properly address the customer's needs, becoming more precise in their value proposal. In 2006, Clive Robert Humby, mathematic and entrepreneur in the field of data science and customer-centric business strategies coined an emblematic expression asserting that "data is the new oil". Such a sentence resembles that, just as oil, also data is a source of value but, as its counterparty when changed into gas or plastics for instance, requires to be broken down and analyzed in order to gain a real value.

2. *Autonomous robots*

Also in this case, we are not referring to something new. Algorithms are making industrial machineries intelligent, enabling them not only to communicate each other through networks but also with humans which, in turn, translates into a future where robots will eventually interact and work safely, side by side, with humans and learn from them (Scalabre, 2016).

3. *Simulation*

The collection of real-time data arising from the machines, products and human activities allows industrial operators to apply simulations. These are important in order to test

and optimize specific stages in the product development phase for instance, where machineries will be able to build up specific product features in the virtual world and accurately test them in order to have a better and ready result in the real world.

4. *Horizontal and vertical system integration*

This is a concept we already went through in paragraph 2.2.1, where we have seen how much the fourth industrial revolution is oriented to the concept of value network, where firms, corporate bodies and capabilities are much more cohesive than they were in previous eras. This, in turn, translates into truly enabled value chains. In such a context, vertical integration is the internal integration between the different functions of the firm, in order to make more efficient the value chain of the firm (Stock & Seliger, 2016). Horizontal integration, deals with collaborations of partners along a supply chain (Stock & Seliger, 2016).

5. *Industrial Internet of Things (IIoT)*

Such technologies are an important body of those actually composing the Industry 4.0 scenario, whereby sensors, machines and even unfinished products are networked and utilize the embedded computing technology. However, IIoT solutions are not something new, which rather is the way in which those can be utilized and implemented, thus bringing to a fast-pace and decentralized decision-making.

6. *Cybersecurity*

One of the most hot topics is cybersecurity, since almost everything nowadays can be made digitally. In such a context, companies are already investing to secure the transmitted data and to protect their infrastructures from eventual threads. Especially during the lockdown established for limiting the spread of the Coronavirus pandemic, many activities were carried out through digital channels and in many different contexts. For instance, due to the limitations imposed in order to grant the so-called social distancing, companies had to carry out many activities virtually and such aspect has created room for revisiting the cybersecurity theme and how companies have to secure their process in order to avoid digital hacks for instance.

7. *Additive manufacturing*

Such technology basically involves concepts such as rapid prototyping, molten deposition modelling and, mainly, 3D printing. In this sense, such technologies are typically utilized for proceeding through rapid prototyping stages as well as testing activities. However, through 3D printing many product components can be realized which, indeed, is something

currently happening in different industries, enabling manufacturers to significantly reduce their production costs, complexity and lead time. It is easy to understand that technologies such as 3D printing or additive manufacturing aided by a large number of big data, will enable manufacturing companies to proceed over a highly customized value proposal at reasonable costs.

8. *Augmented reality*

Also with respect to augmented reality, the benefits that such technology can bring are tied to simulation activities mainly. Such a technology allows to completely combine virtual and real dimensions, displaying digital data and analytics information. As consequence, real-time data are available for decision-making purposes as well as carrying out training activities more efficiently.

9. *The Cloud*

The utilization of such technology has faced a dramatic increase in the last years and many multinational enterprises (Amazon, Oracle, Microsoft, Google) are actually offering cloud systems and solutions to other firms or end-customers. Such solutions can assume different forms and thus value propositions, namely: SaaS (software-as-service), DaaS (data as a service), HaaS (hardware as a service), PaaS (platform as a service) and IaaS (infrastructure as a service). As it easy to understand, this is one of the technologies that has faced a strong development, implementation and adoption by different actors over the past years. A considerable value has been created and offered via cloud solution systems and services. This, in turn, has created concern in terms of cybersecurity since enormous quantities of data are stored in those digital environments.

2.1.4. Main drivers of digital transformation in manufacturing

In the previous section we provided languages regarding the enabling technologies that are currently shaping the industrialized context. As we have already mentioned, digital transformation affects the value creation process, since it creates new ways for carrying out the business practices, although, it requires critical changes in the organizations. Indeed, many industrial realities face difficulties that go beyond the mere adoption of the technologies we mentioned and rather are related to organizational adoption processes. Indeed, Klötzer and Pflaum (2017) argued that: “the rather disruptive process concerning the transformation of companies into their digitalized counterparts constitutes an element of uncertainty and difficulty for many decision makers”. As consequence, it is useful to determine and examine the different

drivers able to push the adoption of digital technologies by manufacturing companies, since to make digital transformation a success, it is important to determine which needs and desires of individuals and organizations have to follow this revolution of production processes (Zhu et al., 2006).

An important contribution to the literature in terms of defining the drivers of digital transformation in manufacturing was given by Liere-Netheler et al., (2018) who conducted a research in order to determine the factors able to drive the transformation. In line with their findings, we can distinguish between three different sources: organizational, external and individual drivers. Starting from the organizational ones, six main drivers can be envisaged. At first we have process improvement, whereby self-adapting systems take over the planning, control and execution of production, thus bringing a higher efficiency and, respectively, a reduction of the error rates. In this case, a major role is played by innovations such as detective and predictive maintenance, process interlock and self-adjustment, all able to completely change the way in which a production process can be carried out. The second organizational driver is represented by a workforce improvement, where complex or dangerous activities can be performed by robots, as highlighted in the previous paragraphs, thus gaining benefits in terms of safety and usefulness. The third driver, instead, considers vertical integration issues, whereby the utilization of IIoT technologies, such as sensors, enable to collect data directly at an operational level. As consequence, the flow of information deriving therefrom is processed for integration on management level and, subsequently, it is sent back through hierarchy to the production systems.

The overall gathering of information, as described, enables a manufacturer to better plan the production level, for instance through gaining a higher product variation. The fourth organizational driver pertains management support especially in terms of vision and strategies to be developed. An aspect that typically includes the setting-up process of corporate structures and thus involves the assignment of responsibilities to different peers within the organization. Furthermore, such a driver is also tied to the previously mentioned workforce improvement. Indeed, companies aiming at digitalize their business, have typically to engage with a different workforce, thus hiring different and new profiles able to manage the transformational wave. The fifth driver relates to horizontal integration that, according to Kagermann et al. (2013), involves “the integration of the various IT systems used in the different stages of the manufacturing and business planning processes that involve an exchange of materials, energy and information both within a company (e.g. in- bound logistics, production, outbound logistics, marketing) and between several different companies (value networks)”, to highlight that digitalization is expected to bring the adoption of new business models. The last organizational

driver, pushing the adoption of digital transformation by manufacturing companies, is cost reduction. Not surprisingly, a digitalized organization faces shorter set-up times thus gaining improvements in its production process.

On the other hand, the authors envisaged external drivers able to facilitate the adoption of digital transformation logics for manufacturing companies. At first, due to the customer demand, which asks for a higher traceability of commodities and intermediate products over the entire production process. Secondly, the common planning and execution of different operations with other companies, customers and suppliers increases the need for digital technologies. In other words, a series of activities in the supply chain (e.g. R&D) can be mutually designed with other partners, in the value network thus bringing different value to customers and facilitating practices. The third factor is innovation-driven, since new innovation are a prerequisite for enabling a digitalization process. While coming up with innovative projects, manufacturers have to determine the value of such innovations which, in turn, forces entrepreneurial realities to act. Consequently, the degree of competition in the market would be higher and this translates into the fourth driver: market pressure. Especially in highly competitive industries, companies are pushed to digitalize themselves or embrace advanced technologies as a way of differentiation. As consequence, it is important to avoid to be cut-out from the market and fall behind the market technological standards, thus loosing competitive advantage with respect to other industry players. At last, governmental and legal frameworks drive the adoption of digital technologies, since these are able to apply changes over environmental standards. This latter aspect finds also confirms in what is currently happening in Italy, as a response to the Covid-19 outbreak, where the Government is collecting resources and giving incentives to make the country a step further in terms of digitalization. Finally, Liere-Netheler et al., (2018) came-up with a sole individual driver: employee support. The reason is that employees, through digital technologies, perceive work easier, more interesting and safer, to highlight that many times the digitalization's adoption is also a matter of the employee's willingness to engage with innovative systems.

2.1.5. The success factors of digital transformation

During the 21st century, the role of digital strategy shifted from a decentralized hierarchical functional structure to an IT-enabled global network structure, as suggested by authors like Bharadwaj et al., (2013) and Nolan (2012). Moreover, as highlighted in the previous paragraphs, an increasing competition together with the development of new technologies, such as big data, have changed the requirements for companies and, in turn, the way in which they develop their digital strategies. In addition, the new role of customers also influences the way

of developing a strategy and the strategy itself (Woodard et al., 2013). Due to the deep integration of DT into the value creation processes, the strategy is more in focus than the technology, as stated by Kane et al. (2015). To sum up, DT is "a disruptive or incremental change process. It starts with the adoption and use of digital technologies, then evolving into an implicit holistic transformation of an organization, or deliberate to pursue value creation" (Henriette et al., 2016).

In the previous section we have analyzed the drivers actually pushing manufacturing companies to engage with digital transformation. Here, instead, we want to determine how such entrepreneurial realities can concretely apply a digital transformation and come up with a strategical transformation as well. In this sense, according to Vogelsang et al. (2019), some success factors are needed in order to successfully implement the digital and strategical shift by manufacturing companies. The authors identified three different success factors able to drive the abovementioned implementation: organizational, environmental and technical. Starting from the organizational success factors, we can argue that, as already mentioned in the previous section, the major expected change produced by a digital transformation process is the shift from a centralized to a decentralized machine-controlled organization. Such a shift, requires a higher autonomy which can be achieved through utilizing connected machines e.g. autonomous robots. In such a context, a manufacturer able to collect and analyze data can gain a twofold benefit: on the one hand, the firm will be more precise in addressing the customer's needs and, on the other hand, it can offer better services and connected devices to its customers. In developing such new offerings, the firm shall rethink its culture, since working practices would be different with respect to a traditional way of carrying out business activities. This latter aspect is also related to the employees' qualifications, whereby the staff must be trained and supported by members belonging to the top-middle management.

To successfully apply a digital transformation process, there also some environmental factors to be taken into account. As previously highlighted, cooperation is an important asset when transitioning into a digitalized scenario, though it is not enough to be successful. Indeed, collaboration is needed since complex tasks require it, both internally and externally. Especially in this latter case, companies have to be ready and seek a higher connectivity with suppliers and customers, trying to keep the flow of data, arising from products, processes and integrated parties, as transparent as possible. The combination of these aspects, pushes the authors in suggesting that the role of the manufacturing enterprises is shifting to a more service-oriented configuration, where the customer has a completely different role. He/she not only receives products or services, but provides data which, in turn, translates into a different value creation. However, the connection between new products and services with big data collection creates

concerns, therefore companies have to create an empathy line with their customers, showing them which benefits can bring automated processes for instance.

The final category of success factors envisaged by Vogelsang et al. (2019) is about technical systems. The introduction of new technologies shall fit the companies' requisites and have to provide reliability, adaptability and availability in order to be effectively adopted and implemented.

The combination of organizational, environmental and technical factors highlights that dynamic and flexible organizations are more likely to be successful in implementing a digital transformation pathway, provided that the alignment towards such shift, where companies are also called to collaborate each other in order to come up with stronger value chains, is achieved. Once defined the main drivers pushing organizations to evolve through a digital transformation path, and having determined through which factors entrepreneurial realities can successfully translate such transformation under a strategical point of view, thus coming up with new business models, it is now the time to look at the role of digital technologies in the service business transformation.

2.2. The role of digital technologies in service business transformation

Many scholars in literature believe that digital technologies facilitate the service innovation of manufacturers (Neu and Brown, 2005; Kindström and Kowalkowski, 2009; Belvedere et al., 2013; Coreynen et al., 2017) by enabling novel product service offerings (Lerch and Gotsch 2015), transforming the structure of supply chains (Vendrell-Herrero et al. 2017) and reshaping industry competition (Porter and Heppelmann, 2014). Therefore, in this section we want to understand how three digital transformations, namely Internet of Things, Cloud computing and predictive analysis, support the service transformation of manufacturing companies. For this reason, we will at first start from defining the abovementioned DTs and then we will define different digital capabilities required for the service transformation.

2.2.1. Internet of Things

In recent years, the Internet of Things (IoT) has generated significant interest among researchers and companies' executives. For this reason, it is worth to start with looking at some definitions. Originally, such concept was defined by Kevin Ashton in 1999, who stated that IoT refers to uniquely identifiable interoperable connected objects with radio-frequency identification (RFID) technology. Pretz et al. (2013), indicated that the Internet of things (IoT) is a things-connected network, where things are wirelessly connected via smart sensors, thus suggesting that IoT is able to interact without human intervention. Other authors, instead, rely

on the following general definition of IoT: “dynamic global network infrastructure with self-configuring capabilities based on standards and interoperable communication protocols; physical and virtual ‘things’ in an IoT have identities and attributes and are capable of using intelligent interfaces and being integrated as an information network” (IERC, 2013; Kirtsis, 2011; Li et al., 2012 a,b). The words “Internet” and “Things” mean an inter-connected world-wide network based on sensory, communication, net-working, and information processing technologies (Li et al., 2014), which might be the new version of information and communications technology (ICT) (Kranenburg, 2013). Furthermore, while referring to IoT-based technologies, according to Hunter et al. (2012), intelligent sensing and wireless communication techniques have become part of the IoT and new challenges and research horizons have emerged. For such reason, it is also interesting to look at the evolution path made by the IoT over the time (see figure 8).

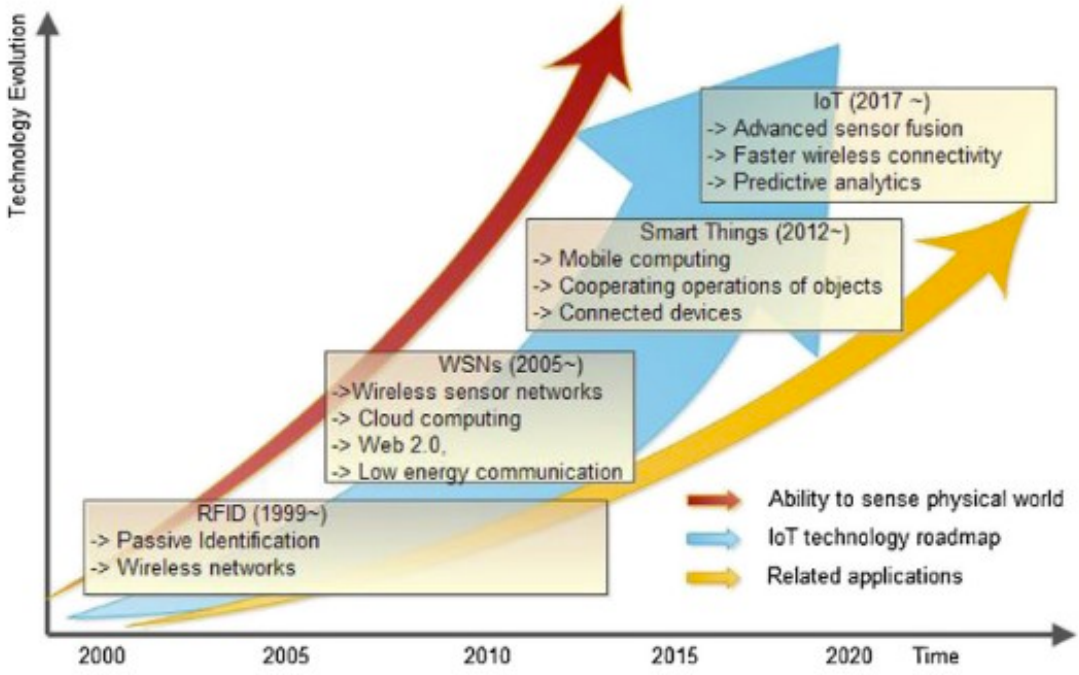

Figure 8 – *Evolution of IoT (Li et al., 2014)*

Initially, as shown in the above figure, IoT started through the so-called radio frequency identification technologies, that have faced an increased implementation in many different industries such as logistics, pharmaceutical and retail (Fielding and Taylor, 2002; Guinard et al., 2010; Guinard et al., 2009; Xu, 2011b). However, many steps have been made in developing wireless sensory technologies, able to collect data from the environment and communicate each other. As consequence, devices started to be developed including a higher degree of sensory capabilities which, in terms of IoT, has brought to the introduction of many different technologies, namely: wireless sensor networks, barcodes, intelligent sensing, low energy

wireless communication and more. Around the 2012, the evolution of the abovementioned technologies has led to the smart things era, where physical things could be accessed and identified through the Net. Nowadays, the emerging technologies (cloud computing, sensing, ubiquitous computing) are able to increase the potential of IoT, enabling to come up with solutions such as the machine-to-machine networks for instance and, as suggested by Li et al. (2014), the future trend of IoT will be a fusion between sensing and Internet, provided that all of the networked things should be flexible, smart, and autonomous enough to provide required services.

Another important matter to be taken in consideration is the IoT architecture, since the 'things' must be inter-connected. Authors, such as van Looy et al. (2014) and Ulmer et al. (2014), suggested that the designing activity involving an IoT architecture is a complex matter, involving different aspects such as networking, communication, business models and processes. That is why, in developing and designing an IoT architecture the extensibility, scalability, and interoperability among heterogeneous devices and their business models should be taken into consideration. In this sense, it is worth noticing the role of a service-oriented architecture (SoA) within an IoT context. Ciganek et al. (2014) and Hachani et al. (2013) believe that SoA might be an imperative for service providers and users, since it ensures the interoperability among the heterogeneous devices in multiple ways (Panetto and Cecil 2013; Jardim-Goncalves et al. 2013; Wang and Xu, 2012). In this sense, Li et al. (2014) argued that when SoA is applied in IoT, it is designed to provide the extensibility, scalability, modularity, and interoperability among heterogeneous things. The authors provide an example of SoA for IoT represented below (see Figure 9), where the role of four main layers shall be exposed.

Referring to the sensing layer, we have to say that the idea behind IoT is the one of a world-wide inter-connected network, where things are connected and can be monitored remotely. Therefore, in such a layer the smart systems on layers are able to capture data from the surrounding environment and exchange information with various devices. As previously mentioned, technologies, such as the RFID, have experienced significant improvements in the past years, which resulted into the development of a new technology known as universal unique identifier (UUID), thanks to which each object owns a digital identity. However, to successfully provide services, sensors shall be active 24/7 in order to acquire real-time data, thus allowing the service provider to act instantly.

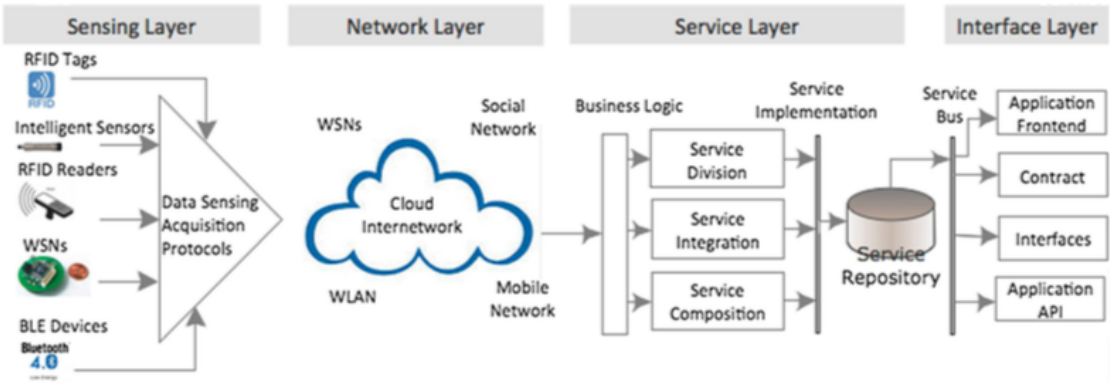

Figure 9 - Service-oriented architecture for IoT (Li et al., 2014)

The network layer plays another fundamental role within a service-oriented architecture, since it connects all the things and enable them to recognize the environment. Such recognition activity typically translates into the capability of such devices to share real-time data regarding the surrounding environment, thus enabling the service provider to come up with strategical management and processing decisions, which is something particularly useful in presence of high-level complex services, where decision-making units require a large amount of data to strategically act.

The service layer, instead, is based on the so-called middleware technology, where hardware and software platforms can be reused. This is probably the most important layer since all of the service-oriented activities – information exchange and storage, communication and data management – are performed in the service layer.

At last, we have the interface layer, where the authors wanted to highlight that, in IoT, a number of different devices are in place. This means that a company, aiming to build up a SoA, heavily needs to estimate the compatibility among the different devices, since these can be produced by different vendors and thus may not communicate together. Companies tend to solve this compatibility issue relying on Universal Plug and Play systems, technologies able to set protocols thus granting a minimum degree of interaction among devices.

The potential of such digital transformation technology lies in the relationship between IoT systems and services, which is seen as an opportunity for manufacturing companies having a direct contact with end-customers (original equipment manufacturers - OEM). Such realities, according to Paiola and Gebauer (2020), are in a privileged position for leveraging on their installed base and unleash the power of digital servitization. Indeed, having a direct relationship with customers allows OEMs to be away from distribution channel conflicts and, at the same time, there would be no need to position themselves differently in their value system. As consequence, manufacturing companies would reach the chance of implementing complex service-based BMI and come up with advanced services tied to the customers' needs.

2.2.2. Cloud Computing

The manufacturing industry is undergoing a major transformation enabled by IT and related smart technologies, where collaboration, Internet of things and cloud have been identified as key business technology trends that will reshape enterprises worldwide (Bughin et al., 2010). We have already provided languages regarding IoT, thus now we want to define what cloud computing is and how such technology can be utilized by manufacturing companies in delivering services.

The National Institute of Standards and Technology (NIST) defined cloud computing as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction". According to Xu (2012), everything in Cloud computing appears as a service, where different infrastructures are involved (see Figure 10). Starting from the lowest level, we have an architecture known as Infrastructure as a service (IaaS) where fundamental computing resources – processing, storage and networks – are defined as standardizes services over the network. In the middle, instead, we have another architecture known as platform as a service (PaaS), whereby different services are provided in order to develop, test, deploy, host, and maintain applications in the integrated development environment. The application layer favors a full application set for another architecture, namely software as a service (SaaS). Cloud computing is considered as a multidisciplinary research field, as a result of evolution and convergence of several computing trends such as Internet delivery, "pay-as-you-go/use" utility computing, elasticity, virtualization, distributed computing, storage, content outsourcing, Web 2.0 and grid computing (Xu, 2012). Indeed, cloud computing can be considered the business-oriented evolution of grid computing (Foster et al., 2008).

Thus, the cloud computing implementation made by a firm, would translate into a shift from an organizational standpoint, especially in terms of the business and IT infrastructures. In such a scenario, services and data storage are outsourced to third parties and made available to enterprises and customers.

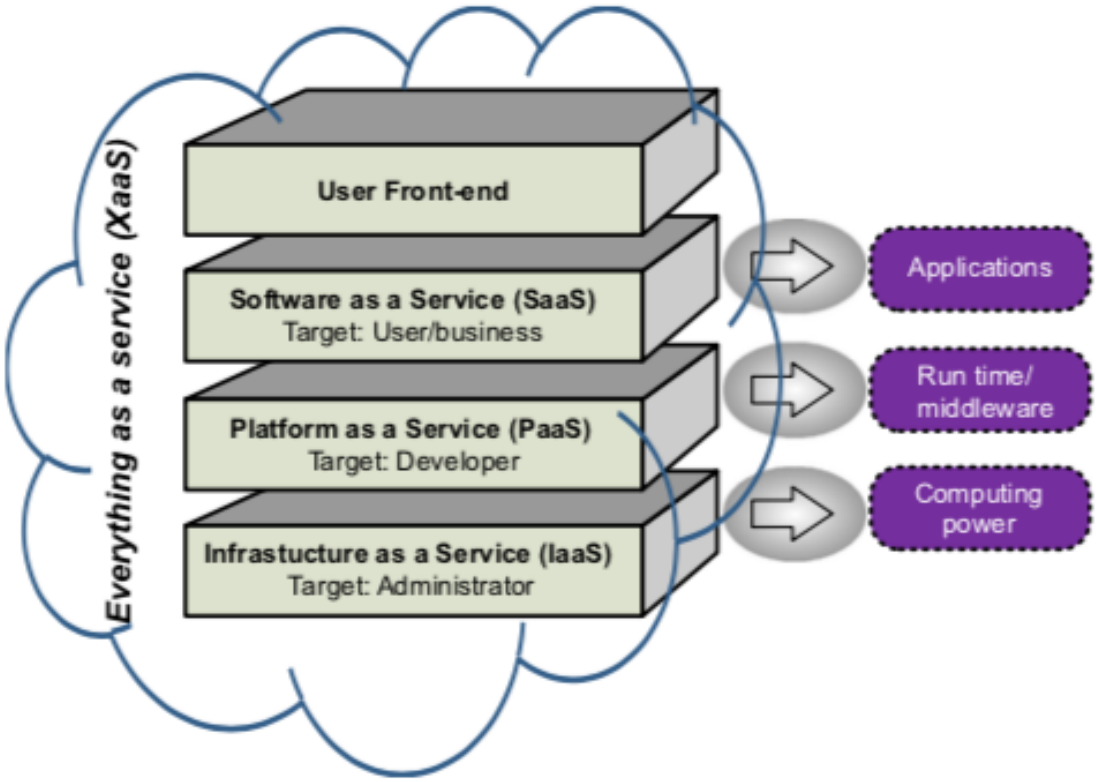

Figure 10 – *Cloud computing - everything is a service (Xu, 2012)*

An increasing number of businesses and organizations are taking advantages from, as well as implementing, cloud computing solutions. Moreover, according to Kunio (2010), Cloud-oriented Service Platform Solutions play an important role in transforming enterprise systems, contributing to cost reduction, agile deployment of services, expanded flexibility and improved productivity.

Once analyzed the main features of cloud computing, it is now time to explore how manufacturing companies are utilizing the said technology, since it rapidly moved from early adopters to mainstream organizations. In terms of cloud computing adoption in manufacturing, the key areas are around IT and new business models that the cloud computing can readily support, such as pay-as-you-go, the convenience of scaling up and down per demand, and flexibility in deploying and customizing solutions. The adoption is typically centred on the business process management (BPM) applications such as human resources, customer relationship management, and ERP functions with Salesforce and Model Metrics being two of the popular PaaS providers (Xu, 2012). The functionalities brought by cloud computing translate into cost benefits, as well as enabling the manufacturer to carry out processes differently, allowing the IT to apply changes faster. Such benefits apply also into a business-to-business context where cloud-based solutions enable better integrated and more efficient processes, indeed Xu (2012) provides an explicative example where, cloud computing can assist the development of an application for customer on-boarding process, that is more efficient than

the traditional process of company on-boarding customers. The procedure for a company to on-board customers may involve a salesperson visiting a prospective customer, the customer filling in a form, company credit checking etc. A Cloud-based customer on-boarding process may do all of these automatically via cloud resources on the Internet.

As we have seen in the previous sections, there is a trend faced by product-centric manufacturers of moving towards a service-oriented manufacturing where cloud computing is seen as the evolution and convergence of several independent computing trends, such as Internet delivery, ‘‘pay-as-you-go’’ utility computing, elasticity, virtualization, grid computing, distributed computing, content outsourcing and Web 2.0 (Pallis, 2010). Likewise, Xu (2012) highlighted that cloud manufacturing is also considered as a new multidisciplinary domain that encompasses technologies such as networked manufacturing, manufacturing grid (MGrid), virtual manufacturing, agile manufacturing, Internet of things, and of course cloud computing. In cloud manufacturing resources are managed into a centralized manner, allowing users to request different services from all the stages over a product lifecycle.

Typically, a cloud manufacturing system is made up by four different layers (see Figure 11) namely: manufacturing resource layer, manufacturing virtual service layer, global service layer and application layer. In the manufacturing resource layer we refer to all the resources required during the product development lifecycle. Such manufacturing resources are typically referred to the resources, as raw materials or servers and capabilities such as the know-how degree or analysis tools. Into a subsequent stage, that is the virtual service layer, the manufacturer’s resources are identified, virtualized and packaged as cloud manufacturing services. In this case, a number of technologies belonging to the IoT field, can be applied for satisfying the abovementioned tasks, such as radio-frequency identification or wireless sensory technologies.

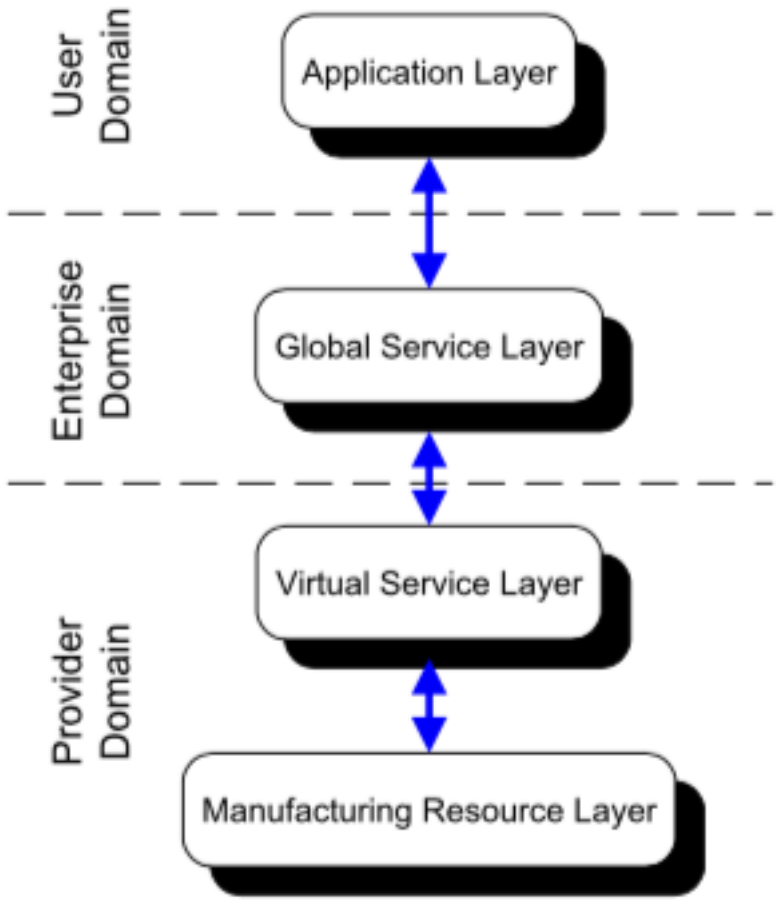

Figure 11- Layered architecture of a cloud manufacturing system (Xu, 2012)

However, in performing such tasks the manufacturer shall have developed consolidated capabilities, that Zhang et al. (2010) reassumed into a four-dimension array: Task, denotes a manufacturing job; Resource, denotes the manufacturing resources that are needed to do the task; Participator, represents human resources needed for the job; and Knowledge represents all the knowledge required to do the job.

At an enterprise domain, the manufacturer can benefit from three different mapping methods for virtualizing its resources. The easiest mapping method is the one-to-one, since it applies to manufacturing resources offering a single function and therefore can be encapsulated into one service only. A different matter is the many-to-one mapping, since here many resources – each serving a specific function – are combined to come up with a service. This implies that the end-user of that specific service will be unable to define which resources have been implied. Finally, the one-to-many mapping involves a sole resource which, however, appears to the customer as multiple resources.

The global service layer is basically the most complex degree of cloud manufacturing technologies, since it refers to the so-called platform-as-a-service (PaaS) solutions. Said complexity arises from the fact that a manufacturer, able to provide such solution to its

customers, takes full responsibility of the entire cloud operational activities. As consequence, a global service layer would be responsible for locating allocating, fee-calculating and remote monitoring the manufacturing resources (Xu, 2012).

Finally, we have the application layer serving as an interface between the user and manufacturing cloud resources. Through such layer, the user is potentially allowed to define and construct a manufacturing application through the virtualized resources. Such a manufacturing application often involves more comprehensive manufacturing resource services that provide users with a value-added service (Guo et al., 2010; Zhang et al., 2010).

2.2.3. Predictive Analytics

Another technology able to move the decision-making process and strategical business decisions, to facts and evidence-based as well as enabling organizations to predict future outcomes with high levels of certainty, is the predictive analytics. Though such topic was well known also in the past, the benefits and potential have only recently been appreciated due largely to the phenomenon of big data (Ogunleye, 2013b). The reason is that many organizations have the desire of utilizing the said technology, not only for informing strategical business decisions with concrete facts and evidences, but also to be able to predict future outcomes with a reasonable confidence.

According to Ogunleye (2014), predictive analytics is "the application of skills, expertise and software capabilities to extract, interrogate, analyze and transform data into clear, digestible form feed-able into organization planning or decision making process…predictive analytics combines human skills and expertise with technology such as machine learning of patterns in current and historical data and the application of algorithms not only to identify patterns in the data but also to forecast future probabilities of the outcome of those patterns". From such definitions, it comes easy to understand that people, tools and algorithms are crucial and that said technology is forward looking oriented, therefore the predictions arising thereof are only based on data.

As previously mentioned, the world is facing an exponential growth in digital, physical, enterprise, public, sensor, transactions and social media data. According to the SAS Institute (2012) the 85% of these datasets are unstructured and not metric data, meaning that are huge, quite complex and embody variety, velocity and variability. For such reasons, predictive analytics is very important to sense-and-meaning-making of Big Data, as such technology not only makes it possible to harness the power of big data (Heitmueller et al., 2014) thereby leveraging on organizations data assets (Ogunleye, 2014), but also critical to transform Big Data into meaningful, usable business information (Abbott, 2014).

Predictive analytics brings together management, information technology and modelling (Miller, 2014), and three elements – environment, models and architecture – are crucial in operationalizing it (Taylor, 2012). Environment is especially important, since, in solving complicated managerial issues, there is the necessity to have a place where people are encouraged to work in team and collaborate effectively. The second process, modelling, is at the heart of predictive analytics and according to Taylor (2012), the modelling process has to be 'repeatable, industrial-scale' to ensure effective development of 'dozens or even thousands' of required predictive analytic models. At last, a robust architecture for predictive analytics is needed to deploy and manage analytics models in production systems and come up with strategical insights.

2.2.4. Digital capabilities for service transformation

In the previous section we have defined three main technologies actually shaping the manufacturing scenario and changing the pathway through which executives undertake business decisions. In this paragraph instead, we want, at first, to understand which are the digital capabilities provided by Internet of Things, Cloud computing and predictive analytics and how those are tied with the concept of service transformation in manufacturing. In doing so, it is better to precise which form, the term capability will assume hereafter, indeed it refers to the "firm's capacity to deploy resources for a desired end result"(Helfat and Lieberman, 2002), whereas a digital capability identifies those capabilities deployed thanks to the DTs analysed so far (IoT, CC, PA). In this sense, Ardolino et al. (2017) identified eleven digital capabilities introduced by the technologies mentioned in the previous sections. In line we the authors and for each of the following capabilities, we will look at their relationship to the product-service development as well as their connection to IoT, Cloud computing and predictive analytics.

The first important capability pertains the identification of users and products since, on the one hand (user), it enables to determine who is using a product at a specific time instance and, on the other hand (product), enables to determine which product configuration is under consideration. The identification of an user can be the example of a car sharing service, whereby an user needs to log him/herself into the product before they can use it. Regarding the relationship with the DTs previously mentioned, we have to say that the identification of an user is typically an IoT application, since we are clearly referring to tracing technologies able to link an user to his/her master data. The data involved, regarding the name, address, credit card number and more, are then stored thanks to cloud computing thus enabling for secure connections with field devices. As far as the identification of an user or multiple users is

concerned, such capability is important for developing pay-per-use services and individual billing, that is the case of car sharing where a customer pays for the time spent driving. Regarding, instead, the identification of a product, it enables to precisely define its architecture and functional configuration.

There are many IoT-related technologies that can fulfil this purpose, for instance the abovementioned RFID (see paragraph 2.2.1.), capable of reaching data from the surrounding environment. In a second stage, such data are stored into a Cloud without any kind of storage limit and, in this way, products can be accurately built and maintained (Wuest, 2013). As above, such capability is relevant for coming up with pay-per-use services as well as in traditional product support services (PSS).

The third digital capability refers to the geo-localization of the product, which enables a manufacturer to support fleet management activities. Also in this case, IoT technologies (RFID, Wi-Fi) make possible to gain a more effective indoor positioning and, once such flow of information is stored into the Cloud, they typically are matched with both the product and customer data. This latter aspect enables to exploit existing application programme interfaces (API) for the most common maps platforms and services (Ardolino et al., 2017). As previously highlighted, such capability enables effective fleet management and, especially, location-based services that, thanks to the technology, are better delivered and performed.

Time-stamping is the fourth digital capability envisaged and enables to precisely detect in which time frame a specific event happened. This is possible since IoT technologies enable to collect and transmit real-time data about product access, activation and/or stop. Said capability enables to effectively perform availability-based services, especially when those are designed upon time-based pricing and pay-per-use logics. Moreover, in presence of time-stamping, the role of cloud computing assumes the nature of push notifications, since the triggered event is signaled directly by the cloud.

The fifth digital capability is intensity assessment, that is particularly useful in determining how much a specific product or part has been utilized. Here, IoT technologies enable to collect data, whereas the cloud aims at storing those data in order to enable a manufacturer to apply analysis and come up with useful managerial insights. As it is easy to understand, the intensity assessment is particularly important where availability-based services are delivered, especially when those are designed upon a pay-per-use or consumption-based pricing logics.

Condition monitoring, instead, is maybe one of the most known digital capabilities, since it enables the manufacturer to estimate how the product is actually working and behaving. Indeed, a number of different parameters can be determined such as temperature and even vibrations. Furthermore, if an unwanted event verifies, such digital capability enables a manufacturer to

rapidly detect and thus solve the arisen problem. This is typically realized through installing sensors, able to collect and communicate analogic and digital data and transmit them to remote applications. Also in this case and due to the nature of such data, these are stored in clouds in order to perform further analyses. Supplier able to develop condition monitoring capabilities can exploit large opportunities in the field of performance-based services, since they eventually have a complete overview regarding the product and thus are more likely to meet the desired performance on behave of their customers.

The seventh digital capability relates to the so-called usage monitoring, which enables to determine why a specific product is used. In this case, the IoT technologies have a marginal role, since they only aim at collecting the data, while the cloud computing facilitates the development of applications whose aim is to match the collected data in order to address a usage mission. Not surprisingly, such digital capability comes in handy where a performance-based contract is in place, since it facilitates to reach higher quality thresholds and mission achievements.

Prediction is another major digital capability able to provide insights regarding where a specific event will bring to. As it is easy to imagine, the role of predictive analytics is crucial, since the analysis and interpretation of data, collected via IoT and stored through a cloud, makes possible to be faster in case of issues and proactively apply the interventions needed; something crucial for companies providing performance-based services.

Adaptive control, instead, allows to determine how a specific issue can solved and/or a customer experience can be improved. It usually translates into remote actions, where predictive analytics models can serve different purposes, like reconfigure the machine settings and make diagnostic checks. In this sense, the presence of a platform-as-a-services further increases the potential of IoT, enabling a bidirectional communication through user-friendly interfaces thus, for instance, reducing the likelihood of failures during the performance of some processes. As consequence, adaptive control gains an increasing importance where specific efficiency threshold have to be met.

The tenth digital capability relates to optimization and prescription, both aimed at determining how to improve efficiency and effectiveness. Real time analyses, predictive models and decision support systems act as a sole main body, in order to improve product and process performances. Still, a major role is played by predictive analytics, implied for reconfiguring or restoring the product settings. In performance-based services, companies are always asked to perform at a higher efficiency and thus need to their internal supervisory control through heavily leveraging on their predictive analytics skills.

The journey concludes with a last digital capability envisaged by the authors, autonomy. Especially to improve the degree of performances within an automated context, a manufacturer shall determine how a product can be connected with other products and systems performed by the product itself. A proper combination of all the DTs introduced (IoT, CC, PA) is highly needed in order to develop cyber-physical systems able to communicate and reach a common sense.

We can conclude such section making some considerations starting from the IoT, which can be clearly considered as a starting point for developing the abovementioned capabilities as well as for enabling manufacturers to move to high-complex services. In this sense, a successful implementation of the IoT-related technologies and logics enables a company to adopt or adapt pay-per-use revenue models. On the other hand, the full exploitation of cloud computing is a longer process, since different capabilities are required to fully implement its potential. The easiest aspect covered by a Cloud is that of storing large quantities of data, making them available in the most efficient way, which is something typically achieved through its Infrastructure-as-a-service (IaaS). However, much more opportunities can be exploited when data are not only aggregated and rather are also processed in order to interpret information and gather them, a stage actually requiring the combination of IaaS and SaaS. The last challenge for exploiting a cloud's complete potential is to develop predictive analytics-related capabilities, such as adaptive control. In this sense, the utilization of a platform-as-a-service infrastructure (PaaS) is highly needed, since it would enable the firm to create the so-called 'data-lakes' that, in turn, may enable the company to create a new ecosystem for instance.

The concepts exposed so far highlights that many manufacturers can exploit the potential of DTs in order to transit from a traditional way of doing business to a more customer and service-oriented business model. The extent to which this is possible and the dimensions in which it can be applied will be further analyzed in the following paragraph.

2.3. Servitization and digitalization: business models innovation

Digital disruption is growing across all industries and ecosystems, also altering firm interdependencies and network positions. Digitalization involves the use of digital technology to provide new value-creating and revenue-generating opportunities (Gartner, 2017) and typically goes "hand in hand with adopting a servitization strategy" (Parida et al., 2015). Whereas, digital servitization refers to the utilization of digital tools for "the transformational processes whereby a company shifts from a product-centric to a service-centric business model and logic" (Kowalkowski et al., 2017). The combination of such definitions together with the

main technologies analyzed in the previous paragraph, has pushed many industrial realities to shift their paradigms in terms of value creation.

However, while successful enterprises such as ABB, General Electric and Siemens are investing strategically in data gathering and analytics capabilities and in cloud-based platforms (Sklyar et al., 2019), many other industrial enterprises remain concerned about how to best address digital disruption and enable digitalization (KPMG, 2017). For such reasons, we want at first to define how companies can organize for digital servitization and then move into new value systems and business models to be developed by manufacturers.

2.3.1. Organizing for digital servitization

According to Neu and Brown (2005), to gain the benefits of servitization, firms need to set up a structure properly aligned with its strategy, where a firm's structure is primarily determined by two factors. At first, it is important to properly combine internal resources with strategic business requirements (Sklyar et al., 2019) and, secondly, a degree of administrative heritage is required (Bartlett and Ghoshal, 2000). Furthermore, it is worth noticing that when a business is focused locally, a high responsiveness to changes in markets and customer's needs is especially important when delivering services. However, as suggested by Ghoshal & Nohria (1989), when customer relationships are organized locally, centralization can generate a major corporate dissonance, reason for which servitizing firms attempt to solve such issue through delegating some decision making powers to those managers that are closer to the customer. On the other hand, a centralized form of decision-making is more appropriate when the need of local adaptation is low and, at the same time, the company is willing to maximize its global efficiency.

In terms of organizing for digital servitization, Gebauer et al. (2013) found also that both relational and structural embeddedness are particularly important, since the delivery of high-complex services and solutions requires collaboration among the actors in the value network. Such concept can be further extended referring to Neu and Brown (2005) who demonstrated that embeddedness yields to a better understanding of what market conditions are actually in place and in which direction the customer's needs are changing.

As previously mentioned, also the firm's administrative heritage is important while organizing for digital servitization, since it makes possible to execute all of the activities aimed at performing the said shift. However, there are many cases of companies that, in order to properly apply the transition thus becoming more servitized, have decided to establish separated service organizations. Indeed, Oliva and Kallenberg (2003) suggested that some manufacturing companies were attempting to walk the servitization pathway through establishing service

organizations to enhance performance accountability and service orientation. This last aspect resembles a fundamental issue characterizing the transition pathway, which lies into the tensions between products and service faced by organizations. Not surprisingly though, many industrial enterprises, in an effort to solve such tensions, decided to create new structures comprising customer-facing front-end units, back-end product and service units, and a strong strategic center for decision-making and coordination (Kowalkowski & Ulaga, 2017). It is worth noticing that at the time of organizing for digital servitization, both products and service units can be assigned with new roles and, according to Cenamor et al. (2017), back-end units could handle activities related to the modular product-service architecture, while front-end units assume responsibility for customizing module-based offerings. As consequence, different configurations of product and service units as well as back-end and front-end units may co-exist into the same organization.

The foreword made in this section allows us to move to the trajectories that can be undertaken by manufacturing companies in their pathway for digital servitization, thus coming up with new business models and creating value following different patterns.

2.3.2. Service transformation trajectories for manufacturing companies

A growing number of researchers have been exploring how manufacturing companies have managed the transition from a good-centric focus to a more service-oriented approach, resulting into the implementation of service-led growth strategies. Such intellectual work collimated into the development of useful frameworks able to properly highlight the main challenges and opportunities behind these new ways of intending the business practices in manufacturing. Although, among many, Parvinen and Möller (2013) belongs to that body of literature who believes that many industrial realities are still struggling in terms of strategic and operational decisions. Further debate is found when the discussion moves to the precise trajectory followed by manufacturers in walking their pathway for servitization. For instance, Oliva and Kallenberg (2003) believe that such transition path moves along a product-service continuum, where a manufacturer starts with basic product-oriented services and then moves to more customized services, that typically are process-oriented and, ultimately, the firm will move to the solutions' field.

However, Storbacka et al. (2013) argued that few firms make a complete transition downstream in practice, whereas Kowalkowski et al. (2012) pointed out that service-led growth and expansion is multifaceted and does not necessarily imply a unidirectional development towards the provision of more extensive services.

In this section, however, we will refer to service-led growth strategies as defined by Davies et al. (2007), thus referring to the so-called "selling systems" which Mattsson (1973) defined as "a combination of products and services, a fulfilment of a more extended customer need than is the case in product selling". Therefore, in line with Kowalkowski et al. (2015), we will introduce three main trajectories (see Figure 12) that manufacturers can adopt while moving to 'selling systems'.

The first trajectory, named "becoming an availability provider", refers to equipment providers expanding their offering from basic to more advanced services. Typically, manufacturers move over the said trajectory through leveraging on their existing service capabilities with a twofold aim: on the one hand, such industrial players are pushed to improve their service base to reach a business growth; on the other hand, they want to increase the customer loyalty. As it is easy to understand, the combination of such objectives would bring the manufacturer to benefit from more stable revenue streams. In order to effectively apply said shift, manufacturing companies typically establish separate service units, leveraging on automation opportunities, customer maturity and top management attention.

However, due to the fact that this is not an 'over-night' change, there are some hurdles that have to be passed. Not surprisingly though, a manufacturer may face an internal resistance able to interrupt the entire change. Said resistance can assume different forms and features, for instance can be represented by a lack of overview and coordination among different corporate bodies or it can suffer from a too product-centric sales force.

This latter aspect does not surprise, since manufacturers moving to the solution field are, originally, product-centric companies that are organized for selling that value rather than selling systems, solutions or hybrid offerings. Another aspect able to stop a manufacturer, aiming to become an availability provider, is represented by the wrong choice of partners. Especially in case of delivering and developing high-complex services, a strong collaboration between the supplier and third parties is required. By the way, the first major step to be made by industrial firms moving along such trajectory is to bundle products and services that were previously sold separately and thus preserve an input-based approach in terms of value proposition. Indeed, the best solution would be that of engaging with more extensive service agreements (e.g. maintenance, repair and overhaul services), though Kowalkowski et al. (2015) claim that few firms are truly able to move toward bundle offerings, except for very large contracts, thus becoming an availability provider only to a limited number of customers.

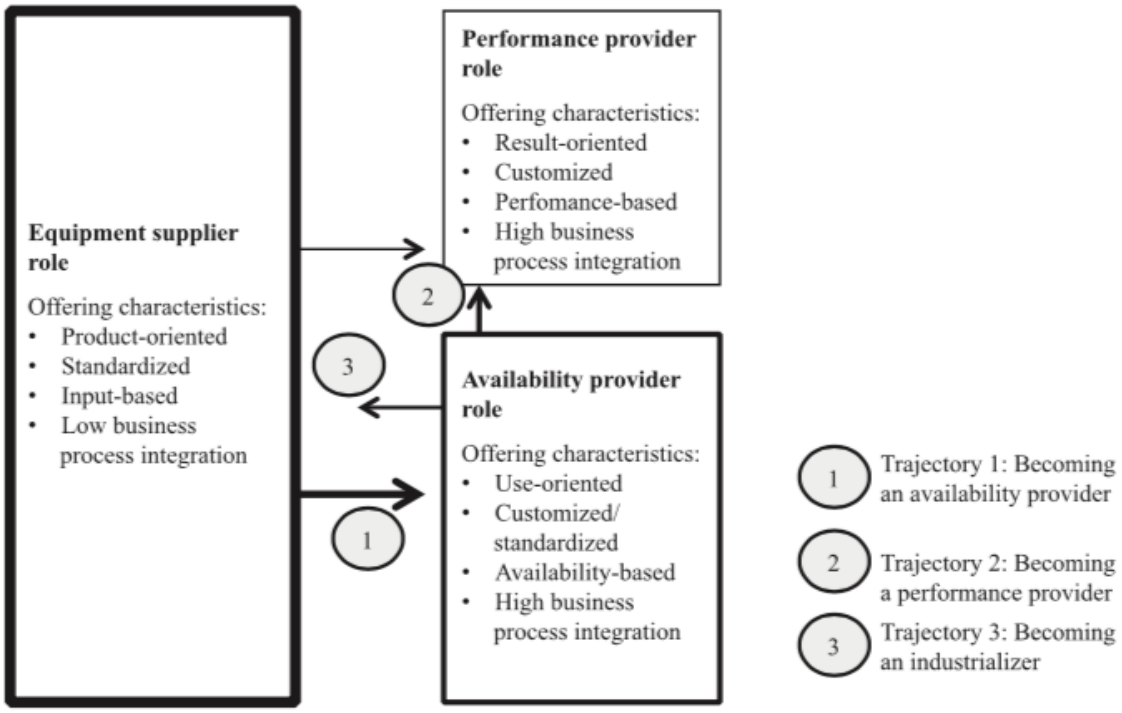

Figure 12 - System supplier roles and service growth trajectories (Kowalkowski et al., 2015)

A company already able to carry out business activities as an availability provider has the room for engaging with even more advanced solutions, able to solve strategically important customer-specific problems (Storbacka, 2011). As consequence, these offerings are not offered as part of the standard portfolio and, as Azimont et al. (1998) argue, system suppliers may evolve beyond solving customers' operational problems to a more strategic form of marketing which addresses long-term objectives. This, in turn, translates into a manufacturer becoming a performance provider, since a higher degree of both technical application integration and business process integration facilitate the role of performance provider (Matthyssens and Vandenbempt, 2008). The key drivers pushing manufacturers to walk such trajectory are, at first, linked to the customer demand which, in turn, can translate into a powerful source of differentiation for the supplier as well as building strategic partnerships with customers. However, due to the nature of the offerings that a performance provider is called to perform, several challenges need to be addressed, since a higher value with respect to the availability provider is delivered. In this sense, both operational and financial risks have to be properly evaluated as well as establishing a proper integration and coordination with third parties. This latter aspect, once more, reinforces the concept that a performance provider often develops its offerings and solutions together with its peers. Within said network, in order to fulfil contracts, a complete set of risk mitigation capabilities is required, resembling that service supplier and customers need to trust each other, share risks and successes, be flexible. If met, all of these

aspects would avoid unwanted situations concluding into an unplanned customization, leading to dissatisfaction and losses.

The third trajectory envisaged by Kowalkowski et al. (2015) is known as "becoming an industrializer". In this case, the service growth trajectory differs consistently with respect to the expansion from basic to advanced services we have just seen. In this case, indeed, we refer to situations where the supplier have been offering both customized and operational solutions for many years (e.g. equipment rental, long-term service agreements). The benefits an industrializer can meet are consistent with Storbacka and Pennanen (2014), who argued that "industrialization means standardization and 'productizing' the solutions in order to create the prerequisites for repeatability and scalability". The main drivers for which companies undertake said pathway are clearly tied to the concept of economies of scale, as well as the utilization of in-house knowledge and resources. This, in turn, translates into "offsetting the higher operational and strategic risks associated with operational solutions, and of sharing development costs with other customers" (Kowalkowski et al., 2015). However, few firms are effectively able to move from customized solutions to standardized solutions (Gebauer et al., 2005) and the reason is that the so-called 'industrializer' is a company with several years in the service business, has a profound knowledge of customers, analyses and collects data, has developed modularization competences.

In this section, we have seen which are the main trajectories driving manufacturers to adopt service-led growth strategies, which are the main barriers they face and which competences and capabilities are needed to perform the transition. We have also seen that as the customization and complexity of service offerings increases, the need for collaboration between suppliers and customers raises. For this reason, in the next section we will analyze the concept of ecosystems and how these are related with digital servitization.

2.3.3. Digital servitization business models in ecosystems

Many authors in the servitization literature are convinced that digitalization is an enabler and driver of the business model, value creation and value capture (Lerch & Gotsch, 2015; Parida, Sjödin, & Reim, 2019; Porter & Heppelmann, 2014). Furthermore, evidences brought by authors like Grubic, (2018) and Rymaszewska et al. (2017) have demonstrated that companies such as Rolls-Royce, Wärtsilä, and Caterpillar have used a variety of sensor-based technologies to enable product-service- software systems and smart solutions.

In the previous sections, we have also highlighted that there are many companies still trying to overcome the challenges of such transition, especially those related to data collection and warehouse analytics. Indeed, the adoption of smart solutions is not an immediate process, since

smart product-service systems entail changes in terms of business model configuration (Kohtamäki et al., 2019), where customers expect solutions to be customized according to their needs. In addition, in delivering complex offerings, companies no longer operate separately, rather they co-operate with customers and partners, indeed Kohtamäki et al. (2019) argue that: "smart solutions must be designed to operate and interact with the solutions offered by many other manufacturers, used by customers, delivered by distributors, maintained by different service partners, and operated by third parties". Hence, we can argue that the proper implementation of digital servitization business models is process which extends beyond the single firm's boundaries. In this sense, manufacturing companies use to define their own value systems in order to understand how and where there are positioned, in order to determine their boundaries and how digitalization may affect their BM. To better comprehend this latter aspect, it is worth citing the example by Rabetino and Kohtamäki (2018, see Figure 13).

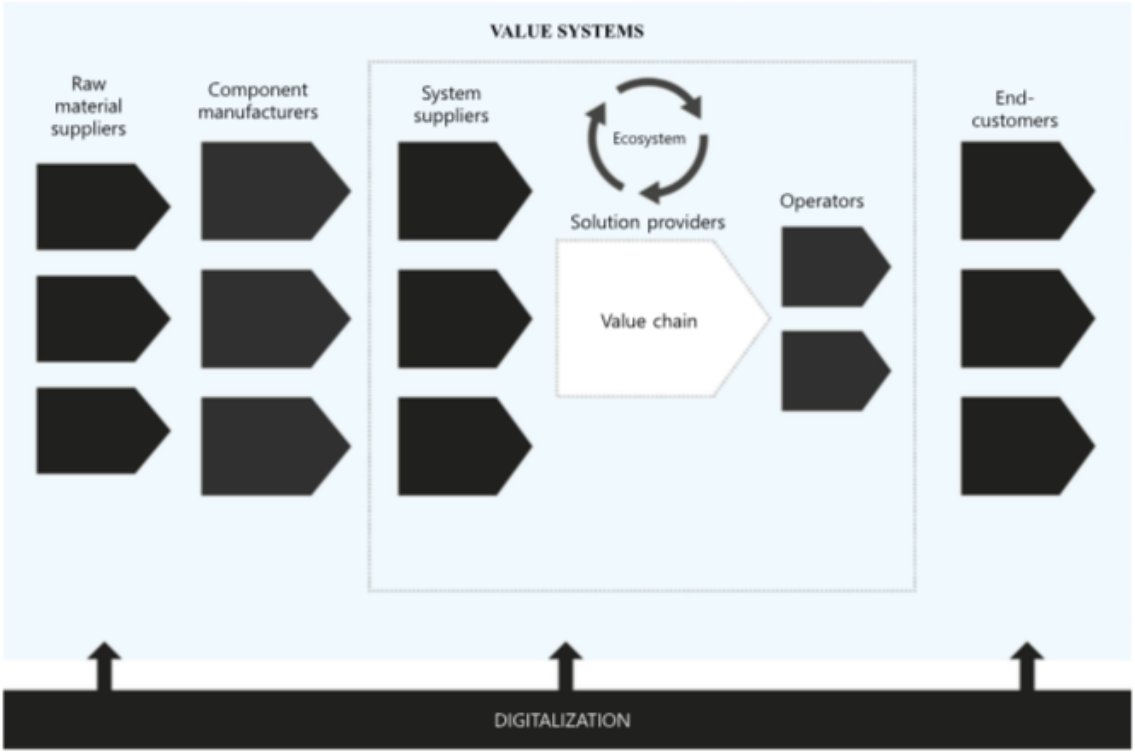

Figure 13 – *Digitalization effects throughout value system/ecosystem (Rabetino and Kohtamäki, 2018).*

As we can see in fig.13, the value system moves from raw material suppliers to component suppliers, system suppliers, solution suppliers, operators and, finally, to end-customers. In this context, ecosystems can exists within the value systems through networked organizational forms. Here, make-or-buy decisions have turned into make-or-collaborate-or-buy, thus emphasizing that value creation and value capture are determined between related firms. For this reason, when firms come up with smart connected products embracing IoT technologies, new ecosystems can arise. However, these new ecosystems do not necessarily

assume a network nomenclature, rather can be also organized as markets. In this sense, Gawer and Cusumano (2014) highlighted the concept of platforms defined as "products, services, or technologies that act as a foundation upon which external innovators, organized as an innovative business ecosystem, can develop their complementary products, technologies, or services", thus platforms enable different actors to stay connected within an ecosystem. An example could be a webstore actually linking many different customers and suppliers, such as Uber or Airbnb.

However, as showed in the previous section, there are many different configurations able to ensure optimal outcomes to a manufacturer. Moreover, a number of different dimensions can be used to build offerings in digital servitization, though, in this issue, we will refer to those set out by Kohtamäki et al. (2019). The authors identified three main dimensions, the first of which has been analyzed also in the previous section.

At first, so, we have the solution customization dimension, where basically we move from standardization to the customization of offerings. As we have previously seen, at the beginning product-service solutions are seized over the customer's needs. As it is easy to understand, the fact that a manufacturer is able to customize its solutions, according to the customer's needs, has strong implications over the business model both in terms of value creation and value capture. The second dimension envisaged is solution pricing, whereby we move from a product-orientation to an outcome-orientation. As pointed out by Gebauer et al. (2017), pricing solutions is a fundamental step in terms of value capture and can bring to different results since pricing activity of a specific offering can be product oriented, agreement oriented, availability oriented, or outcome oriented. The last dimension is named solution digitalization, indicating the movement from monitoring to autonomous solutions. In this sense, we have seen many times how the digital software has been considered important in terms of servitization especially when we have emphasized the role of IoT and that of smart connected products.

The three dimensions envisaged by Kohtamäki et al. (2019) can be interpreted to come up with different business models starting from the concept of solution offerings. In this context, as stated by Osterwalder et al. (2010), a business model is a collection of routines applied by a company to create, deliver and capture value and therefore a manufacturer's business model can assume a variety of strategic configurations (see Figure 14).

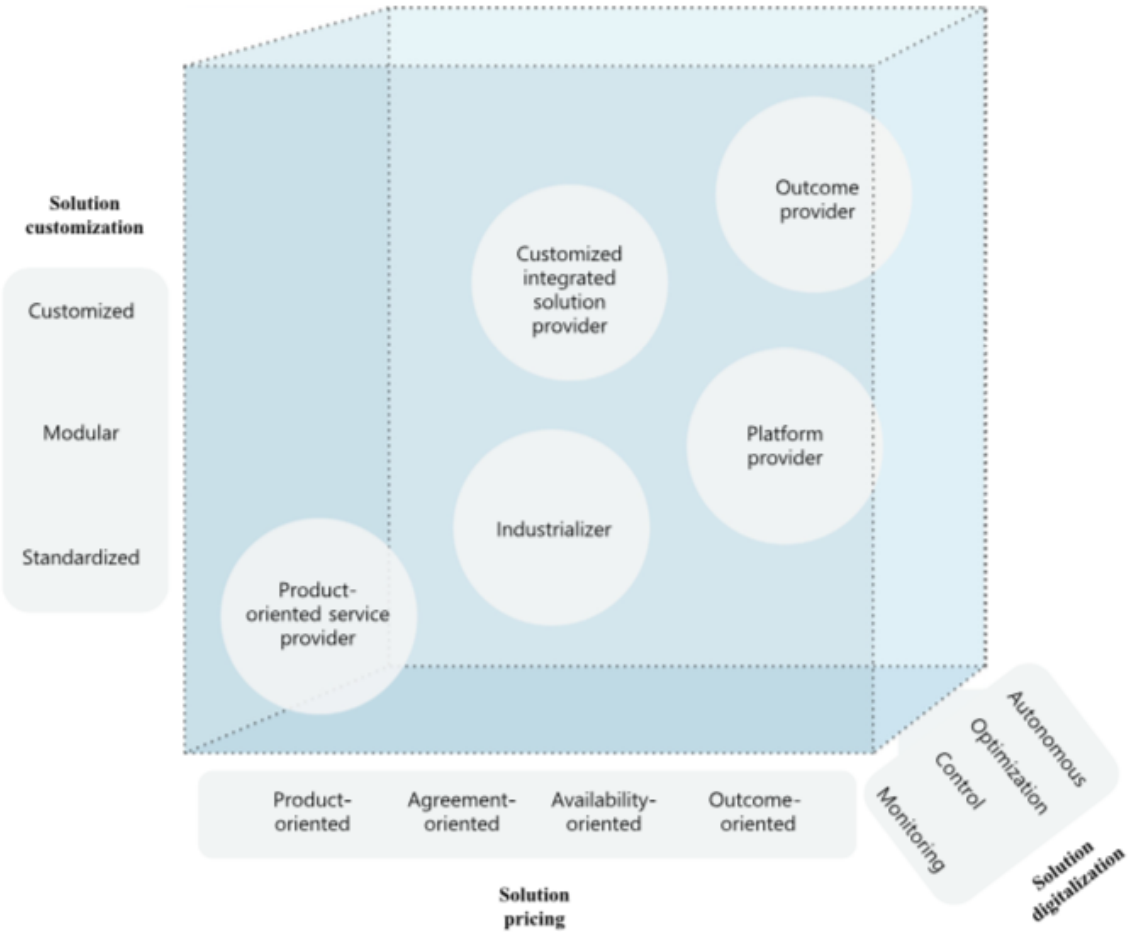

Figure 14 – *Understanding the characteristics of solution offerings in digital servitization business models (Kohtamäki et al., 2019)*

2.3.4. Pay-per-use contracts

In the previous sections we have seen that manufacturing companies may dispose of a number of pathways for applying the transition from a product-oriented value proposal to solutions, whose nature may vary from case to case. Therefore, in this section we want to focalize on a particular kind of advanced service able to reconfigure the value proposition, from an input orientation to an output orientation, a business model innovation taking the name of pay-per-use services. These kind of solutions are able to support firms against phenomenon like commoditization, quite frequent especially in manufacturing, and thus represent a source of competitive advantage.

Cusamano et al. (2015) state that pay-per-use services enable customers to pay only for the product usage, meaning that they typically do not have to purchase it, while Gebauer et al. (2017) suggests that the pay-per-use concept started as a payment structure enabling customers to access to desired products paying for their usage only.

Furthermore, companies such as Xerox (pay-per-copy), General Electric (pay-per-use) and Rolls Royce's (power-by-the-hour) are examples of companies who moved to pay-per-use contracts being able to exploit large business opportunities (Cusamano et al., 2015; Fischer et

al., 2012; Baines & Lightfoot, 2013). Such examples reinforce the concept that companies moving along said solutions were able to re-design their business model, moving from an input to an output approach, thus being able to create value through services. It is worth noticing the similarity between pay-per-use services and process support services (PSS) analyzed in paragraph 1.3.3, in which product ownership remains with the product provider, with product usage being made available as a service to the users (Tukker, 2004). As we have seen, pay-per-use services enable customers to try products rather than buying them, thus facilitating the market creation, as in the case of Xerox where customers were able to pay only for copies rather than buying a printing machine. The same holds in the aircraft industry, where engine-producer companies started to sell the flight hours, rather than engines, facilitating the market penetration for a specific engine. The common feature brought by pay-per-use contracting lies in how such services can generate revenues. Indeed, differently from revenues arising from selling products or other services, here the costs coverage is a longer process, since it will take time before revenues are generate by usage fees.

As highlighted by Gebauer et al. (2017), costs are mainly referred to R&D, equipment, operation and maintenance activities. In this sense, a manufacturer would efficiently provide pay-per-use services, thus gaining cost-advantages, only when able to predict customer product usage. Many times in this chapter we highlighted who much is important for a supplier involved in advanced services, to collect and analyze data arising from product usage in order to successfully provide advanced solutions to its installed base. This latter aspect is mainly tied to the capabilities to be developed by a manufacturer in its service-led growth pathway, with some differences with respect to the languages provided so far. Indeed, companies entering in the pay-per-use field are those already having developed service capabilities, especially under an organizational standpoint.

Although, it is not obvious that a firm is able to translate such capabilities in order to get involved with more advanced services as pay-per-use are. As consequence, the set of capabilities required shall translate into core competences in order to truly reach a competitive advantage.

The aspects covered so far suggest that few firms are able to engage with pay-per-use solutions and, according to Gebauer et al. (2017), three main areas shall be considered. At first, it is important to determine how to finance such advanced services, starting from understanding strategic customer needs. For instance, an important aspect to be determined by the company, in this stage, can be referred to the customer's preferences of subscribing a pay-per-use contract, instead of a leasing or renting one. In designing such contractual agreements, other actors are typically involved to reach the necessary finances, such as banks or external investors. This

means that also such entities must agree with the prospective contract, meaning that some investors may decide to get involved in contracts with specific risk thresholds, whereas others could prefer to engage with low-risk agreements.

The second organizational capability refers to the alignment of costs with the equipment usage. The main challenge here is not primarily related to understanding the costs of alignment, since this aspect is typically covered through ERP systems. Rather, what is challenging for a supplier is to allocate costs to the actual product usage by customers, through an appropriate conversion. In this sense, Opresnik & Taisch (2015) suggest the fundamental use of collection and transfer of data. According to their Data-Driven Servitization framework, virtualization grows in importance, since it enables suppliers to effectively capture data and have a comprehensive overview regarding the cost structure. In turn, data can be then analyzed, in order to evaluate the forecasts made together with their goodness. As it is easy to understand, collection and data analysis can be performed when IoT related technologies are in place, as this would enable a supplier to remotely monitor the equipment conditions for instance. In making the overall process more transparent, another solution could be that of reducing the vertical integration, thus relying more on external suppliers provided that those do agree with the pay-per-use design, as seen in the case of financing such agreements. Finally, it does not surprise that, in order to effectively develop pay-per-use solutions, the customer's involvement and even collaboration is highly required. Through establishing dialogues with end-users, a supplier will be more likely to forecast the production level and, mainly, it can come up with complete solutions. Here, some fundamental after-sales activities shall be executed – maintenance, remote maintenance – since these can further extend the possibility for the pay-per-use supplier to reach data and improve the value proposal. In addition, the collection and analysis of big data, arising from post-sales activities, yields a supplier to better comprehend the customer's patterns that, in turn, translates into better pricing choices. A further improvement that can be done on the way for service-led growth is represented by outcome-based contracts, actually representing the most complex offering to be delivered by a supplier.

2.3.5. Outcome-based contracts

In 1972, Theodore Levitt coined an emblematic sentence: "People do not want to buy a quarter-inch drill, they want a quarter-inch hole" (Levitt, 1972). Such concept embodies the fundamental nature of outcome-based contracts where a customer is actually purchasing an outcome, an output or a result.

Hou and Neely (2017) gave a definition of OBC, which can be described as: "an agreement between the provider and the customer in which the provider provides total solutions and is

paid based on the outcomes of the solutions or the outcomes of customer value in a continual use situation". Such a definition suggests that, through OBCs, manufacturers develop new business models since high complex value-creating systems involving products, activities and individuals are delivered. A growing number of contracts involving the achievement of specific performance thresholds of equipment has been issued so far, just as Rolls-Royce's did. Said company was able to provide a new solution to its customers based on the "Power By the Hour" concept, whereby the aim is to achieve required outcomes rather than meeting a set of prescribed specifications (Bramwell, 2003).

The change in the value proposition carried by outcome-based contracts is able to influence the business model of manufacturers in three different ways (Ng et al., 2013). At the very beginning, the incentives of the parties involved into an OBC are aligned towards the outcome, meaning that no opportunism occurs. Indeed, it is worth noticing that while in service contracts an opportunistic behavior may arise, due to the fact that the firm providing maintenance and repair could have no incentives to avoid equipment breakdowns – since those can actually generate revenues – OBCs create a structure of mutual orientation, able to mitigate opportunistic behaviors through reducing the cost of servicing the customer on a long-term basis. Not surprisingly though, when parties share the ownership of an outcome the likelihood of opportunistic behaviors reduces (Teece et al., 1997).

The second way in which an outcome-based contract affects the business model lies into the risk distribution, which is primarily delivered onto the firm and then on the customer. In this sense, as suggested by Madhok and Tallman (1998), the fact that the supplier bears a larger portion of risks provides the firm an opportunity to integrate resources for value creation in the use of the equipment with the customer. As consequence, the firm can benefit from higher revenues arising from a more efficient integration of both the parties' resources. This latter aspect represents another motivation against the abovementioned opportunistic behavior, since the company has the interest of investing in resources able to make more reliable products as well as offering services (e.g. repair) to increase the overall profitability.

Therefore, in the outcome-based contracts field a firm able to be highly coordinated, able to collaborate and even co-operate with its customers, will gain superior organizational capabilities making possible to extract additional rents. This, in turn, may also push a firm to engage with self-enforcing agreements, where the degree of mutual orientation is even higher than in OBCs. However, due to the nature of OBCs, we have also to say that many challenges have to be addressed by companies aiming to deliver such solutions. Indeed, if on the one side, such contractual agreements enable a firm to change its orientation and business model, it is also true that the supplier is called to manage the collaborative aspects regarding its customers

into a completely different manner. The reason is that in presence of an outcome-based contract the supplier is directly involved in reaching a customer's outcome.

Another major challenge lies in how a company is able to effectively manage such new business model, where the supplier has to achieve the customer's outcome cooperatively. Not surprisingly, Zott and Amit (2009) stress this aspect, since outcome-based contracts push companies to understand how the organization will change through adopting a different business model. It seems clear that in the OBC field, strategic alliances – where suppliers and customers are able to effectively cooperate and combine their own resources – are the most successful. Although, achieving an efficient coordination is not so simple as it could seem, since many differences may arise between the supplier and customer especially in terms of information gathering and management of conflicts.

Developing cooperative capabilities is not the only aspect to be taken under consideration when engaging with outcome-based contracts, indeed Ng et al. (2013) suggest that it is also important to include the value drivers into cooperation itself. Such a concept is further analyzed by Gronroos (2004) according to which, specific resources – people, infrastructures, systems – are combined in order to achieve the customer's maximum utility. Therefore, providing OBCs involves co-production or co-creation where the value delivery happens cooperatively. An important study carried out by Ng et al. (2013) has highlighted that, in delivering OBCs, value is co-produced with customers through three value-drivers, namely: (i) Transform materials and equipment, (ii) Transform information and (iii) Transform people's behaviors. The authors claimed that a firm starts the designing of processes around a consistent transformation of materials/equipment, since these are the primary value driver of equipment-based services. Furthermore, in the OBC field it is also important to reach a transformation of both people and information in order to achieve the customer's desired outcome. These last two transformation are generated intra-firm typically, although, are obtained at a management level rather than at an operational level. The combination of the abovementioned value-drivers is not solely provided by the firm and, instead, are jointly created with customers.

Further languages shall be provided regarding another key characteristic embodied by outcome-based contracts: the risk. As we have seen, the issuance of such contractual agreements brings a transfer of risks from the customer to the supplier, where risk is related to an outcome, a performance or an output to be met by the supplier on behalf of its customers. However, it seems quite difficult to give a precise definition of said thresholds a supplier is responsible to reach, as well as giving a risk definition in the OBC field. Hou and Neely, (2017), for instance, defined risk as "an event with the ability to directly inhibit the mission, strategy, projects, routine operations, objectives, core processes, key dependencies and/or the delivery

of stakeholders' expectations". Moreover, the authors provided an important framework aimed at analyzing the risk aspects within outcome-based contracts (see Figure 15). In designing an OBC we have two main risks faced by the provider, namely commercial risks, that mainly involve contracting decisions and negotiations and operational risks who, instead, include aspects such as failure to achieve a specific customer's outcome or pertains service delivery activities. The framework proposed, highlights five main dimensions in which OBC can be categorized.

At first, it is worth starting from the contextual factors that, in turn, bring to reason in terms of two different dimensions. The first of these relates to complexity issues, since outcome-based contracts are adopted in complex scenarios, where typically suppliers face high uncertainty. As consequence a number of different aspects, involving shareholders, customer's demand and environment, must be taken into account. If complexity describes somehow the current state of an OBC, dynamism considers long-term issues of such agreements, with a particular focus on how, the environment in which the supplier operates, could change and how customers could modify their preferences over the time.

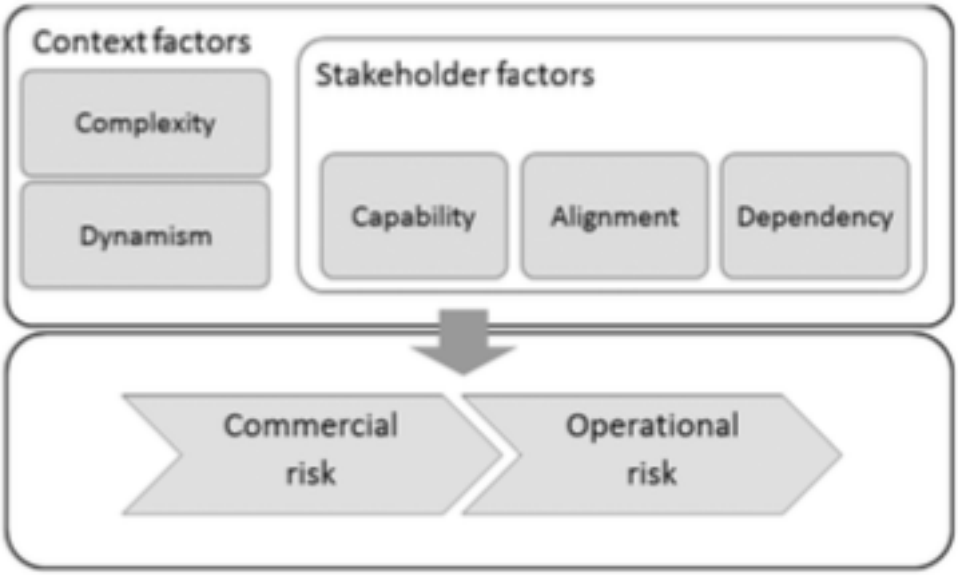

Figure 15 – *Risk framework of OBCs from a provider's perspective (Hou and Neely, 2017)*

Capability refers to the lack of capabilities from key stakeholders (providers, partners, customers) with respect to commercial and operational risks. Said lack may involve an absence of the required capabilities, both at the time of delivering an OBC as well as at the time of contracting. Moreover, it can also be an internal inconsistency of the provider or even an internal resistance to deliver advanced solutions. Alignment is another important dimension to be mentioned, since the authors believe this is one of the main reasons for the occurrence of both commercial and operational risks. Alignment refers to the ability of both the parties

involved into an OBC – customer and supplier – to share common goals, visions, adapt their cultures to successfully collaborate.

At last, dependency highlights that, on the one hand, a provider of OBC solutions depends on its customers and on other partners for delivering said services, thus it is important to what extent such dependency applies. On the other hand, a supplier is also able to influence the behavior of other customers or partners when delivering OBCs. Taken together, these two aspects suggest that, for instance, a provider can forecast with reasonable precision what will happen in case of failure of a customer or of a partner and the related impact on the issuance of OBC solutions.

2.4. Servitization and digital servitization in turbulent times

2.4.1. The role of servitization in mitigating crises effects

As we have seen in the previous paragraphs, services have become increasingly important for many product firms and the reasons for which said industrial players might invest more in services, thus transforming themselves are different. For instance, companies like General Electric, IBM or Caterpillar started to strategically rely on services, in order to increase their sales thus creating other sale channels, different from those already established for products. Such an approach translated into the establishment of service departments, able to give to the customer the confidence to make the purchase.

Moreover, according to Cusumano et al. (2015), some products require sales of services that are important for customers to use the product, and product manufacturers may choose to capture some of these sales themselves. The sale of a car or a tractor, for instance, leads to services such as loans, leases, extended warrantees, maintenance, and repair. In addition, a large body of literature (Davies et al., 2006, 2007; Galbraith, 2002; Tukker and Tischner, 2006) demonstrates that some manufacturing companies combine products with services tailored with customers' needs, thus generating customer-specific or even industry-specific solutions, being more competitive than standalone products.

The languages provided so far, regarding services and how these are implemented by manufacturers, generate room to evaluate their role in times of crises or shocks. In this sense, Quinn et al. (1992) demonstrated that product firms are tempted to move into the service business, when solutions are able to provide a more stable source of revenues and profits with respect to more volatile product sales. An aspect further confirmed by both Gadiesh and Gilbert (1998) and Wise and Baumgartner (1999), who found that product-related service revenues can amount to five, or more times, the retail price of the product over the lifetime of its use. This latter concept enables us to look at the role of services in comparison with the industry lifecycle.

2.4.2. The industry life-cycle and services

Although the industry lifecycle cannot be seen as a crisis per se, it actually poses the basis for our discussion in determining how services behave in turbulent times. According to this topic, a number of researchers (Davies et al., 2006; Fang et al., 2008; Galbraith, 2002; Oliva and Kallenberg, 2003; Quinn, 1992; Sawhney et al., 2004; Teece, 1986; Tukker and Tischner, 2006; Wise and Baumgartner, 1999) provided languages regarding the fact that services delivered by product firms bring beneficial effects, especially when a mature industry is characterized by a high degree of commoditization, where it has become difficult for companies to differentiate themselves through products.

Teece (1986), for instance, suggests that manufacturers are likely to engage with services when a standard design emerges within the industry and the competition moves to cost-based dynamics, where services can represent a source of differentiation in such a competitive scenario. The latter considerations we made are, according to Cusumano (2004, 2008), envisaged at a company-level account perspective. In line with his findings, information technology firms such as Oracle, IBM, Hewlett-Packard or Dell have all experiences large increases in maintenance as well as other product-related services, as a percentage of their total revenues, when sales arising from product lines declined or when product prices have fallen.

To sum up, there are many contributions in literature actually stating that product firms invest in services as a way of differentiating themselves, when approaching with a mature stage of the industry in which they operate. Therefore, all scenarios where prices have fallen due to a high competition or when the market potential was reduced.

However, we still need to understand in which industry lifecycle's stage, product firms shall offer services. In doing so, we have to highlight that the main researches, regarding the industry life-cycles, (Abernathy and Utterback ,1978., Anderson and Tushman 1990., & Klepper , 1997) agree upon the fact that the early stages of the abovementioned life-cycle are characterized by uncertainty and cost. In this sense, uncertainty refers to the producer's decision regarding the underlying technologies, designs as well as production techniques to be chosen in order to properly compete into a growing market. Cost, instead, is typically referred to secure the necessary resources and capabilities required for producing a specific product. Cusumano (2015), in an attempt to solve the literature debate, involving the industry lifecycle's stages, define such stage as "ferment" phase which is, indeed, characterized by a high degree of uncertainty.

The author mainly relates uncertainty to the introduction of a new technology where said novelty, is not only faced by a manufacturer but also by its customers. Overall, such newness

translates into the uncertainty regarding how the product will perform, which will be the problems to be addressed and which functional characteristics will be important. Furthermore, Utterback (1994) highlights that, in the ferment phase, manufacturers apply a large experimentation regarding the adoption of different technical designs and business models, since a product-core technology can follow many different trajectories which, in turn, are difficult to be predicted by manufacturers.

As consequence, the output volume will be low and the entrance degree will be high, with many entrants focused on innovating the product. On the other side, according to Utterback (1994), customers may be unsure regarding the technology being introduced, thus asking themselves whether to buy or not the product. In turn, both the product company and customers do not have profound knowledge regarding the product, its usage or performance characteristics. If, on the one hand, such an uncertainty does not favor the introduction of services, able to alter the product functionality – maintenance, repair, technical support – which at this stage may be unknown yet, on the other hand it favors the introduction of what Cusumano (2015) calls "adapting services".

Due to the general lack of understanding a still-developing product design, the early adopters will require significant modification to the product design in order to fulfil their needs. In this context, the customer can ask a knowledge-intensive customization able, for example, to create new functionalities or new usages. For this reasons, Cusumano (2015) believes that adapting services – bundles of products and services – enable experimentation of the product, allowing customers to understand and, at the same time, require for modifications regarding the new technology. However, due to the nature of such industry's phase, many buyers may be even reluctant to purchase the new product. The reason is described by Simon (1962), who argued that said unwillingness of purchasing novel products is due to the fact that these require time-consuming and expensive-use-specific solutions that, in most of the case, are difficult to be achieved.

Therefore, in contexts where the customer assumes a "wait and see" posture, a solution could be that of offering a service as substitute of the product, where the product firm offers the product functionality as a service to its customers, bearing the risk of owning the product. Conclusively, von Hippel (1988) suggest that, especially in industries like scientific instruments, industrial machinery and machine tools, manufacturers develop products that have experienced substantial modifications, in order to fit the customer's specific requirements. An aspect further confirmed by Jaikumar (1986), in his discussion of the machine tool industry where he argues that: "manufacturing now responds much like a professional service industry, customizing its offerings to the preferences of special market segments".

As previously mentioned, there are cases in which different customer's groups may ask for same requirements regarding specific product features, for example stamping presses specifically designed for the automotive industry. In such scenarios, the adaptive services envisaged by Cusumano (2015) may represent a profitable opportunity, since these may create room for generating vertical-specific versions of products.

Moving forward from the ferment stage, another industry's phase is envisaged by literature scholars and it is typically characterized by a decreasing uncertainty and production costs. For instance, Abernathy and Utterback (1978) identify such shift as the emergence of a dominant product design, whereas Anderson and Tushman (1990) identify a growing market demand around a stabilized product. Said industry's stage is defined by Cusumano (2015) as transition phase where, basically, products have become standardized. Meaning that both companies and customers better comprehend their characteristics and have a higher knowledge regarding the different product's usages. Consequently, the increasing focus on process innovation pushes competitive decisions away from technological differentiation and rather involves product reliability and cost.

As consequence, since the market is no longer demanding a higher product variation, there is no need to provide services that adapt or develop specialized uses of the product. For this reasons, Cusumano (2015) believes that smoothing services represent a powerful resource to be delivered in such industry's phase. Indeed, due to the fact that some manufacturers experience significant gains in scale, services such as repair, maintenance, assistance and training, regarding the product's uses, would help the producers in building customer's acquisition and retention as demand grows. The author further highlights that the smoothing services named above are less resource-intensive than adapting services, which complements the shift toward greater scale and increased cost-based competition and investment in process innovation.

The last stage is commonly defined by scholars as maturity phase, whereby we have low uncertainty regarding both the product and the market. According to Klepper (1997), in the maturity stage there is less product differentiation, due to the fact that the number of competitors in the industry is at low levels, as consequence there is an increased cost-based competition. Moreover, Kahl (2007) suggests that, from a customer standpoint, a dominant "use" may have emerged in this industry stage, meaning that many customers are using the same technology to perform similar functions. Therefore, considering the low levels of uncertainty and a strong-based competition, Cusumano (2015) believes that the maturity stage of an industry life-cycle is appropriate for hosting smoothing services.

The reasons is that here is easiest to find connections, commonalities and patterns across implementations that support the unambiguous exchanges between the product firm and customers of smoothing types of services. Moreover, customers who kept products operating for long periods of time will express a higher willingness for services such as maintenance or repair, thus increasing such demand. On the other hand, adapting services will experience a lower demand by customers who became particularly price sensitive in this stage and may not perceive feature enhancements brought by the service. In addition, such category of services requires a different set of organizational capabilities to be developed by a manufacturer. Such latter aspect is not simple to be fulfilled, especially because of the high financial and resource commitments needed; all aspects that are difficult to be met by companies competing on price. However, there also instances where the demand got saturated, as production expanded to cover most of the addressable market. In such cases, companies may be tempted to further expand their offerings, thus reaching new customer segments who, according to Cusumano (2015), have some need for the product, but whose scale and purchasing power is not high enough to justify the product purchase. In an attempt to reach such customer segments a manufacturer may engage with the so-called substitution services defined above, although these instances seem to be quite rare.

With respect to the maturity phase, an explanatory example lies in what General Electric strategically applied in the locomotive industry. Such sector was considered to be at its mature stage during the 1990s indeed, competition was basically based on costs. However, the company was able to utilize services to make the purchase, ownership and operations of its locomotive products easier for the customer. Moreover, General Electric was able to set up maintenance facilities for locomotives as well as offer boxcar scheduling and routing services and started to provide tracking services, thus improving the truck utilization of its customers (Wise and Baumgartner, 1999). Cusumano (2015) extends such discussion also for home appliances industries, where the maturity of the sector has pushed companies, like Whirlpool, to heavily rely on services like maintenance and/or repair, since those were useful in building customer loyalty. Other examples, in line with our discussion, are represented by John Deere and Hilti, industrial realities who decided to go through rental services in order to acquire more customers and extend their revenues. The overview just made, regarding the industry life-cycle and the role that services assume in each of the stages characterizing this topic, is an important basis to further analyze the role of services during disruptive periods, in particular with respect to crises.

2.4.3. Service resilience during the 2008-2009 collapse

In the previous section we have analyzed the role of services during different industry life-cycle's phases and how these are implemented by manufacturers to mitigate uncertainty or high competition characterizing a specific sector.

In this section, instead, our aim is to look at the role of services during the great recession also known as financial crisis started after the United States housing bubble of 2005-2006. The subprime mortgage crisis was, indeed, characterized by a deep fall in the value of mortgage-backed securities owned by investment banks, thus causing a hard collapse in the financial markets worldwide. The events on which we will pay attention in this issue are those happened between the 2008 and 2009 where trade in goods experienced the steepest decline ever recorded in history, with both exports and imports dropping four times more than income (Freund, 2009; Levchenko et al., 2010).

As pointed out by Baldwin (2009), the fall was severe and highly synchronized across countries, involving especially durable goods. Conversely, Ariu (2016) demonstrated that trade in services remained stable and those belonging to specific categories like business, telecommunication and financial continued to grow at their pre-crisis rates. Moreover, Borchert and Mattoo (2009) were the first in demonstrating that services did not experienced a collapse during the crisis of 2008-2009, showing that both exports and imports of services did not decline. The authors claimed that the reason, for which services did not collapse, lies in that service demand is less cyclical and they less rely on external capital. This latter aspects were further confirmed by Ariu (2016), who discovered that the crisis hit goods more severely than services, with goods exports got reduced by the 30% after September 2008 and services showing no clear discontinuities worldwide.

However, we still need to understand the reason why product and services reacted differently during the crisis of 2008-2009. In doing so, we can firstly refer to the supply side, where different languages have been provided by many scholars (Chor and Manova, 2012; Ahn et al., 2011; Auboin, 2009 and Amiti and Weinstein, 2011) who came up with a common thought. Indeed, the authors believe that severe credit crunch contributed to increase the severity of an already hard crisis, since banks reduced the availability of external capital for exporters and, as consequence, the aggregate trading volumes dropped.

From a service standpoint, as we have previously highlighted, exporters rely less on external trade capital since services are typically intangible and, most of times, highly customized. Moreover, due to the intangibility of services, which makes them also impossible to be stored, they might have suffered less from the inventory adjustment process and from the disruption of global value chains (Ariu, 2016). This latter aspect was, indeed, observed by both Altomonte

et al. (2012) and Berns et al. (2011), who found that the international nature of global value chains makes downstream demand shocks propagate through them, with magnified upstream volatility due to inventory adjustments.

In addition, Borchert and Mattoo (2009) highlight that services can be traded over the net, which implies a lower need for external finance to make the necessary investments to be able to export. Considering also the lower risk associated with the service delivery, the working capital needed to support the firm from production to delivery is lower with respect to products (Ariu, 2016).

On the demand side, instead, Ariu (2016) highlighted that the durable goods' demand, actually representing most of the export values, collapsed during the crisis, while that of services and consumables, constituting most of the domestic income, stayed relatively high. In turn, the combination of the aspects envisaged so far, suggests why services were considered to be more resilient with respect to products, especially when those were durable goods, in facing the 2008-2009 collapse.

2.4.4. Servitization in the European automotive industry

The financial crisis mentioned in the previous section had tremendous impacts on a number of different sectors such as foodservice, retail, traveler accommodation, manufacturing, automotive and more. For this reason, it was interesting to analyze the role of services within one of these sectors and possibly determine how those have helped companies to mitigate the crisis impacts. After the 2007, the European automotive industry has lived hard times, since the demand for vehicles has dropped, especially in the truck sector (Gaiardelli et al., 2014). In 2012, the European Automobile Manufacturers Association (ACEA, 2012) issued data regarding the importance of the automotive industry in terms of the Europe's GDP (6.5%), with a turnover of 551 billion €. In addition, at that time, the 5.3% of the European employed population was employed either directly or indirectly into the abovementioned sector, with 3.4 million jobs related to sales and in-use services such as maintenance, rent and lease (Gaiardelli et al., 2014). The economic recession mentioned above, together with a lower willingness to purchase cars by younger generations (AlixPartners, 2013), translated into a strong decrease in sales of cars, trucks and professional vehicles.

In turn, the complexity and difficulties governing the European automotive industry from the 2007 to 2013, translated into a series of factors able to push manufacturers to shift their business strategy, compromised by a high and costly competition, to services. Under a strategic and marketing level (Vandermerwe and Rada 1988), said shift was due to the fact that services enable a lock in effect, able to generate benefits for Original Equipment Manufacturers.

Typically, such benefits are achieved through issuing long-term contracts that, for instance, may translate into a mandatory maintenance.

Consequently, those industrial realities being able to collect and analyze remote information from their installed base, gain a differentiation advantage with respect to other competitors, who lack such resources and capabilities. In this sense, Toyota not only relied on long-term contracts but was also able to come up with innovative projects such as DuoTec, which increased both the speed and quality of the service offering. Another example is represented by Car2go, whereby customers can lease a car according to a pay-as-you-go model within the city (Gaiardelli et al., 2014). In chapter 2, we have mentioned how long-term contracts and solutions represent new business models and thus how such offerings are able to exploit different opportunities and satisfy new customer needs.

The research carried out by Gaiardelli et al. (2014) has demonstrated how European automotive manufacturers, due to the financial crisis mentioned above, have switched to services in order to increase their profitability and reach a larger customer base. Their analyses have shown that most of the services introduced had the aim of enhancing the vehicle features or support the vehicle availability. However, there are also examples of manufacturers who engaged with offerings tied to the vehicle life-cycle, such as upgrading and outfitting or the refurbishment of spare-parts.

This picture shows that Original Equipment Manufacturers, involved in automotive, wanted to identify and design possible solutions able to fulfil the needs of different customer segments. As suggested by the authors: «repair and maintenance activities are promoted with a wide number of warranty forms and are available in a large set of alternatives, ranging from the provision of traditional support to the delivery of express (fast-fit) services. The activities can be associated with a 24/7 workshop opening, and/or can include road assistance in case of emergency rather than an at-home direct assistance». Examples of product-service bundles are also envisaged by their research. Especially in chapter 2, we have seen that some manufacturing companies are able to couple their products with specific services, thus making an hybrid offer. In the automotive industry such path was undertaken to reduce the assets' obsolescence and preserve the customer's working capital, without transferring the vehicle ownership to customers, as suggested by Gaiardelli et al. (2014). However, in their research there is no evidence of companies able to design result-oriented services.

The reason probably lies into the fact that companies proceed over servitization along a continuum, through different stages each characterized by a different service complexity (Oliva and Kallenberg, 2003). As we have seen in chapter 1, result-oriented or performance-oriented services are the most complex offerings to be delivered by a provider, due to the large set of

resources, capabilities and experience required. Reasoning also in terms of supply chain, an effective implementation of a service strategy requires coordination and integration from all the players involved (Cohen et al., 2006). Indeed, Gaiardelli et al. (2014) believe that dealers, for instance, play a crucial role in service delivery, since those represent an effective connection between the OEM and customers.

Even if it is true that many manufacturers in automotive are still focalized on delivering product-oriented services, the analysis carried out by Gaiardelli et al. (2014) demonstrates that a progressive diversification of service portfolio is occurring, and different companies have started a process of dematerialization of their product service-portfolio, in line with the implementation of a servitization strategy. In order to give a final overview, regarding the servitization adoption in the automotive industry, soon after the financial crisis mentioned in the previous section, I report the Table 5 from Gaiardelli et al. (2014) which explains in details the kinds of services and offerings that have been provided by manufacturers competing in the industry.

Service description	Car	Heavy truck
Financing scheme for product sale	✔	✔
Fleet management services (in outsourcing)	✔	✔
Fleet management training and consultancy	✔	✔
Support for maintenance activities and spare-parts management (consultancy) for customers with own workshops		✔
Support for maintenance activities and spare-parts management (training) for customers with own workshops		✔
Web community services (app, social network, etc.)	✔	✔
Use-oriented		
Leasing	✔	✔
Rental (short term)	✔	✔
Rental (long term)	✔	✔

Table 5: Services offered in the car and heavy-truck industries (Gaiardelli et al., 2014) continued

Service description	Car	Heavy truck
Transactional services for product support		
24/7 repair and maintenance services	✔	✔
Body, glass, tire, maintenance, and repair	✔	✔
Express maintenance/repair (fast-fit)	✔	✔
Fly & fit	✔	
Onsite diagnostic, maintenance, and repair	✔	✔
Product dismantling management	✔	✔
Product upgrading/outfitting	✔	✔
Refurbished spare-parts	✔	✔
Repair and maintenance during warranty period	✔	✔
Road assistance	✔	✔
Service for alarm systems	✔	✔
Summer/winter check-ups	✔	✔
Take back	✔	✔
Vehicle cleaning	✔	✔
Vehicle preinspection/precheck-up	✔	✔
Relationship-based services for product support		
Extended warranties	✔	✔
Remote monitoring and diagnostics	✔	✔
Repair and maintenance long-term contracts	✔	✔
Spare-parts supply and maintenance packages (all inclusive)	✔	✔
Spare-parts supply and maintenance packages (for old vehicles)	✔	✔
Telematics assistance	✔	✔
Transactional services for customer activities (driver/driving)		
Courtesy vehicle	✔	✔
Driver accommodation and repatriation in case of accident	✔	✔
Driver accommodation during repair activities	✔	✔
Financial support (in case of accident, emergencies, etc.)	✔	✔
Healthcare assistance in case of accident	✔	✔
Help desk (information/emergency)	✔	✔
Insurance packages	✔	✔
Legal support in case of accident		✔
Merchandise	✔	✔
Online documentation (products, accessories, merchandise, parts)	✔	✔
Online monitoring (tracking) of repair activities	✔	✔
Services for mobility of handicapped	✔	
Sport- and eco-driving courses	✔	✔
Visibility on workshop activities	✔	✔
Relationship-based services for customer activities (driver/driving)		
Credit/debit card	✔	✔
Fidelity card	✔	✔
Financing scheme for product repair services	✔	✔

Table 5: Services offered in the car and heavy-truck industries (Gaiardelli et al., 2014)

2.4.5. How servitization has changed the photocopier industry

The photocopier industry is considered by many scholars as one of the forerunners of servitization (Finne et al., 2013; Matsumoto and Kamigaki 2012; Visintin, 2014). Within such an industrial scenario, original equipment manufacturers embraced the implementation of

servitized business models and have been able to develop consistent system-integration, application-development and consulting capabilities. As consequence, companies such as Xerox are, nowadays, able to integrate print needs within total ICT solutions and compete against system integrators, consulting firms and software vendors in a large, diverse and growing document management market (Visintin, 2014). Apart from such considerations, the servitization path undertaken by manufacturers, competing in the photocopier industry, has not followed a 'forward-unidirectional' trajectory, as suggested by Finne et al., 2013.

Therefore, in line with our discussion in this paragraph, we want to determine why said industry has changed, thus moving into services. A primary reason can be envisaged through the languages provided by Sampson (2001), who points out that photocopier manufacturers have always considered the service provision and supplies as low-risk and long-term sources of revenues. Moreover, since photocopiers are typically products embodying many mechanical parts, the demand for maintenance services arising thereof is quite stable.

During the 1950s, many original equipment manufacturers, competing in the photocopier industry, already adopted 'razor and blades' business models (Finne et al., 2013) and applied a modest mark-up on their production costs, in order to maintain the selling price at low levels, with the consequent aim of ensuring the product affordability and expand the installed base (Visintin, 2014). In these years, the cost of papers, together with the different types of supplies required by those early copiers, represented another factor able to show the potential assumed by the aftermarket, characterized by stable and profitable revenue streams (Chesbrough and Rosenbloom 2002). Furthermore, as we have seen in the second section of this paragraph, disruption is more likely to occur when a major technology is introduced that, in turn, is what happened in the photocopier industry, where the mimeograph process was substituted by the electro photography process (Owen, 2004). Said innovation was introduced by the Haloid Company (Xerox today) and allowed to utilize cheap paper instead of expensive chemical paper. However, the feature-enhancement made by Xerox was, especially at the beginning, high costly and difficult to be commercialized. Indeed, Chesbrough and Rosenbloom (2002) point out that even Kodak, General Electric and IBM did not supported Haloid in introducing the product to the market.

The costly nature of the new product created by Haloid, pushed the enterprise to change its business model, moving from the abovementioned 'razor and blade' logic to a leasing scheme, relying on fixed monthly fees. As consequence, the company was able to cover all the expenses required by services and support. Such a business model innovation is also in line with pay-per-use services – that we mentioned in chapter 2 – and enabled Haloid to reach an even larger customer base. The value proposition, now based on leasing the product, was also

complemented by favorable contractual conditions, faced by customers, indeed they were allowed to cancellate the binding obligation arising therefrom with a 15 days' notice, according to Chesbrough and Rosenbloom (2002). In turn, the pay-per-use configuration implemented by Haloid, translated into the company being in control of the 60% of the photocopier market and 95 % of the plain paper photocopier business around the 1970s, as suggested by Kearns and Nadler (1992).

However, such monopolistic state by Haloid had a short duration, since the Federal Trade Commission issued an antitrust suit against Xerox in January 1972 for alleged monopolization of the office photocopier market (Tom 2001). As consequence, the company was forced to rely-back on the 'razor and blade' business model and, in addition, the market was penetrated also by both IBM and Kodak (Markides, 1999). Furthermore, these latter firms decided to conquer market share by offering better products and/or better maintenance services at lower prices (Ortt, 2007), nonetheless, in such an high-end market segment, where both IBM and Kodak tried to compete, Xerox was still into a favorable position. The reason is that within said market segment products were critical, high-speed and complex-to-repair, thus any unavailability of these latter would have created damages over customers, resulting into the fact that end-users were less sensitive to an increase in maintenance service prices (Visintin, 2014).

If on the one hand, US-based firms were not a full threat for Xerox, on the other hand a concreate threat, in terms of competition, was represented by Japanese companies. As just mentioned, IBM and Kodak decided to compete with Xerox into a high-end market segment, while companies such as Canon decided to challenge the market leader penetrating into the low-end market. The success factor of the Japanese firm was to include all the photocopier's key components – drum, charger, toner and cleaner – in a replaceable cartridge (Johnstone 2004). Such an invention made it possible for basically everyone to replace spare parts and even apply simple repairs (Ortt, 2007). Furthermore, as highlighted by Markides (1999) Canon was also able to establish an innovative distribution and service strategy, where each product was distributed through a capillary network of dealers and retailers. Especially local dealers were the ones responsible for providing service and support (Boulton, 1996).

Moving forward on the timeline, during the 1990s another major innovation was introduced in the photocopier industry, which brought to a move into more servitized business models. We are referring to the transition from analogue products to digital products envisaged by Visintin (2012). As consequence products, such as photocopiers, started to be also, and at the same time, printers, scanners or fax machines in one device only (Matsumoto and Kamigaki 2013). Again, the digitalization wave that hit the photocopier industry had immediate effects, since the number of competitors in the industry increased, with firms like HP and Samsung producing multi-

function devices as well (Rogowsky, 2009) and such multi-function products became part of the customer ICT infrastructure (Visintin, 2014). In turn, the industry became more price-sensitive and therefore companies started to define new strategies for proposing value to customers, delivering long-term solutions. However, as we have seen in chapter 1, delivering solutions implies that firms shift towards more customer-oriented and relationship-based business models. Indeed, while some original equipment manufacturers in the photocopier industry have successfully applied said transition, others are still transitioning.

As we have seen so far, OEMs, in the photocopier industry, have walked a 60 years path in order to apply the transition from product-centricity to servitized business models. Said transition can be summarized through three main factors according to Visintin (2014). At first, the author refers to new and untapped customer needs, as a factor for increasing the servitization degree in the industry, since nowadays many companies utilize products such as photocopiers, printers and scanners. Especially in large organizations, the presence of so many devices translates into the proliferation of outdated or redundant devices able to increase indirect administrative and logistic costs as well as bringing paper and energy wastages. For these reasons, the author believes that paper processes have become non-core processes since photocopier manufacturers have to addresses a series of needs. For instance, a common need lies in reducing the printing environment costs of which companies are aware. On the other side of the coin, also customers need to implement sustainable business practices and thus need help in defining printing policies. Moreover, firms operating in the photocopier industry need to create a balance between allocating printing costs to cost-centers and monitor the printing volumes .

The second factor, favoriting the servitization of the photocopier business, lies into the dynamics characterizing this market. Indeed, the combination of lower sales, lower prices and shrinking margins envisaged by Brewer (2009), the declining global spending on hardware (Rogowsky, 2009) and the increasing commoditization, characterizing the photocopier industry, are other major factors pushing for the development of a regular flow of new models and types, to be attractively priced (Visintin, 2014).

The last factor involves decreasing print volumes, which is something able to drive the demand for consumables and break-fix services. According to IDC, in 2011, the total number of printed pages (3.09 trillion pages A4) decreased by 1 % compared to 2010 (IDC 2012). According to Weilerstein and Drew (2012), such a decrease was certainly due to a digitalization of the document workflow, but also accelerated by factors like generational turnover and the diffusion of smartphones and tablets. The discussion made in this chapter, regarding the role of services in turbulent times and how service-led growth strategies have been embraced by OEMs

belonging to different industries, as a way for generating more stable revenue streams, is an important basis to introduce what comes in the next sections. Indeed, a detailed discussion regarding the role of digital servitization in mitigating the impacts of Covid-19 will be provided.

3. Empirical evidences from the Italian industrial scenario

Introduction

In this chapter, the aim is that of highlighting and presenting the main evidences arisen from a research being carried out with DT-Lab. To address this issue, a series of interviews and an extended survey have been arranged and have been performed together with firm's representatives belonging to the top management team of each of the companies participating. However, before proceeding into the main body of our research, the research goals and methodology, together with previous studies performed on the same matter, will be discussed and analyzed. In the conclusive part of this chapter, languages involving the actual state, in terms of service and digital solution, in relationship with the automotive and printing industries, will be provided. The aim behind such choice is that of having an in-depth analysis regarding these two industries since, as we have seen in the previous chapter, differences in terms of service-led growth strategies and the degree of servitization being implied in both the sectors, appeared according to the reference literature. Therefore, two additional interviews have been performed, in an attempt to build up a complete picture regarding the role of services and technologies and how these can help manufacturers to be resilient.

3.1. Research goals and methodology

Before proceeding into the main body of our investigation it is worth setting some important differences, especially in terms of impacts, between Covid-19 and other major outbreaks. In this sense, we can start with the often-cited "Spanish Flu" H1N1 pandemic (1918-1920), broken out soon after the conclusion of the World War 1st and able to generate more than 500 million people infected (Karlsson et al., 2014). In these times, main sentiments towards global trade rose during and after the World conflict (Lindert & Williamson, 2003) and some studies (Garret, 2009) have even shown how, said pandemic, brought increased wages in manufacturing. Another major pandemic was the SARS-CoV (2002-2003), the first outbreak characterizing the twenty-first century. As pointed out by Viret et al. (2003), the impacts brought by said emergency were able to generate a rapid and collaborative global response to develop a vaccine. Initial differences in terms of impacts, between the Covid-19 and SARS-CoV, can be envisaged through the languages provided by Wuest et al. (2020), who ties those with the evolution of global supply chains. Indeed, while in 2002 China was manufacturing low value-added

products mainly, in 2020 they are considered as a manufacturing powerhouse by the authors, capable of providing crucial industrial components and high value-added products. Regarding, instead, the economic impacts on global economy, that SARS-CoV (2002-2003) had, different are the views. Indeed, a study carried out in 2004 by Lee & McKibbin estimated the economic impacts of said pandemic to reach a number close to US$ 40 billion, whereas Keogh-Brown & Smith (2008) suggested that the impacts were less severe than previous models predicted. Conclusively, as suggested by Wuest et al. (2020) the "Swine Flu" H1N1/09 (2009), the last recorded pandemic, had significant impacts on global trade and manufacturing. In 2009, similar measures to the ones we are actually experiencing were applied "including a two-week quarantine of potentially infected workers", the authors claim. On the other hand, the MERS-CoV (2012-2013), in spite of its higher mortality rate, had lower impacts in terms of global manufacturing, since the areas in which it developed had low connectivity with major world economies (Wuest et al., 2020).

The languages provided so far are helpful in defining a fast-changing phenomena, like Covid-19, as well as introducing the investigation carried out, provided that limited research exists on the specific impact of pandemics on manufacturing scenarios and industrial supply chains (Ivanov, 2020). The pandemic that we are facing is novel, indeed no remedies or vaccines are available and such novelty applies also to how the virus spreads and by which mortality ratios it is characterized (Gates, 2020). A series of measures and efforts have been implied in order to contain the Covid-19 pandemic, such as stay-at-home orders and travel bans. Said measures, perfectly underline how, the impact of SARS-CoV-2 (hereinafter Covid-19) pandemic on manufacturing and service activities, is still a matter of discussion even after the March 2020 lockdown in Italy.

As consequence, it is more topical than ever to reason about what we have been used to calling "next normal" since March, or how an unforeseen health crisis shall not be considered as an isolate case. Rather we shall reason taking into account health care attention and restrictions as part of our future life. In these days, many institutions, both private and public, and analysis and research companies are continuously contributing to the issue, updating projections of Covid-19's progression and questioning the consequences it will have in the lives of people and businesses in the short and long term. Overall, the national and international discussion, regarding the next normal, involves central themes namely the stabilization of remote or smart working in organizations, the modernization and digitization of industrial value creation processes, the revision and innovation of business models of companies. Provided that answering to all the questions that companies are actually making to themselves, with respect to the effects generated by the Covid-19 outbreak, is not an easy task, the aim of myself and my

colleagues of DT-Lab was that of having a deeper overview regarding the impacts that Covid-19 is having on Italian manufacturing companies, within the so-called "phase 2". More precisely, we wanted to perform a detailed study regarding the elements of strategic resilience that emerged in the phases immediately following the lockdown, with an express and specific focus, no longer on the immediate reaction to the crisis, but on the foreshadowing of how one expects the future and what one intends to do to prepare for it, in other words on the challenges of the transition to the next-normal that awaits manufacturing companies.

The research presents a series of unpublished information and data from targeted interviews and an extensive survey activity, with the aim of assessing in depth the impact of the crisis on the business model of companies and the role of digital technologies and customer services, as an element of re-reading their relationship with business and the market in the near future. In an effort to give a better overview regarding the activities covered by our research, a summary of the various stages being performed is presented below:

1. Analysis of evidence from previous research and recent publications: reflection on the data emerging from previous research and continuous comparison with a reference community of managers and entrepreneurs are the basis of the research protocol;

2. In-depth interviews with managers: in order to assess the evolution of events and the relevance of new variables and resources for companies, especially in relation to technology and services, in-depth interviews were organized through a structured protocol with a total of 17 managers and entrepreneurs of manufacturing companies, in order to frame the directions of change and structure the survey in point 3.

3. Investigation through an on-line survey: a wider spectrum survey finally involved 80 mainly medium-large companies, which provided detailed information about a number of effects of the crisis on their operations and on planning and strategic investments in technology and services in the future;

4. Evaluation and discussion of empirical evidence: the extensive and detailed material collected in the research finally gave rise to a reflection on the fundamental strategic elements emerging, in order to provide useful insights for companies.

The research has respected the utmost procedural and methodological seriousness. However, like any exploratory analysis of a phenomenon in continuous evolution, the present

research has its limits, due to the fundamental choices made by the researchers (the focus on medium-large manufacturing companies) and the need to compress the survey time (which necessarily limits the number of companies in the sample).

3.2. Previous investigations

As previously highlighted, the Covid-19 pandemic has brought severe economic impacts since customer demand, industry-related activities and general confidence have dramatically collapsed. In this sense, the International Labour Organization (2020) has estimated manufacturing to be one of the most economically impacted sectors, with many major players such as Airbus, BMW, Boeing, Ford, General Electric and Volkswagen lowering their manufacturing capacity or even closing some factories (Wuest et al., 2020). Such an emergency is particularly evident in the aviation sector, where the Airbus's CEO has defined Covid-19 as "probably the gravest crisis in our sector" (Hollinger & Woodhouse, 2020).

The languages provided in chapter 1st and 3rd with respect to the servitization phenomena – the transition from a product-centric to a service-centric business model and logic (Kowalkowski et al., 2017) – suggest that said shift has typically helped manufacturing companies to stabilize their business practices in turbulent times (Kwak and Kim, 2016). As we have seen in chapter 2nd, during the financial collapse of 2008-2009 product trades were much more impacted with respect to service trades. However, Covid-19 is alike from other disruptive events, indeed many productive and economic activities were totally or partially interrupted in a number of geographical areas during March and April 2020, especially. For this reason, Rapaccini et al. (2020) raised some questions regarding the role of services during the pandemic: "how can firms provide spare parts and components when supply chains are interrupted and buffer stocks are lacking? How can firms manage a service business model that relies on labour-intensive field service, which implies high levels of customer proximity, when boarders are closed and travel bans have been imposed?". Such questions will be addressed in the following section, where a discussion regarding the research carried out by Rapaccini et al. (2020) is provided.

3.2.1. The role of services in tackling the Covid-19 crisis: "the phase 1"

A previous research project, born from the collaboration between ASAP SMF and DT-Lab, investigated the role of services in tackling the Covid-19 crisis in the so-called "phase 1"[1]. The research shows that, while the challenges that the pandemic has brought are primarily related

[1] Adrodegari F., Paiola M., Rapaccini M., Saccani N. (2020), Reagire a covid-19 l'importanza dei servizi, Asap SMF White Papers.

to survival during the crisis and to the restart of the economy, the perception of managers is, at the same time, that in the following phases other no less important challenges await companies, asking them to evolve towards a new future. Though such a scenario appears as complex and difficult to be managed, especially due to its fast-changing nature, there is a positive and active reaction to the restart, even in the most penalized sectors, helped by a general climate of collaboration in which all the company's stakeholders – customers, suppliers, distributors, forwarding agents, competitors, trade associations, trade unions – participate in order to find a common solution. In addition, in the forced improvisation of many of the solutions undertaken during the first phases of the virus spread, the weight of previous choices to adapt IT infrastructures, to migrate document repositories, applications and office automation tools to the cloud is evident, as premises that have allowed even the most numerous staff to move to remote working in just a few days. The main key facts that can be collected from the research carried out by ASAP SMF and DT-Lab are those covering the following issues:

1. The product-plant sales business has a much more negative perspective than the services business.

2. The most advanced services are those less impacted by the crisis.

The reason is related to something we have already discussed in this issue, whereby especially service offerings based on long contractual relationships are more stable and less exposed in turbulent times with respect to other types of services. Furthermore, said solutions do not require a constant presence of the supplier, an aspect that was completely inhibit by Covid-19.

3. The travel bans translate into the fact that many companies will need to revise their field service operating model, with prospects for increased digitization and remote data-driven service development. As we have seen in the previous section, in order to contain the spread of the virus, mobility constraints have been introduced by the Italian Government. Said measures, translated into field service operations to be partially or completely stopped during the lockdown months.

4. The transition to remote working is surprisingly easy, with no apparent loss of productivity.

Another major finding proposed by the research is a 4-stage reaction model, which has been included in an international publication in a prestigious industrial marketing magazine[2] , that recognizes the progressive nature of the timescale and the evolution of the actions put in place to react to Covid-19 and build in next normal (see: Figure 16).

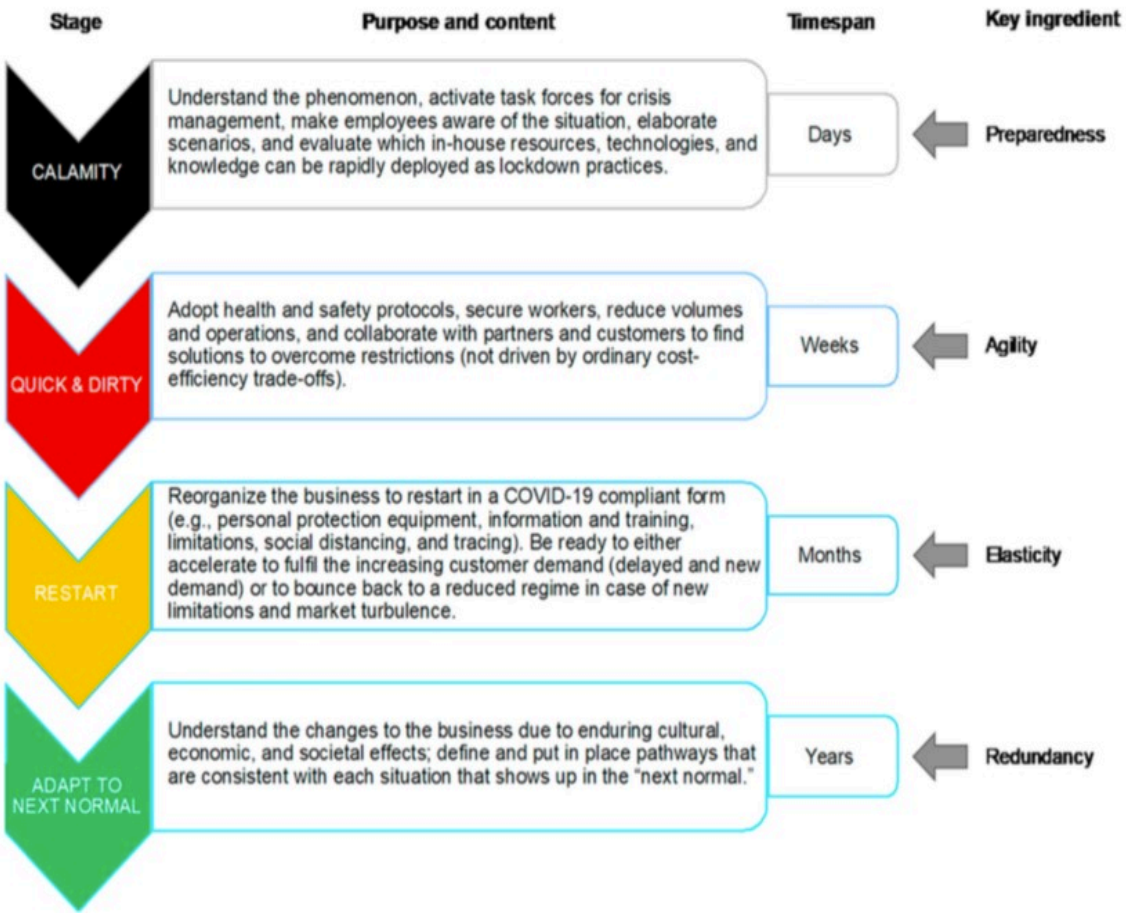

Figure 16 – *A four-step COVID-19 crisis management model (Rapaccini et al., 2020)*

As shown in figure 16, the first phase, named "calamity", involves a series of factors whose combination brings to the awareness of the pandemic in the initial days of its spread. In line with the authors, companies that appeared to be more prepared and informed regarding the emergency, thus coming up with a quick activation of task forces or predict future actions, were those having subsidiaries in China (first country to be hit by the pandemic), those providing services facing a bacteriological risk or those that already faced epidemiological situations like those envisaged in the previous section. Such players, as it is easy to understand, have developed distinctive knowledge and practices to mitigate the negative impacts that arise in force of the spread of pandemic like Covid-19 is.

[2] Rapaccini, M., Saccani, N., Kowalkowski, C., Paiola, M., Adrodegari, F. (2020). Navigating disruptive crises through service-led growth: The impact of COVID-19 on Italian manufacturing firms. Industrial Marketing Management, 88, 225-237.

However, in the immediate weeks after the break out of the virus on a world scale, a series of measures – named by the authors as "quick and dirty" – were introduced in order to guarantee some sort of business continuity. As consequence, companies had to rely on already adopted technologies and available resources, due to the fact that there was no time available to start something from zero. Such sentiments, of acting as quickly as possible, were shared both internally and externally by companies and other actors from the supply chain, thus demonstrating a distinctive spirit of collaboration (Rapaccini et al., 2020). In this sense, an interesting example, regarding the implementation of 'quick and dirty' measures by a multinational firm operating in the photocopier industry, is provided by the authors. Said organization, in order to respond to the increase in the customer support requests that previously were outsourced by the company itself, decided to adapt its staff and fulfill those needs without a contract negotiation.

The third stage, instead, is related to the reactivation of the Italian industrial businesses who could "restart" their operation from the 4th of May. However, in that days the Italian Government introduced a series of measures aimed at ensuring social distancing and workers protection. Said mechanisms had implications, especially with respect to the working environments, since it was necessary to re-think the industrial layouts, close common areas, monitoring the employees' temperatures, arrange different working shifts. The term 'elasticity' adopted by Rapaccini et al. (2020) is quite important in defining which characteristic companies had to develop in this stage of the pandemic evolution as well as in the following months. Indeed, considering the present situation of the Covid-19 in Italy (October 2020), the number of infected people is raising and, unfortunately, is scoring new records day-by-day; therefore companies are still applying the abovementioned rules and schemes accordingly with the pandemic evolution.

As far as the last stage is concerned – "adapt to the next normal" – many economists and business leaders agree upon the fact that the post-Covid 19 world will be much different from before. Overall, companies have to get ready and prepare themselves, thus adapting to a such difficult scenario and evolve in order to survive. An important aspect envisaged by Rapaccini et al. (2020) – regarding the pathway to the next or new normal – lies in the managers' positive expectations regarding the fact that Covid-19 will mark a "massive adoption and implementation of industrial internet, condition monitoring, predictive maintenance, digital rooms, augmented and virtual reality, and digital twins in services and solutions". Such latter aspect is, indeed, confirmed by figure 17, actually representing the main digitalization programs that companies will accelerate as consequence of the pandemic.

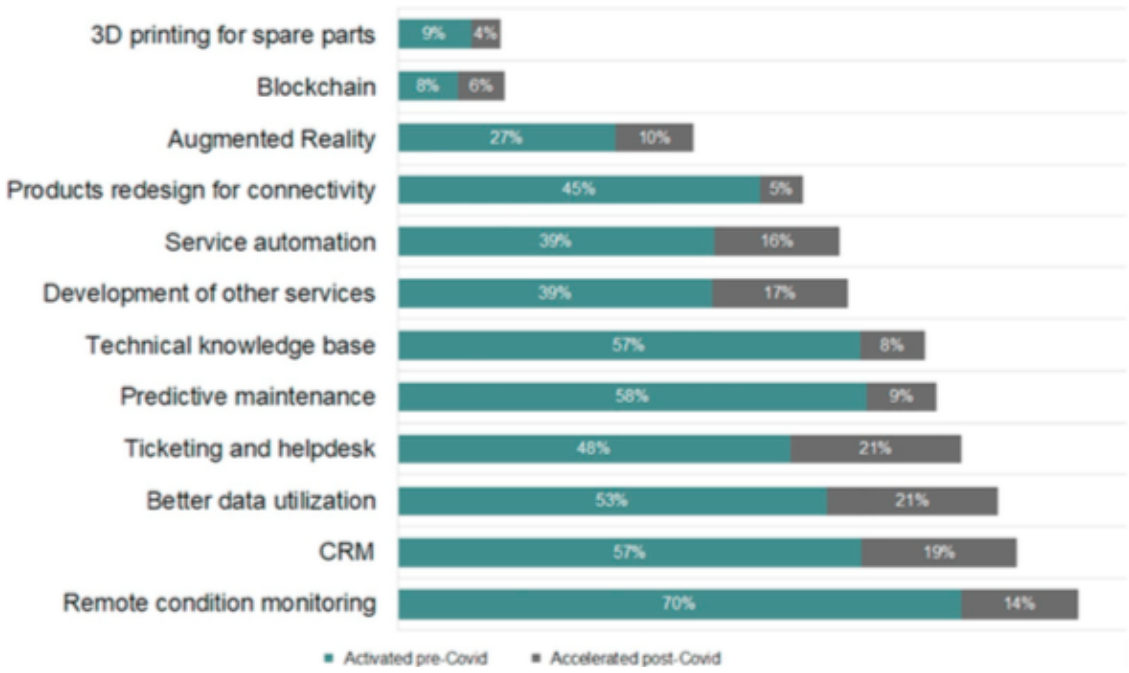

Figure 17 – *Digitalization programs, pre–COVID-19 and accelerated because of COVID-19 (Rapaccini et al., 2020)*

3.2.2. Pandemic impacts from the instant papers

The disruptive effects of the Covid-19 emergency have triggered a series of research, study and verification initiatives, that have so far mainly concerned a rapid publication of data and phenomena of the last hour, with continuous updates over the weeks. The numerous contributions and white papers consulted – published by prestigious national and international organizations – converge in stating that the digitization of products and processes and the servitude of company offers are not temporary phenomena. The evidences brought by the previously mentioned research are, indeed, echoed in surveys conducted elsewhere, which highlight the better resilience of services compared to product business during the Covid-19 crisis and, in particular, the centrality of modern forms of service, based on digital technologies. These are phenomena that – because of their ability to guarantee agility, resilience and rapid and effective response to clients' needs – are destined to redesign the business reality of the next-normal, where resilience will undoubtedly be needed, given that Covid-19's impact on manufacturing has been a drastic decline both in production [-33.8%] and orders [-51.6%] (Confinustria, 2020). Hence the need for companies to rethink their business models to adapt to this new context as soon as possible: defining their own digital strategy, guiding the company towards change, acquiring the necessary resources and skills and assessing operational (cybersecurity) and strategical (new business and profit models) risks.

The examination of the instant papers has led to the definition of some critical aspects upon which the discussion is still under development. Many companies worldwide have implemented remote collaboration systems to facilitate effective remote working and practices, in order to

guarantee their operativity. Although, in order to gain the benefits arising from scalable digital platforms as well as assuring the employees to work from their houses, some sort of digital preparedness is needed. As pointed out by major consulting firms – BCG, McKinsey, PwC, and EY – being able to ensure remote collaboration is an important prerequisite for those companies aiming to embrace an agile working system, whereby the integration of the employees' digital skills plays a significant role. In this sense, the implementation of an agile model, thus referring to the company's ability to reconfigure its structure, strategy, processes, employees and technology quickly, is a very useful assets in facing pandemic like Covid-19 (Sneader & Singha, 2020), indeed such a decentralized and flat organization is useful in times of crisis to take effective countermeasures quickly and flexibly. Provided that such approach is a major challenge for companies, especially in the short-term, many firms have already embarked on a path in this direction and now may be the right time to increase their efforts. However, designing such implementation is not an easy task, since a complete involvement from the top-firm hierarchical levels is required. Other major findings arisen by the instant papers are tied to the digital transformation.

In this sense, a series of studies carried out by McKinsey[3] have shown that, especially during the lockdown months in Europe, there has been an increase in the rates of digital adoption by companies attempting to give continuity to their business activities by using new digital technologies. In such a context, it has been found that customers are migrating from traditional to online sales channels, whereby technologies such as IoT, Cloud, AI and 3D Printing will play a crucial role in improving the management of supply operations and building the Digital Supply Network to achieve greater interconnectivity between different players and improve collaboration, efficiency and responsiveness.

Such changes will lead to a re-thinking process involving the supply models adopted before of the pandemic spread. Indeed, a study carried out by Deloitte[4] shows that global and relocated chains are more fragile in the event of crises and border closures. The 75% of companies who participated suffered a negative impact on their supply chain due to logistical restrictions, while 62% experienced delays and longer delivery times for components from Chinese suppliers. In this context, a great attention is given to the risk management activities upon which companies

[3] Baig, A., Hall, B., Jenkins, P., Lamarre, E., McCarthy, B. (2020, May 14). The COVID-19 recovery will be digital: A plan for the first 90 days. McKinsey Digital. https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/the- covid-19-recovery-will-be-digital-a-plan-for-the-first-90-days; Fernandez S., Jenkins P. and Vieira B. (2020, July 24), Europe's digital migration during COVID-19: Getting past the broad trends and averages, McKinsey Digital. https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/europes-digital-migration-during-covid-19-getting-past-the-broad-trends-and-averages.

[4] Mazzucco, U. (2020, May 7) From now on: Supply Chain Sfide e opportunità, da oggi in poi. Deloitte. https://www2.deloitte.com/it/it/blog/italy/2020/covid-19-e-supply-chain---umberto-mazzucco.html

have to spend their efforts since, as many are arguing, Covid-19 and its consequences, such as the alternate lockdown impositions, will last more than we expected.

3.3. Reacting to Covid-19 with services and digitalization: "the phase 2"

The following sections embody the main aspects that emerge from the investigation carried out with DT-Lab, in which a total of 17 interviews and 80 surveys, in the period from the end of April to the end of August 2020, have been carried out. In order to have a better overview regarding the research timeline and main events we propose figure 18. The industrial realities being interviewed are large and medium-sized enterprises mainly and belong to the manufacturing sector, deeply hit by Covid-19. The firms belonging to our sample can be defined as product-centric realities, meaning that they are focalized on physical products, where the capital goods or durable consumer goods sectors play an important role.

In order to further investigate the trends arisen by the previous research and in the readings of the pandemic, given by national and international contributions, an interview protocol has been set up for managers in top positions in industrial companies. In figure 18, we have represented a series of events, among which the 4th May is particularly important to be envisaged, since the so-called "phase 2" started here, with many production sites able to open again. However, it is better to precise that, basically, all the industrial realities who participated in the research activity were able to resume their natural business practices through giving notice to the relevant police headquarters and thus avoided to wait until the 4th of May.

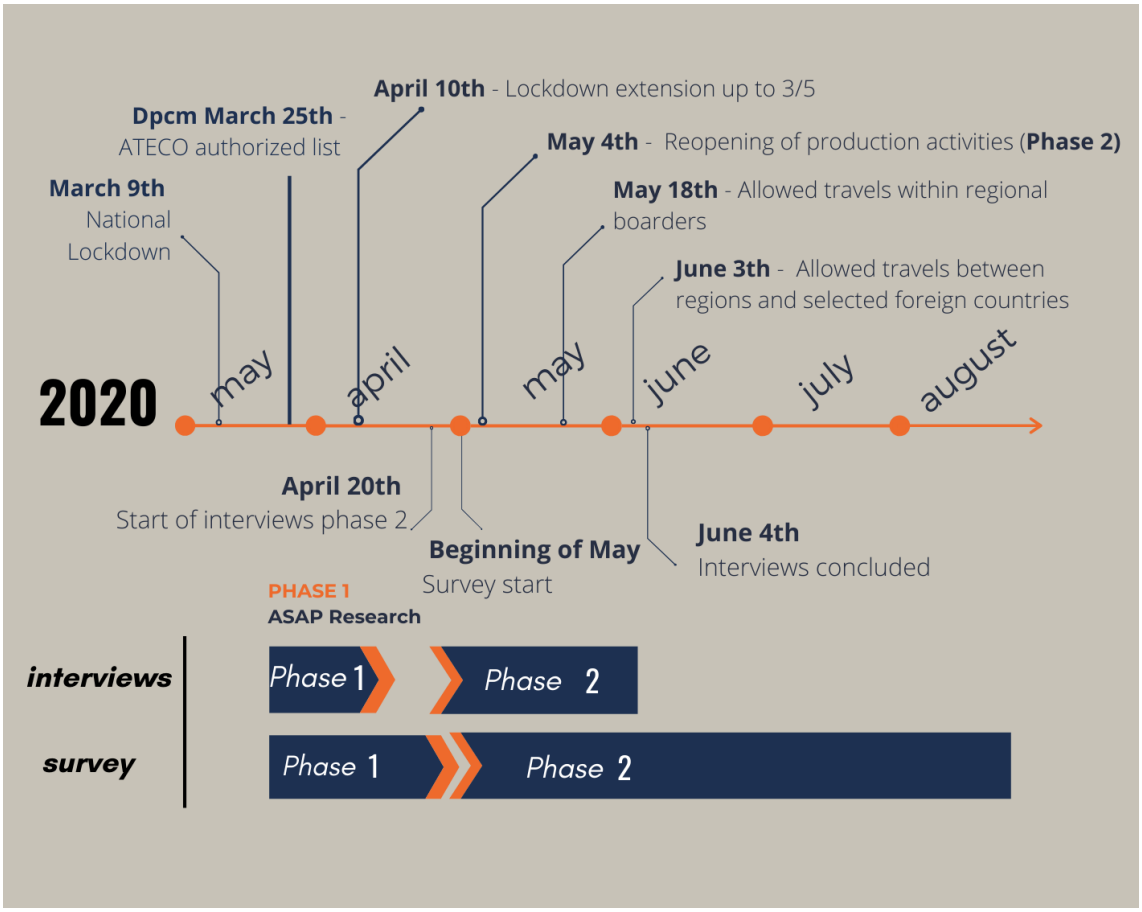

Figure 18 – *Research timeline (translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020).*

The aim of the interviews – conducted in the timespan involving the so-called "phase 2" – was that of gathering information about (i) previous phases of Black Swan and March-April lockdown and the solutions put in place to deal with the emergency and mitigate the impact of the current crisis on business (Quick & Dirty solutions); (ii) the modalities under which the reopening has been carried out (React stage); (iii) the design of changes in the operational and business models of the service offering for the future, namely: new services, a greater digitalization, risk management solution, how to be a more resilient organization etcetera (the new normal stage).

As shown in table 6, firm's representatives being interviewed, belong to the Top Management Team of companies, with particular attention to executive and managing directors, sales, post-sales and service managers of companies and Business Units that provide products and services. For confidentiality reasons the names of companies and respondents are not reported, rather we assigned codes – letters of the alphabet – to each of the firms participating in the analysis. The companies in our sample belong to different sectors, such as the construction of machinery and industrial plants (machine tools and automatic machines), the construction of equipment for agricultural, industrial and commercial use (HVAC and air

treatment, wine processes, professional catering), the production of electronic and industrial components. The sectorial distribution, characterizing the sample, is deliberately extended, so as to be able to provide a sufficient variety of indications about the different situations encountered by the companies in facing the emergency and therefore to offer various points of discussion.

	DIMENSIONS	INDUSTRY	ATECO REGIME	INTERVIEWEE'S ROLE
A	MEDIUM	AGRICULTURAL MACHINERY	PROTECTED	SALES AND AFTER SALES MANAGER
B	MEDIUM	MACHINE TOOLS	PROTECTED	SALES MANAGER
C	LARGE	MACHINE TOOLS	UNPROTECTED	IT MANAGER
D	VERY LARGE	PACKAGING	PROTECTED	IT MANAGER
E	MEDIUM	FOOD	PROTECTED	COO
F	LARGE	AIR HANDLING	PROTECTED	GENERAL MAANGER
G	LARGE	PACKAGING	PROTECTED	CTO
H	SMALL	ENERGY	PROTECTED	SERVICE MANAGER
I	MEDIUM	HORECA EQUIPMENT	UNPROTECTED	AD
L	SMALL	EONOLOGICAL TECHNOLOGIES	UNPROTECTED	AD
M	MEDIUM	MEASURING EQUIPMENT	PROTECTED	SALES AND MARKETING MANAGER
N	VERY LARGE	PACKAGING	PROTECTED	PRODUCT SUPPLY MANAGER
O	LARGE	HVAC	UNPROTECTED	BUSINESS & SERVICE TRANSOFRMATION MANAGER
P	LARGE	HOME AUTOMATION	UNPROTECTED	CIO
Q	LARGE	HVAC	PROTECTED	GROUP SALES & MARKETING MANAGER
R	LARGE	MEASURING EQUIPMENT	UNPROTECTED	DIGITAL TRANSFORMATION MANAGER
S	LARGE	ENERGY	UNPROTECTED	BTOB MARKETING MANAGER

Table 6 – *Firms Interviewed (translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020)*

As far as the turnover is concerned, the Italian companies and legal entities in our sample range between 8 and 1,445 million euros, while international reference groups invoice up to 14 thousand million euros on global markets. These are, therefore, mainly medium-large businesses for the Italian market, and also very large at an international level. The interviews were carried out between 20 April 2020 and 4 June 2020, i.e. in a scenario which, compared to that of "phase 1" of the research mentioned above – carried out between the end of March and the beginning of April – potentially presents a greater awareness of the impact of the crisis and a more exhaustive vision of its consequences and possible reactive moves, in the short and medium term.

The interview protocol is divided into four thematic sections, corresponding to the objectives and general themes introduced above. First, the respondent is asked to briefly describe his/her role in the company and some company characteristics, considered key for the

survey, such as the technological equipment at the time of the crisis and an assessment of digital readiness. The second section concerns specific information regarding the negative impact on the product and service components of the offer, the use of smart working, the role of internal organizational equipment and relations with the supply chain in defining the consequences of the lockdown. In the third section, contrarily, reference is made to the situation of the reopening business, in relation to its direct and indirect market (clients' clients), with the ultimate aim of understanding the methods, actions and level of operations with which companies are about to face the settlement/restart phase. Finally, in the last section, the focus is on the situation after the crisis, the new or next normal phase. In this context, interviewees are asked to forecast expected scenarios related to the transformation that their business is called to undertake, in order to effectively achieve the so-called new normal.

The data were collected, given the impossibility of conducting face-to-face interviews, through calls via digital conference platforms with a good level of interaction, involving 17 managers, for an average duration of about 45' and a total of about 12 hours of conversation. The interview protocol was sent a few days earlier to the interviewee in order to allow a more effective outcome of the interview. The collection and subsequent reduction of data followed the registration, transcription and coding phases, in line with the recommendations of the scientific literature on the subject (Voss et al., 2002).

3.3.1. Main challenges arisen from the interviews

The analysis of the interviews being carried out has highlighted four main challenges, upon which companies have had and will have to face on their pathway for the new normal. The *first challenge* we found, pertains the permanent adoption of smart working as a mode of work. As previously mentioned, a number of Italian Government's legislative decrees has been issued in order to limit the movement of people, thus avoiding groupings, so as to control the evolution of the pandemic. Such controlling measures not only affected people life but also business operations, since companies are asked to continuously rethink their practices and, mainly, to reorganize their workforce, guaranteeing the safety of workers and collaborators. Such overall discussion, collimated into the adoption of smart working practices for all the companies we interviewed. In this context, attitudes towards the adoption of telework logics, although varying from one company to another, are favorable in the vast majority of the sample: only companies A and C declared themselves rather opposed to the adoption of the above mentioned logics, preferring human contact (day-by-day), as a preferential lane in carrying out their business practices.

Apart from the above mentioned cases, many are the instances of entrepreneurial realities that have implemented telework logics willingly and profitably. For instance, companies F and O, who were not used to rely on such remote working logic pre Covid-19, managed to guarantee a very good operation of the company departments, avoiding the massive use of holidays or redundancy funds. In force of these reasons, such firms plan to continue to adopt such logic in the future, considering the possibility of making them an integral part of the carrying out of indirect operational activities.

In line with such firms, we can quote the words of the CTO of company G with particular reference to the introduction and adoption of video-call tools (Skype, Teams, Zoom): «an interesting thing, which we did not use practically before, because more inclined to travel and face-to-face with the customer, are the video-call tools. I think this needs to be reviewed on our part...we have noticed that a lot of things can be handled in this way. Skype and Microsoft Teams are tools that have proved to be really useful and we are particularly satisfied». On the same wavelength, are the considerations made on the topic by the general manager of firm F. Company D, which already gave its employees the opportunity to work one day a week remotely, has even carried out training activities entirely online, thus ensuring continuous training not linked to a physical working environment. The company L declared its intention to include forms of smart working and to review its organizational structure linked to the sales network. Similarly, companies B and Q, considering the advantages and comforts expressed, believe they will adopt smart working also in the medium-long term. Overall, the snapshot involving sentiments of company's representatives, regarding the adoption of smart working practices, is positive.

Another *major challenge* arisen from the interviews lies in the smart management of Field Service activities. As highlighted in the previous sections, Covid-19 is different from other major outbreaks in the human history and one of the reasons lies in the measures being introduced by governments worldwide, as to avoid its spread. Social distancing, particularly, affected field service activities – maintenance and installation mainly – and this is confirmed also in our sample. The interviews carried out show a clear difficulty, expressed by the majority of the firms, in carrying out these activities: companies C, F, O, G, D, A, B, Q, P, M and R have, in fact, totally or partially interrupted these operations. Provided that said difficulties, in supplying FSO, are related to the short term – since in the absence of future restrictions to the mobility of technicians such activities can be carried out regularly – there has nevertheless been an interruption capable of reducing the income related to corporate service.

Such losses, under a service perspective, have been mitigated by some companies in our sample that, during the lockdown, were able to digitize at least part of the above activities,

guaranteeing customer service. Company D, for example, was able to follow this path thanks to previous investments in digital technologies, aimed at a greater digitization of the internal structure and business processes: «as we were unable to move due to the lockdown, we were unable to carry out visits and service or after-sales interventions, in the presence, in our clients' production sites. However, we have made up for this, where possible, by carrying out these visits remotely with digital systems». Coherently, the difficulties encountered in providing these activities have highlighted the need to further invest in digital technologies, developing real teleservice solutions. As stated by H's service manager, the main challenge in delivering digital services is to reduce customer visits and, at the same time, ensure the quality of the service provided. Unlike the above, company A, in order to mitigate the difficulties encountered in providing these services, has decided to resort to an alternative (or complementary) strategy to digitization, entering into agreements with local third parties, in an attempt to assist even geographically distant clients.

The *third challenge* arisen from the interviews involves the rethinking of supply and distribution chains, an aspect largely covered by the instant papers as well. According to this topic, the company O expresses the need to shorten the supply chain, pointing out that the presence of many intermediaries in between and their closures were elements that could further hinder activities, already compromised by the lockdown. Company H, while not currently facing any obstacles along the supply chain, expresses great uncertainty as to the capacity of its sector to withstand the impact of the crisis and the possible future changes that the pandemic could bring to the supply chain. Similar concerns are confirmed by companies A and M, regarding the decentralized supply model. A different interpretation is given by companies G and D, which share almost similar visions and strategies. The former believes it should continue to invest in the opening of foreign branches, using a local-for-local business model, which has proved effective in mitigating the impact of the pandemic. The second, exploits an internationalization strategy through which it has managed to be close to the end customer, also benefiting from optimal supply management and guaranteeing the operational continuity of its worldwide activities.

The *last challenge* involves the future – critical – role of digital technologies. In this section, useful insights were provided by the companies' representatives which, overall, suggest how important digital technologies will be in the pathway that companies are undertaking to the next normal. In line with such premises, we can quote the words of the company I's CEO, who started the speech, asserting that the most digitized companies were able to respond better to the pandemic and proceeded arguing that: «digital technologies play a key role in managing the pandemic by ensuring the continuation of business activities, minimizing their impact and

making it easy and immediate to deal with customers and suppliers». The G company's point of view is similar: thanks to its IT equipment (ERP systems, Cloud platforms, VPN), it has been able to quickly reorganize business practices and guarantee their operations. Similarly, company D was able to count on a series of well underway digital projects, which proved to be a fundamental basis for the development of new and innovative solutions during the pandemic. Accordingly, D's digital manager stated that: «this period was also propitious for the development of new solutions that can also be evaluated at the end of this emergency. In this way, the company will increasingly move in the direction of becoming a real 'smart factory'».

Moving along with such a discussion, thanks to previous investments aimed at increasing the agility of its internal structure, the Q company has been able to effectively implement the logic of smart working and adapt quickly to the new emergency context. In the same way, companies B and D have guaranteed remote assistance to their customers. Especially these latter aspects, highlight that companies who performed investments aimed at increasing their digital preparedness, where those more prepared with respect to others. As consequence, the issue of digital readiness is central to the discussion on the resilience of companies and is also linked to the technologies inherent in the product-service system. Not surprisingly, several companies in the sample will continue to make technological investments in order to develop offers related to the product-service system, so as to meet the needs of the customer even in uncertain periods like the actual pandemic is. In this regard, the general manager of the company F declares: «in the service we have a tool that has been very useful, allowing us to connect to the customer's products through IoT technologies, to do remote monitoring. This technology is something we will focus on and sell even more in future».

In line with F, there is G company who will continue to make investments in remote-condition monitoring, as pointed out by the CTO: «all our machines can be fully supervised remotely, and on this we have improvement and implementation plans that already existed pre-covid, it was all already part of our development initiatives, and that certainly have not lost importance now...». The service manager of H company suggests that they will invest more in tools capable of informing product design: «we will certainly continue to push on tools about the use and analysis of data, so that we can better respond to customer requests». Such a discussion is further extended by D company who believes that one of the most promising technologies to invest in future is 3D printing, which would allow the firm to print the necessary spare parts locally, avoiding some of the supply difficulties that emerged during the current pandemic.

3.3.2. Data from the empirical analysis: the survey

As previously mentioned, the survey "Reagire al Covid-19 con i servizi e la trasformazione digitale"[5] was carried out in the period June-August 2020 and involved the top management team of the 77 manufacturing BtoB firms who participated. To all the data collected were assigned codes, in order to have a precise representation. As far as the dimensions of the firms are concerned, our sample is composed by both small to medium-sized enterprises – between 10 and 250 employees – and large enterprises with more than 250 employees (see Figure 19).

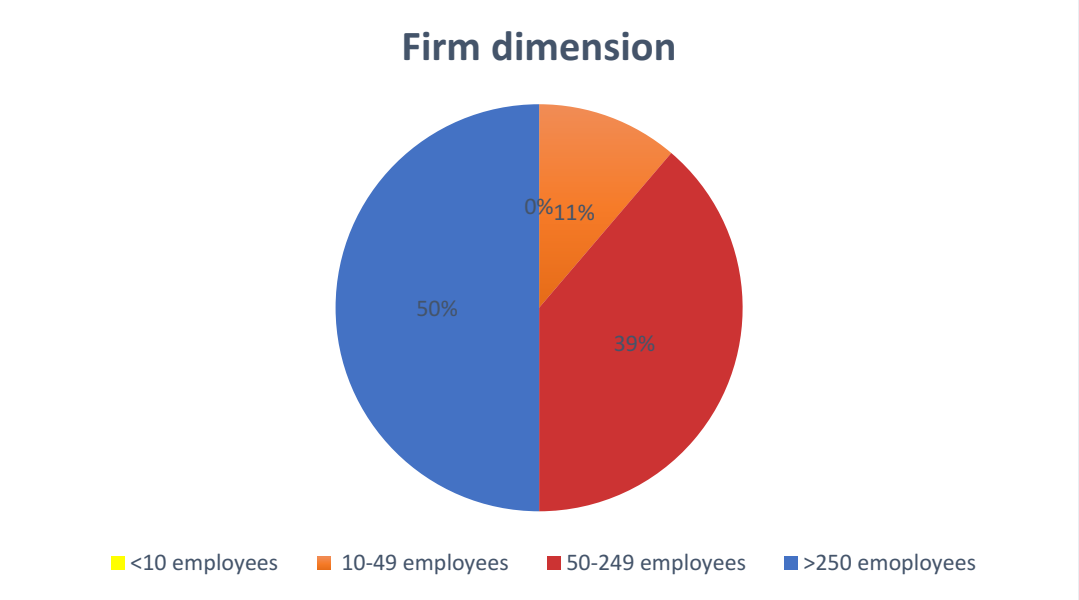

Figure 19 – *Firm dimension* (*translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020)*

Regarding, instead, the distribution of the companies in our sample (ATECO code) we have that the 74% of the firms belong to the machinery and equipment manufacturing sector (of which 10% are food and beverage machinery), 5% are involved in the manufacture of metal products (excluding machinery and equipment), while 7% are involved in the marketing of wholesale products (excluding motor vehicles and motorbikes). The remaining 14%, refers to companies that operate into BtoB contexts such as the manufacture of plastic or leather products to purely maintenance and repair activities (see Figure 20).

[5] DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020

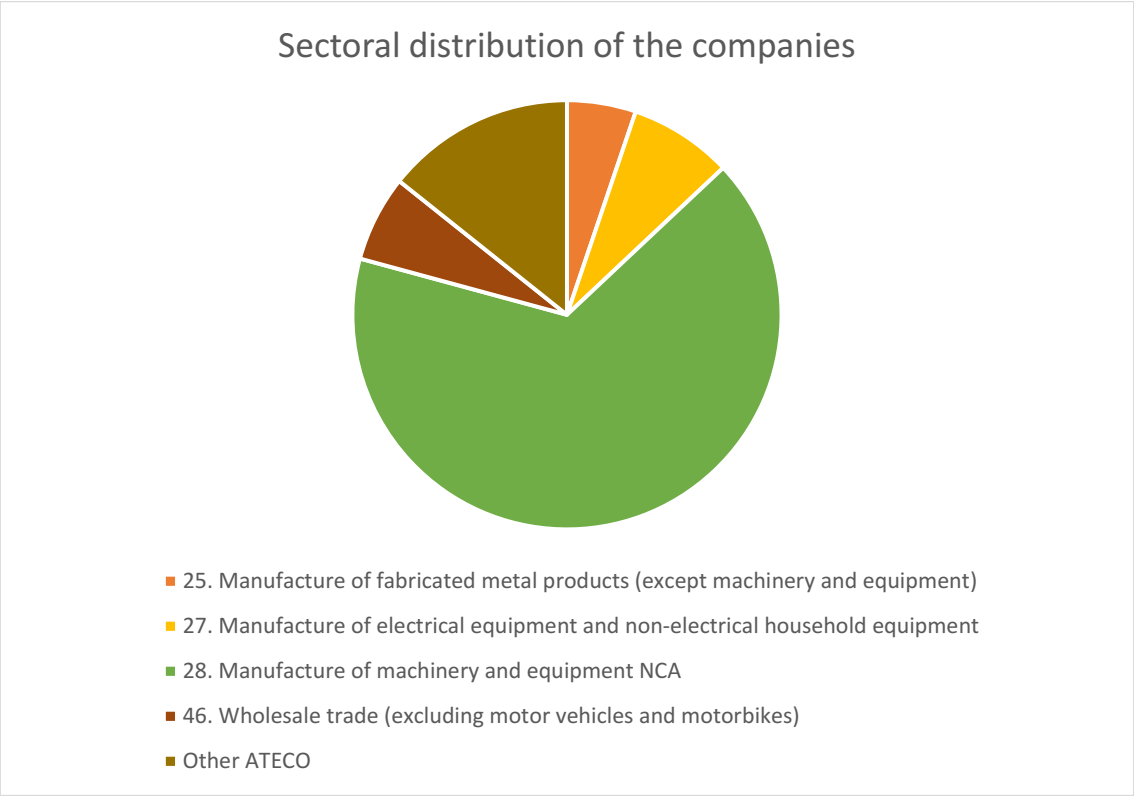

Figure 20 – *Sectoral distribution of the companies* (*translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020)*

The survey being carried out is composed by 4 sections, each made up by a vast number of questions, in order to have a useful overview regarding the different topics. In the first part, we analyze how the offer of the company is made and which is the organizational-technological structure adopted, including the degree of services and the level of digital technologies available to the firm.

Regarding the role of services, we can argue that the majority of the firms composing our sample provide the so-called product life-cycle services (PLS). As we have seen in chapter 1st, these are product-oriented services, whose aim is to facilitate the product usage. Example of PLS services provided by firms in our sample are product warranty (85%), sale of spare parts (82%), online documentation (80%), and product training activities (87%). Moving forward, we have seen that more complex services – the so-called process support services (PSS) – are not so diffused: consultancy related to other companies' products (11%), assistance and support to both marketing processes (21%) and R&D processes (35%). The same holds for solutions and revenue models linked to innovative aspects, such as cradle to cradle circularity models – with used take-back and end-of-life recycling – and those based on product-service-oriented systems – pay-per-use or performance – that are still rather infrequent. However, data suggest the importance of modern value proposition elements, linked to remote condition monitoring and digital technological retrofitting of products, the use of e-commerce platforms in the

relationship with the market, the implementation of maintenance services based on data analysis which tend to be predictive.

Additional considerations can be done around the degree of organizational coordination between product and service. In this sense, the sample analyzed is made by firms having a traditional approach, with a high integration of service activities – from spare parts to field services – with the product function. Indeed, we noticed that for the 56% of the firms, all of the service activities are carried out by the same BUs that develop the products. Still, said circumstance is counterbalanced by the respondents' sentiments regarding the role of services in the offer and their contribute to the company's turnover. In this case, the 55% suggests that there is ample room to expand services in their firms and the 60% of the firms participating have a turnover in services that contributes less than 20% to the total business. The aspects envisaged so far are represented in figure 21, where a plot shows the services offered by companies, in descending order of frequency.

Figure 21 – *Services offered to customers* (*translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020)*

As far as organizational-technological aspects are concerned – especially in terms of digitalization – almost all the firms in our sample utilize hardware-software equipment (92% and 97% respectively). In this sense, most of the industrial realities rely on office automation tools for supporting their business practices – Ms Office and Suite Office 365 – and platforms

for remote meetings such as Skype, MS Teams and Zoom. Another technology implied by the majority of companies (88%) is cloud systems both for data and document sharing (Google Drive and Dropbox). The same holds for enterprise resource planning (ERP) systems accessible through VPN, indeed the 79% of the firms adopt such a solution. This latter aspect resembles what we found during the analysis of the interviews, whereby basic digital equipment enabled companies to quickly adapt their workforce thus shifting to smart working practices.

Considering advanced computerization systems for processes, the picture that can be drawn up is different from above, since such technologies require substantial investments. In line with our data, the systems to be less utilized are those for the management of the Field Service Organization (22%) and solutions for data analysis and Artificial Intelligence (28%). Referring to the adoption of Intern of things solutions, the results have shown a 53% of sample actually implying IoT systems for the connectivity of product sold, whereas the 28.6% implies solutions of Industrial Internet of things. Surprisingly, one in four companies in our sample (26%) utilize dedicated platforms for e-commerce purposes, in business-to-business. Also in this case, figure 22 shows the hardware-software technology solutions in descending order of importance.

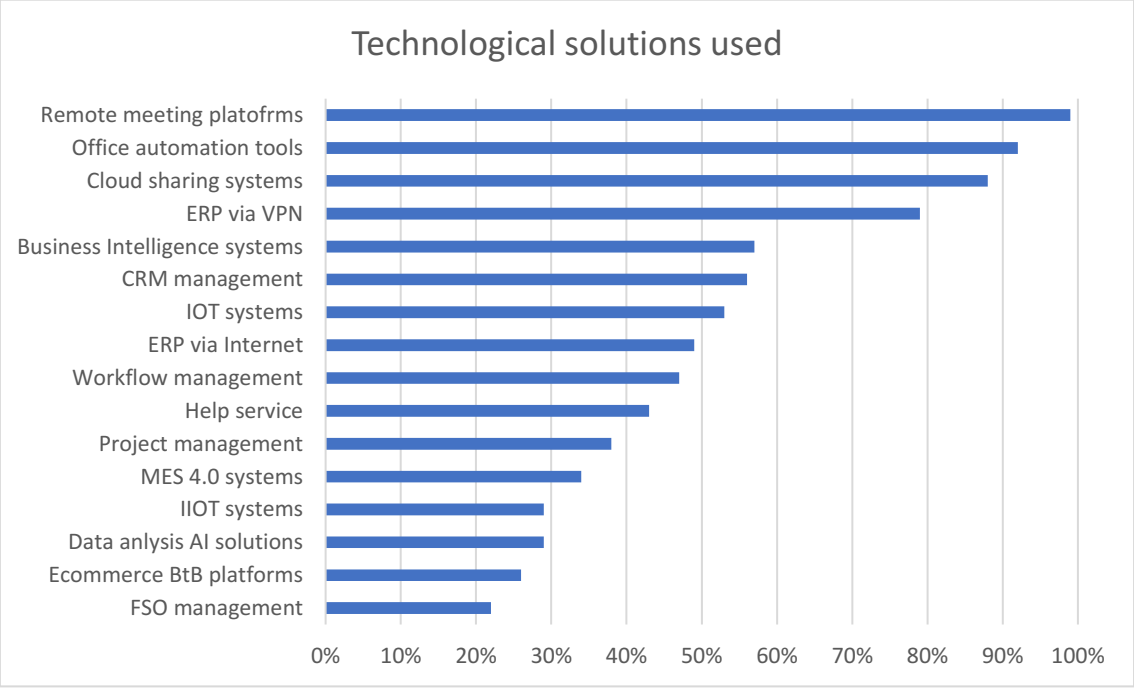

Figure 22 – *Technological solutions used (translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020)*

In the *second part* of the survey the impact that the restrictive measures have had, on the various company businesses, is analyzed in detail. Of the 80 companies that responded, 55% had to close as a result of legislative decrees. Of these companies, 90% closed once, while 10% had to close and reopen more than once. The average closure time was between 2 and 4 weeks,

depending on when the companies were able to reopen, following the different ATECO codes of regulations. The impact of Covid-19 on the firms participating has been quite important, indeed, data suggest an average loss between 25%-50% for production activities, orders, maintenance and repair services, and between 10%-25% in turnover of spare parts and all the other service categories such as contract, training, financial, rental and advanced ones.

However, it is quite clear how much the whole after-sales area suffered decidedly less with respect to the product area, starting from the spare parts business, passing from rentals to maintenance contracts and advanced services. Said differences, arising between products and services, areas are probably due to the different duration of the impacts that such areas suffered. Indeed, as we have seen in the previous sections, services like maintenance, installation and repair have to face impacts that can be reconducted to the short-term, since these activities have restarted once the restrictive measures were aborted. In turn, companies shall be more likely to recover in these businesses than they are in product areas, since the impacts have been lower or are tied to a short-term span. However, in figure 23 we have a graph actually showing the impacts of Covid-19 for different business dimensions, in line whit what just argued.

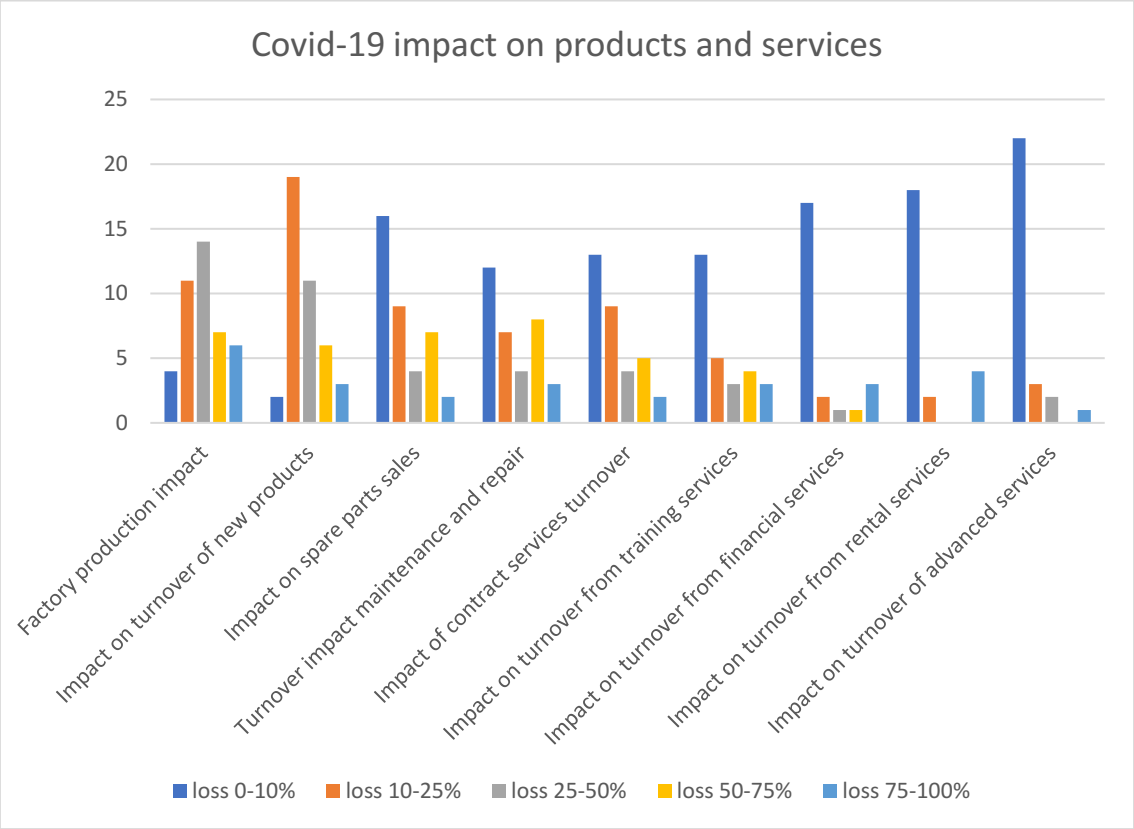

Figure 23 – *Covid-19 impact on products and services* (*translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020)*

The third part of the survey - which we would like to remind you was conducted in June, July and August, when all the companies interviewed had already resumed their activities - addresses the theme of reopening, which together with the construction of the next normal, is

the specific focus of the research. Here, the analysis of data has created room for looking at the relationship between Covid-19's impacts and the role of digital solutions. In this context, through analyzing the challenges of implementing and maintaining the investment budgets, planned in the pre-crisis period, we found that slight delays are expected due to the pandemic on the implementation of 4.0 technologies (from IoT-IIoT, to AI, Robots, VR, 3D printing), while the digitization of internal processes does not seem to be affected, which, as seen before, has played a fundamental role in responding to the emergency. In terms of costs, the solutions and changes implemented to deal with the crisis are of a medium-to-relevant level in 72% of cases, whereas they are of a limited level in 28% of cases. Such percentages suggest that the crisis has awaken companies from their resistance, in terms of getting committed to investments, in both technology and digitalization.

The previous considerations are completed in the fourth and last part of the survey, which aims to understand if and how the reaction to the crisis can accelerate the digital transformation, the one towards services and in supply chain relations as strategies to face the next-normal. One of the main opportunities brought by such a difficult moment is to overcome the cultural barriers to digitization, still existing within companies, and indicated as a real prospect by about 80% of companies. Even stronger (approx. 85%) is the perceived opportunity to introduce new services in the offer: here we note that the proportion of respondents who consider the time to introduce new services (38%) is double that of those who consider it very suitable for the introduction of new products (19%). One company out of 4 (23%) also considers the time highly suitable for entering new markets, thus reaching diversification. Conversely, the most real perceived threats relate to the risks of market contraction and uncertainty related to the new mobility. An overview regarding the abovementioned percentages is provided in figure 24.

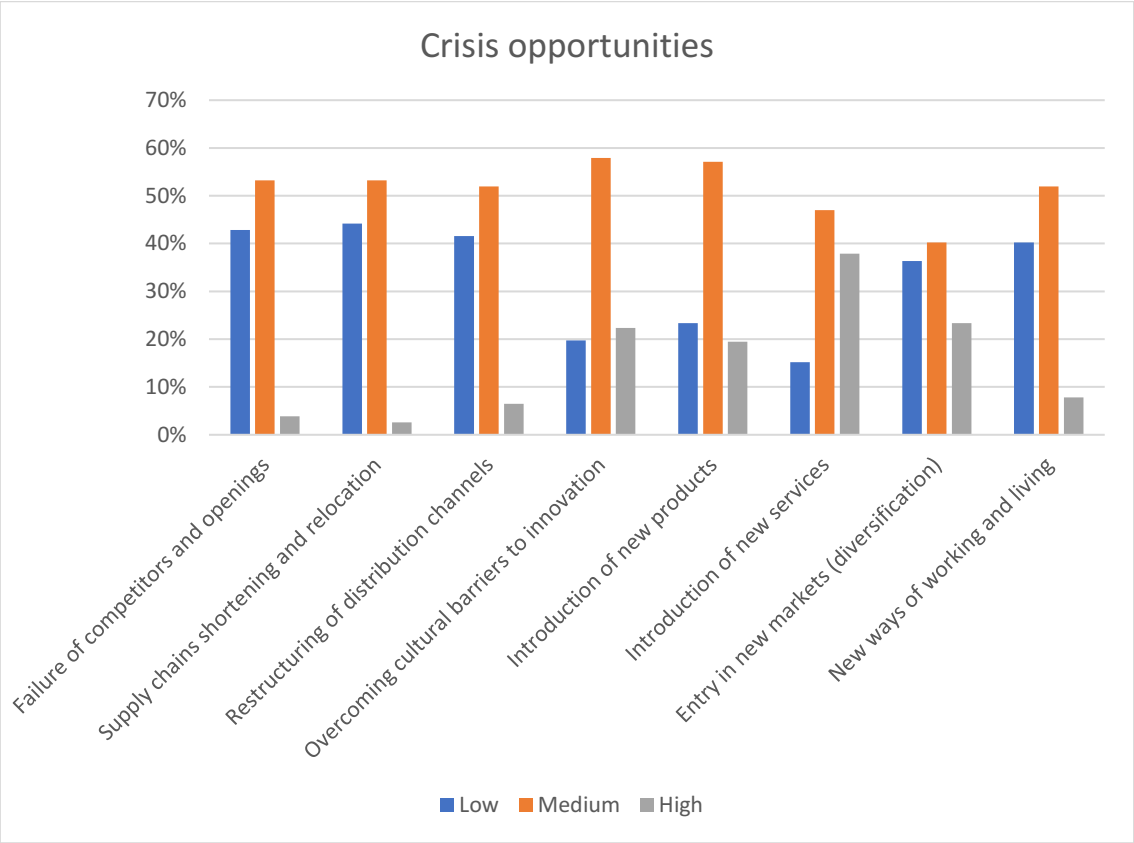

Figure 24 – Crisis opportunities (*translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020)*

With regard to future digitization processes (see: figure 25), one of the most active areas of investment are data analysis and Artificial Intelligence solutions, with 13% of companies planning to carry them out by the end of the year, and 28% in the future. Furthermore, in the near future investments are also planned for CRM management (25% of companies) and for factory 4.0 MES systems (22%). We are still far from hearing from our sample specific investments in FSO management solutions and BtoB e-commerce platforms.

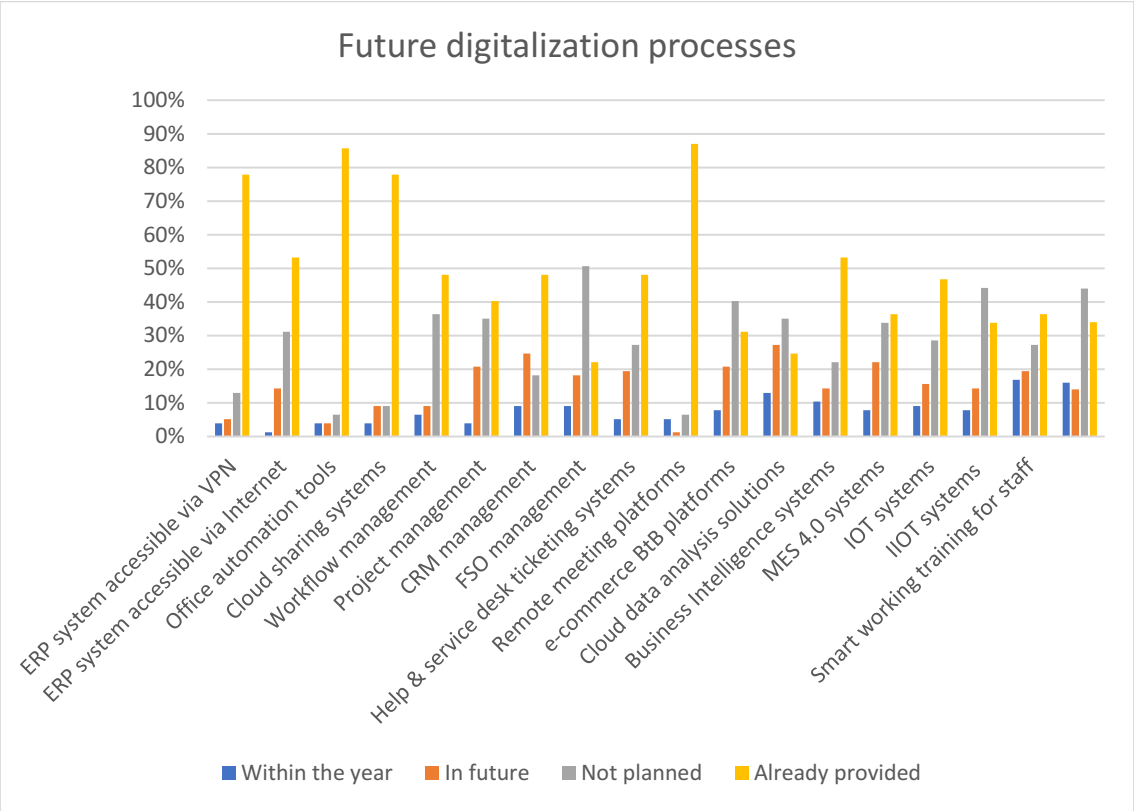

Figure 25 – *Future digitalization processes* (*translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020*)

With regard to after-sales services, spare parts and field services - see fig. 26 - the structuring of the technical knowledge base is the most priority initiative to be carried out by the end of the year (16% of companies). In the future there are also initiatives relating to predictive maintenance, by the 45%, and the use of AI and ML for better customer service by the 38% of the sample. A good part of the companies in the sample already have remote control of products distributed with IoT systems (47%) and ticketing and helpdesk systems (51%). The use of 3D printing for spare parts does not appear among the priorities (not foreseen in 73% of cases).

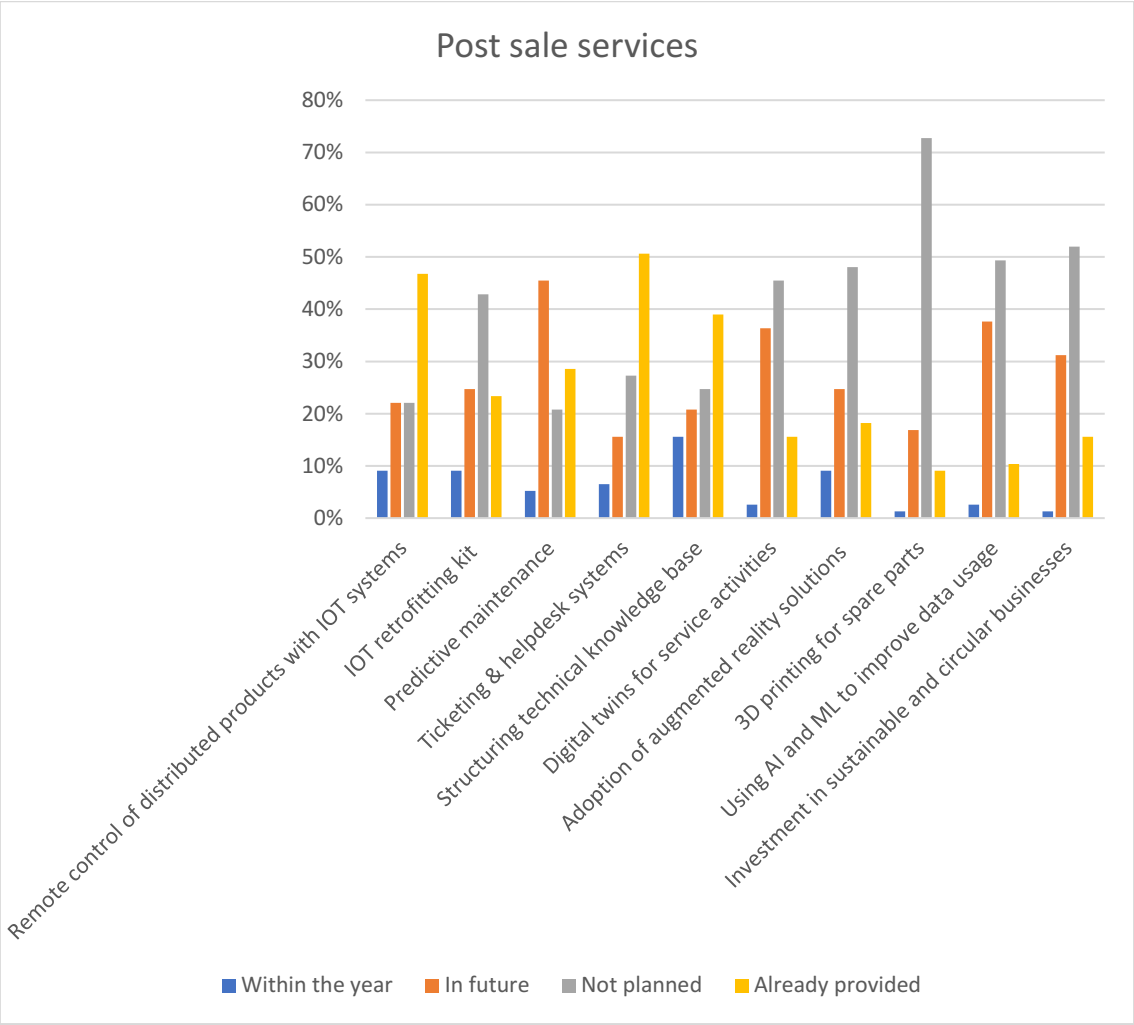

Figure 26 – *Post sale services* (*translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020*)

Another major area of interest – represented by figure 27 – on which languages have to be spent is the product-service system, where the 50% of companies in our sample aim to increase the service component in the offer. More precisely, the 20% defines such initiative as urgent and one in three companies has addressed this strategy in the recent past. Furthermore, the 51% of the firms will increase the offer of complete product-service packages, such as full-service contracts or advanced maintenance contracts. Of these firms, the 12% will adopt such solutions within the year. Conclusively, the 13% of the companies will implement urgent changes in pricing and service revenue models within the year, whereas the 31% intend those as future commitment.

Interestingly, what we found is also the need to operate in the mitigation of client business risks. In this sense, more than half the sample does not consider it, but almost one company out of three thinks it is something to face in the future. In turn, we can argue that the perception of the crisis, as part of a next normal, is perceived as real by a significant number of firms.

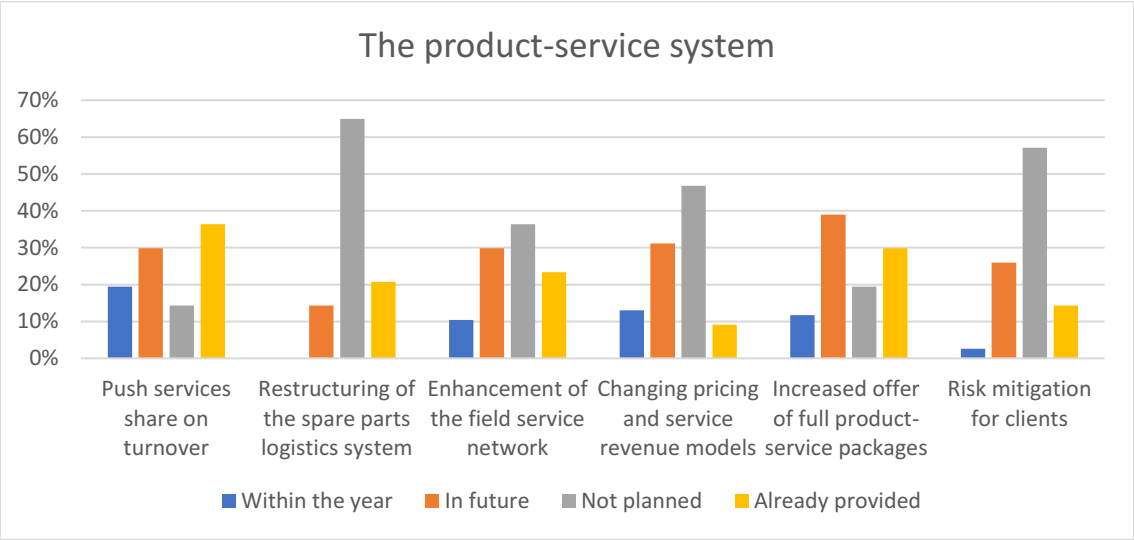

Figure 27 – *The product-service system* (*translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020*)

An interlocutory picture (see figure 28), regarding evolved and digital initiatives is, instead, envisaged with regard to the relationship with the market and the commercial network. On the one hand, two out of three companies declare to make use of social tools for corporate communications, on the other hand some crucial aspects for the firms' future have to be discussed. Indeed, if the search for and recruitment of specific commercial figures for after-sales services and the investment in the training of figures for complex services are not foreseen by a significant part of companies (39% and 29% respectively), it should be underlined that the same initiatives have already been addressed by almost as many companies (33% and 28% respectively). Moreover, it is worth noticing that training initiatives dedicated to commercial figures tied to the after-sales and complex services are, in any case, considered a strategic choice – certainly to be tackled in the future – by 43% of companies (one out of five considers it urgent).

Service automation projects such as web portals and chatbots, as well as the introduction of distant selling tools such as e-commerce – although they do not concern the future of a significant number of companies (28% and 48% respectively) – are objectives that, if not already addressed, are very clear in the future of an equally significant number of companies (45% and 36% respectively). In this sense, we found that investments in service automation systems is a very short-term prospect for almost one in five companies.

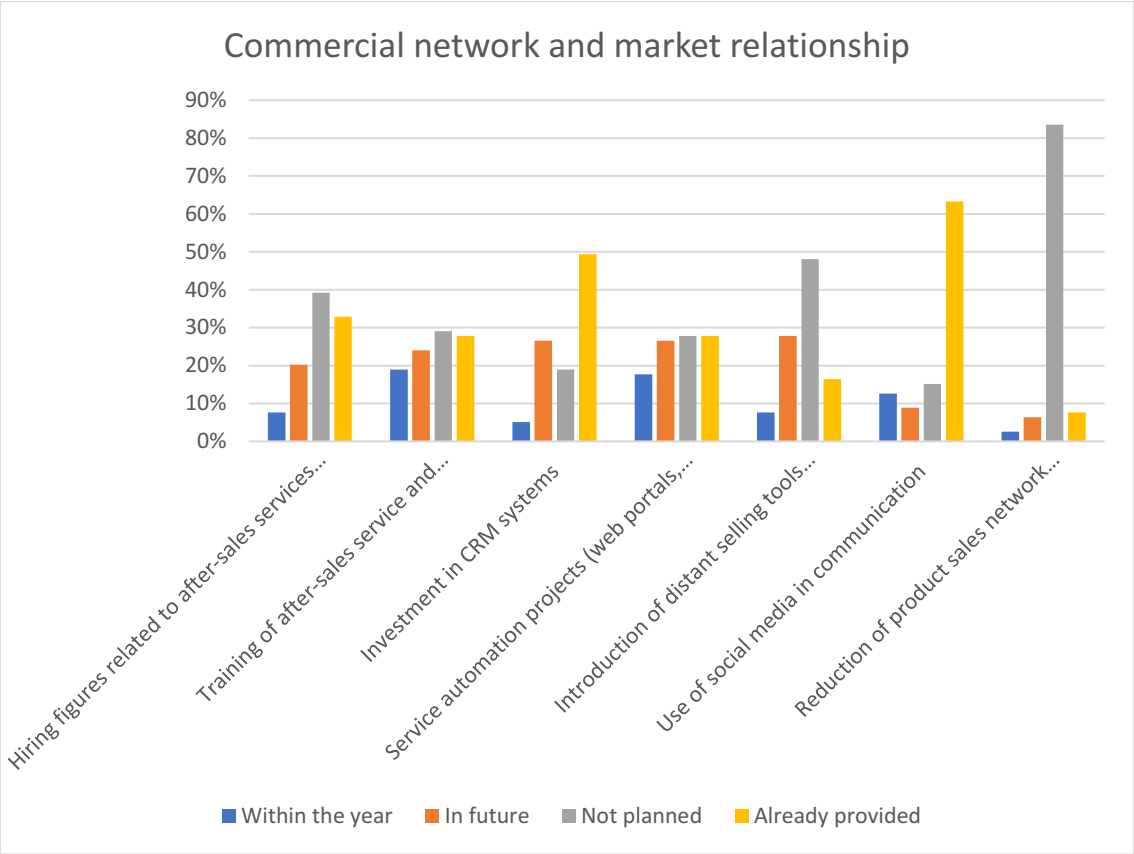

Figure 28 – *Commercial network and market relationship* (*translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020*)

The abovementioned investments will performed implying a budget lower than 100.000€ for the 40% of the sample. The subsequent 35%, will allocate a sum between 200.000 and 300.000€, while a significant 21% will allocate a sum higher than 500.000€. As it is easy to understand, Covid-19 plays an important role in terms of impacts pertaining budget choices, with almost 40% of companies stating that at least 25% of the responsibility for the levels of this budget is due to the current pandemic.

However, as shown in figure 29, the number of companies stating that investments expressly due to the emergency represent less than 10% of the budget is 62%, i.e. almost two companies out of three; this testifies that the process of modernization, servicing/digitization and digitization has become part of the ordinary mindset of manufacturing companies, even regardless of emergencies.

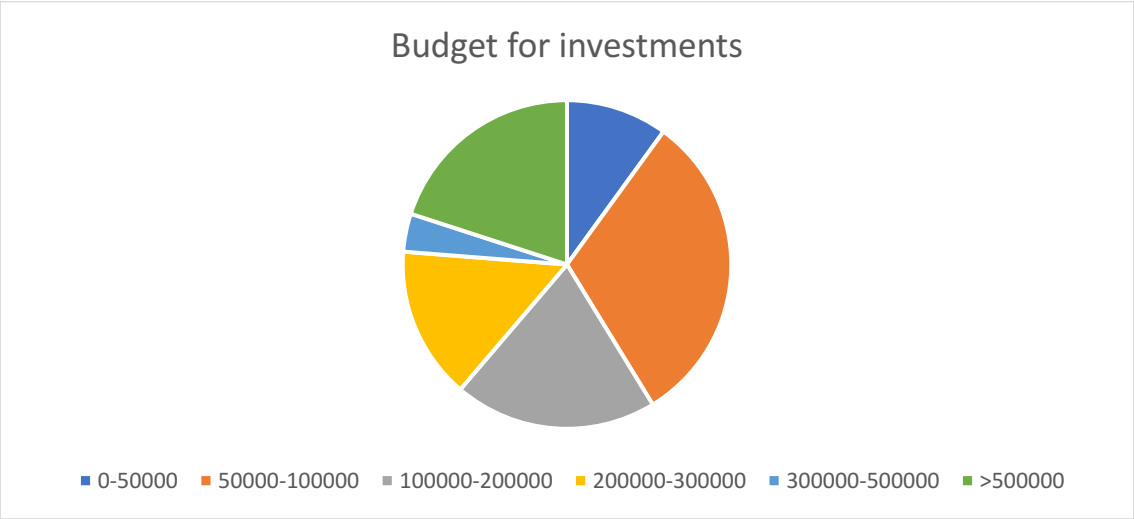

Figure 29(a) – *Budget for investments* (*translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020)*

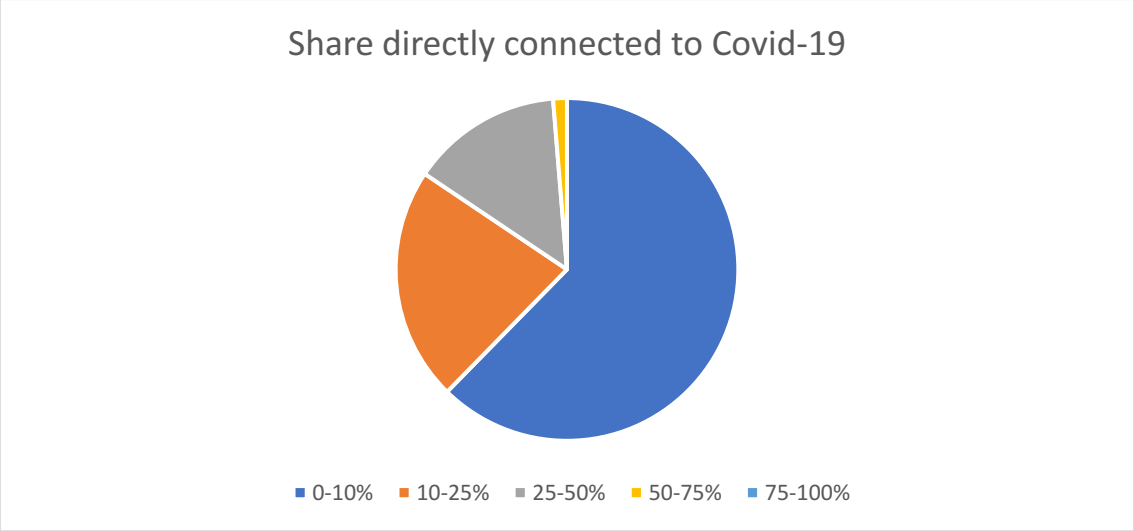

Figure 29(b) – *Share directly connected to Covid-19 (translated from DT-Lab report: Costruire il post Covid-19 con i servizi e la trasformazione digitale, 2020)*

3.3.3. Conclusions and implications

A series of data and information, arising from a complex investigation process, involving manufacturing enterprises and how these are reacting to Covid-19, have been presented so far. In this concluding section, further languages shall be spent in order to compare the results from the so-called "phase 2" and those emerging from previous research, in particular the one born from the collaboration between DT-Lab and ASAP regarding the "phase 1", together with the analysis of the instant papers as presented in the previous sections.

The first aspect to be mentioned, pertains the importance of technological and organizational preparedness by firms. In the "phase 1", such a characteristic had an impact in terms of emergency plans and the organization of the activities to be undertaken in the event of a crisis. In this sense, firms who already had these plans could quickly adapt themselves, in an

attempt to fulfil the needs introduced by Covid-19, thus gaining valuable time to move immediately to the operational phases. In the "phase 2", instead, preparedness sounds more like stabilization and adaptation to the new situation of working methods, that are no longer strictly emergency but with connotations of stability and continuity in the procedures and operational mechanisms of the company, both internally and externally.

The second aspect to be envisaged involves the role of technologies and services, as instruments able to improve the firm resilience. The interviews clearly show the centrality of product connectivity technologies in enabling customer services and maintaining contact with the market during the acute phases of the crisis. As consequence, the digital transformation of companies and connectivity technologies – IoT, Cloud computing and data analytics – are enablers of building a more resilient enterprise. Provided that such a shift is not a task that can be carried out overnight – as it implies a restructuring activity in terms of processes, products and systems – we still believe that this is the right path to be undertaken. In doing so, companies may rely on skills and resources that they already have or that are already available, for instance the through leveraging on data arising from the present installed base and rely on retrofitting campaigns or software upgrades. In this sense, the role of data changes the way in which products can be designed, thus making them more suited to the needs of the client and be an effective basis for the provision of services today and in the future, thus enabling companies to gain an effective advantage.

Moreover, the data, collected and analyzed from the survey, show that manufacturers are willing to expand the service component in their value proposition, thus entering also into high-complexity offerings. Said shift is a journey to be made together with digital technologies, that can automate and make scalable a whole series of reporting, monitoring and remote control activities that, until recently, had to be carried out discreetly and specifically on the territory. The abovementioned technologies allow a series of activities from remote condition monitoring, to predictive maintenance up to assistance or remote updating interventions in a completely unmanned way. On the other hand, the difficulties that have been faced by firms in delivering field service tasks could be mitigated through making investments in terms of tele-service. According to this logic, a solution lies into leveraging on augmented reality and 3D printing: the first enables the firm to perform distant assistance, thus reducing the need to have a technicians on-site; the second can avoid the risk of remaining without spare parts due to a lockdown imposition or closings, thus enabling the firm to print itself the necessary part.

Conclusively, the investigation being carried out has highlighted how Covid-19 acts as accelerator of digital and service projects. One out of five companies in our sample will allocate more than 500.000€ to make investments in digital transformation and services. However, we

have to underline that it is not only a matter involving technologies and services, since what is also highly needed lies in the concept of organizational culture. In this sense, those belonging to the top management team of firms shall actively engage with strategical decisions and setting up the necessary directions to be taken by their firms.

3.4. Use-oriented and outcome-oriented solutions: an in-depth analysis

In the conclusive section of chapter 2nd, languages regarding the role of servitization within the automotive and photocopier industries have been provided. However, the analysis made has created room for evaluating some differences, arose between these two industries, involving the adoption of advanced services such as pay-per-use or pay-for-performance. Therefore, in this section languages will be provided in an attempt to define why the automotive sector is still struggling to introduce result-oriented solutions, whereas the printing industry already provides such offerings. In order to address said interrogatives, two interviews have been carried out, with two different professors and experts, respectively in the automotive and printing industries, in order to estimate also where these sectors are moving to in terms of service-led growth strategies as well as trying to define how said advanced service strategies can be transferred also to other industries. The interviews were carried out during the month of October 2020 – 12/10 automotive and 26/10 printing respectively – and have a total duration of 1 hour and 2 minutes. Also for this kind of investigation, the interviews have been kept virtually, due to the pandemic, and have been literally transcribed.

3.4.1. Service-led growth strategies in the automotive sector

A major doubt arose with respect to the service evolution in the automotive industry, from the lecture of the research paper :«The Automotive Industry: Heading Toward Servitization in Turbulent Times[6]». In particular, what was interesting to be investigated involves the reason for which OEMs, in this sector, are still facing difficulties in providing result-oriented offerings to their customers and consequently – since the paper was published in 2014 – the aim was to determine whether the situation is still unchanged in 2020. To address such interrogatives, an interview with Professor Paolo Gaiardelli has been carried out. The first interesting aspect arisen from the discussion, involves the definition of the automotive, as a sector who, according to Gaiardelli, includes not only automobiles but also heavy and light trucks. Thus, referring to the automobile share of the market, we can argue that this is a business-to-consumer industry where the end user is a person and not another company. However, Gaiardelli suggested that in the automotive sector, customers are increasingly seen as so-called "large fleets". Therefore,

[6] Gaiardelli, P., Songini, L., & Saccani, N. (2014). The Automotive Industry: Heading Towards Servitization in Turbulent Times. Servitization in Industry, 55-72;

the operator who interfaces with the seller, the one who supplies the product, is always more business than in the past.

A different matter applies in the commercial vehicle sector, especially heavy vehicles, where typically reference is made to a business-to-business context. In this sense the commercial vehicle is seen as a real business tool, because trucks, rather than vans, meet different business needs. What the car market and the market for heavy and light commercial vehicles have in common is the difficulty in proposing solutions that aim at the result, because of the characteristics that the products have, indeed Gaiardelli suggests: «therefore, having to think of a business model based on results-oriented solutions is still difficult to implement today». If, on the one hand, result-oriented offerings are not yet implemented in the sector, usage-based business models – car sharing, carpooling, renting – are increasingly being used, since these solutions enable customers to engage with long-term rental solutions and, in turn, to avoid vignettes and insurance. As consequence, said solutions represent a concrete opportunity for customers to better and more easily manage their activities. In a business context, instead, pay-per-use solutions provide better cost control, because customers pay an instalment and are aware regarding the fact that it is all included, thus can control all the costs associated with the vehicle management. Another interesting aspect envisaged by Gaiardelli – which in 2014 seemed to have little appeal and difficult to implement in the BtoB sector such as heavy vehicles and which is finding a wide application - is long term rental for heavy vehicles as well. This solution was already implemented in the so-called light commercial vehicle sector, such as the Ducato.

The discussion, then, develops on the role of technologies in the automotive sector and which are the opportunities under a service perspective. According to Gaiardelli, product innovation has been able to generate new perspectives and opportunities through the implementation of new technologies. In this context, two different scenarios can be envisaged: firstly, the vehicle becomes a platform for the delivery of different solutions, for example «the car becomes a technological platform for the delivery of special services that you can experience during a trip». In reality, the car, intended as a technologically advanced tool, enables business opportunities by moving from a vision of services connected to that vehicle, to a vision of integration, where that vehicle becomes a platform that integrates with other platforms. Indeed, Gaiardelli suggested that a famous company was aiming to create a carsharing platform that would then integrate with other platforms, such as bike sharing or rail transport. In this way, the integration of different platforms leads the customer to have a transport system, no longer linked to the car transport system. In turn, this summarizes the concept of platforms and the idea that, in the future, is important to integrate different platforms

and guarantee the customer, through a single access, a single app, to plan their travel experience, through a single interface based on the integration of multiple platforms. Secondly, such a trajectory unlocks a series of opportunities under a service standpoint, since the technological innovation that has hit the service centers leads to new interpretations in the organization of the service chain: «we are seeing systems that allow the machine to be integrated with service networks, making it possible to disintermediate the choice in repair assistance…which is something evident especially in the heavy vehicle market, but it will also happen for cars». As consequence, «it is no longer me, therefore, who decides when and how to do the service, but my car that integrates with the control system and is able to make a self-diagnosis and is able to decide when and how to do a repair and make an agreement with the service centers». As it is easy to understand, such latter aspect is particularly important under a managerial and business perspectives, because it leads to disintermediation of the decision-maker and therefore brings great concern to the service networks. As suggested by Gaiardelli, if it is the vehicle who decides where to get the assistance, than it is clearly heading for a parent company workshop and not for other workshops. Furthermore, in terms of pay-per-use contracts, new possibilities are tied not only to the integration of different platforms but also to leveraging on the use of the good and its parts: «we recently interviewed a German machine manufacturer who said that the future prospect would be to enter into contracts based on the use not only of the vehicle but also of its components, such as accessories. In fact, if I OEM benefit from a highly integrated system, I can charge you for the use of accessories as well. If you have a sunroof, you will pay based on how many times you use that accessory, for example».

Final languages are spent on the matter regarding how it would be possible to transfer pay-per-use or pay-per-performance business model innovations also in other industries. In this sense, Gaiardelli believes that said contracts can find a large application in all of the business-to-business industrial sectors, since, both the types, enable a manufacturer to control the end-user. The reason for the implementation of result-oriented offerings is that «the result is linked to production efficiency and therefore the more efficient they are the more profitable they generate. As a result, the customer is happy and I have very precise control over the cost structure». Apart from forerunners in this field – namely General Electric and Rolls' Royce, who have been masters in providing such solutions for years – there are also other examples of firms able to introduce result-oriented solutions. Indeed, in line with Gaiardelli: «I have evidence about the application of models based on results in the textile industry, in fact some companies in the Bergamo area wanted to apply these logics in relation to the loom beats. In fact, these companies, producing industrial looms and in relation to the beats made by a loom in a given period, demand a price from their customers. Every stop made by the loom means a

piece of fabric produced, so I, the loom manufacturer, know how much that fabric costs, the variable costs and I can manage everything». Last words have been spent on the future of the automotive sector where new technologies, and their subsequent implementation, have increased the attractiveness of the market itself. Indeed, as suggested by Gaiardelli, companies like Amazon or Google are planning to enter the automotive market, as they have significant technological capabilities. Such latter aspect has generated a vast interest worldwide, with studies and research activities already focalized to determine which will be the effects of the entrance of such big technological players in the automotive sector.

3.4.2. Service-led growth strategies in the printing sector

In order to have a complete picture, thus fulfilling the comparison between automotive and printing/photocopier industries, an additional interview with Professor Mario Rapaccini has been carried out. As we have already said in chapter 2nd, printing and automotive sectors differ in the adoption of servitization practices being implemented. The former is, indeed, considered as a forerunner of servitized logics and offerings which, overall, translates into an early adoption of business models seized over services: «certainly we are talking about the 70s, even before, for many reasons we have moved to models such as pay-per-page. I give you the machine and you don't buy it, but you sign a contract in which you pay a fixed amount and once in a while, depending on how much you have printed, you give me some adjustments. So a fixed and a variable component». Therefore, these solutions appeared around the 1970s, with the advent of xerographic technology, based on an electrolytic copy solution protected by a patent owned by Xerox. However, as suggested by Rapaccini, «when the patent on the Xerografiga print expired, there was a widespread adoption of this business model [pay-per-page], which became the dominant market standard. Thus, all manufacturers in the 1970s and 1980s, including Canon and Ricoh, used this logic». Nowadays, however, the printing market is divided into inhomogeneous percentages, whereby a 60% of the firms' turnover is made up by the production of multi-function systems, printers, photocopiers, «all the stuff that goes into every office in the world», banks, universities, institutions, hospitals and so on. In this sense, such an industry segment was still suffering negative impacts since, as also highlighted in chapter 2nd, less printing has been done. In turn, and as confirmed by Rapaccini, there is «a clear decline in product sales here, aided by the development of new, alternative services, services that are often fully integrated, such as lean services to integrate the press, the printing or archiving system within the management processes, into the context in which the press is to be inserted. In this sense, the printing industry has always developed processes for integrating presses with software and application solutions, often industry-specific». In this sense, it was interesting to

determine the role of the Covid-19 pandemic who, according to Rapaccini «may have accelerated this process of print shrinkage and therefore may have given an even stronger jolt to the decline in sales. It certainly has». The reason lies in where such products are utilized – typically office environments – who have been placed in smart working, thus stopping the printing processes for several months. As consequence, the pay-per-page contracts didn't produce any margins in the 60% component of the market (primary business segment); nevertheless «the basic fees were signed, so the costs were covered». The remaining percentage, composing the printing market, is made up by very complex printing machinery, i.e. multi-verticalized printing: for the graphic arts, printing houses, textiles, construction. As it is easy to understand, here products are not designated for office environments, rather they are implied in production departments operating in other industries, where there was not a decay or degradation of the performances due to the pandemic. However, as highlighted by Rapaccini, while the office printing world was hit negatively by the pandemic, positive effects involve the home printing world, where companies like Epson and Ricoh experienced increases of both printers and ink sales. The abovementioned firms were, thus, able to mitigate the Covid-19 impacts «because they occupy certain market niches able to reduce the impacts experienced by the core business». Regarding, instead, the direction through which the printing industry is moving to, integrated, industry-specific document process services are drawing the trajectory for firms. Such shift – which was already started before the Covid-19 spread – may have been accelerated by the pandemic, according to Rapaccini who argues :«the fact that in many contexts during the pandemic a workplace had to be transformed from a physical (office with a lot of paper) to a home environment, therefore clearly different, with less paper. So the rethinking of the workplace and digitizing the whole environment, in my opinion, is a process accelerated by the pandemic. The more far-sighted and less product-centric, but more service-minded companies - I know Ricoh very well, who is definitely a leader in this together with Xerox and HP - have already started to invest in transforming their companies into consulting firms that support all the processes of workspace transformation». The general picture that can be drawn, regarding firms in the printing industry is, therefore, that of companies who no longer produce printers – «in fact it is rather limiting to call it printing today, and it will be increasingly so in the future» – rather as companies that are actually geared towards providing solutions for the workspace, for the office [workplace management]. Indeed, Rapaccini suggests that: «one day, while yesterday Ricoh was just selling me a multi-function system that I then connect to my network, and the job was done, Ricoh will give me a whole range of integrated solutions consisting of hardware, software, cloud, collaboration environments that are certainly integrated through agreements with Microsoft, Google and others, the usual global players; to

integrate their document management solutions in the cloud, sharing, within very smart, virtual office processes and whether I am at home or in the office, I will be able to use these documents». However, such solutions are already provided by collaborative platforms, therefore, this latter aspect creates room for answering to a licit interrogative emerged during the interview: what is different about Ricoh than Google or Microsoft with Teams, which allows us to communicate, share documents, and more? The difference, very easily, lies into the fact that a firm like Ricoh is a manufacturer and thus «it already has in its catalogue a series of tools, hardware, screens, blackboards». In turn, this translates into the fact that Ricoh is able to deliver an integrated offer, composed by both an hardware and software component. Such aspect, aided by the resources and competences, that the firm has developed over the time, can make the difference in delivering solutions regarding the documentation management to other sectors, such as finance or banking. Indeed, Rapaccini highlights how much the printing world is becoming «more and more a world of distinctive skills to support clients in offices, to better manage sets of documents, data, information that come from outside and need to be stored, managed, shared and processed». Further confirms are those arose around the role of technology in the service transformation within this sector, where it is considered fundamental «as a set of technologies capable of transforming the photocopier into an intelligent device that provides services. The type of services will have to be the most diverse and nobody yet knows what they will be, it's complicated…I believe that everything is moving in the direction of operators able to offer platforms for document management and systems integration. Ricoh, for example, has acquired two important software companies here in Italy, which makes me think in this direction, that is to say, supporting the transformation from a press manufacturer to a company that produces integrated systems within the most odd but still document-based work processes».

With respect to the complexity of service offerings in the printing industry, result-oriented offerings were still delivered and seized upon the requested quality, by the end-user (quite frequent especially in the printing arts). In this sense, Canon has gone even further, with its technicians who set up customers' machines in the graphic arts industry continuously around the clock. Challenges are still holding in presence of outcome-based solutions where, however, the trajectory undertaken by the overall industry – whereby firms are transforming from printers producers to platforms – may bring a further development also under this standpoint. Indeed, Rapaccini points out that: «if the intention is to offer an office process management solution rather than printing, then there's a whole world to explore. Especially at the level of system-integration and cloud-connected platform creation. There will be an uptime to exploit…the

guarantee of accessibility and fruition can lead to the creation and evolution of some new contracts».

Conclusively, a question was spent in order to determine how such business models could be transferred – and thus implemented – also in other industries. A possible answer, according to Rapaccini, can be found in how Xerox managed to convince other players in the industry to rely on the pay-per-page business model. Said shift was possible to be applied by Xerox through issuing an «absolutely flexible contractual form saying that I don't sell the machine to you, you rent it and you pay me a fixed amount per month plus, every now and then, you pay me for how many copies you make. If, at any time, of this three-year contract, you (customer) are not happy, you call me, I come, collect the product and you don't pay anything. So, we are talking about a contract without penalties. So the client felt protected, at relatively low costs. So everyone signed this contract. After a while they noticed that the costs were sustainable, they had much better technology, they could withdraw without cost. This convinced the market». Therefore, in order to transfer such service solutions to other industries, contractual flexibility and experimentation are key factors. This is something which is «already real» in the world of collaborative robotics, where robots are rent and operate within industrial departments performing many different activities (assembling primarily). Finally, Rapaccini makes a final consideration regarding the machine mobility, which will be less anchored and fixed to pedestals in future. As consequence, the same machine can be utilized in different industry areas, thus enabling the service models to be even more implemented.

Conclusions

The thesis work carried out first highlighted how the role of digital services and technologies, in manufacturing, is now a process in full development and being implemented by many industrial realities. With reference to service in the strict sense, the broader inclusion of service logics – translated, in turn, into real service strategies – is a process that has been underway for some time, which is something confirmed also by the managers that I have interviewed. Indeed, the literature review made in this dissertation, together with the interviews and surveys, have highlighted that manufacturing companies, in Italy and around the world, have seen services as a different way of competing and proposing themselves to clients, thus satisfying different, new and highly personalized needs. The same can be said with reference to the digital technologies, inherent to the concept of Industry 4.0, now an integral part of the manufacturing fabric. The combination of these two latter aspects is, indeed, tied to the contents arisen from the last analysis that I made, in October, with Professors Gaiardelli and Rapaccini. In this sense, both the automotive and printing industries – though with different BMs and offerings – are heavily relying on both services and technologies in an attempt to fulfil new and increasingly customized customer needs. On the other hand, what I also found is that challenges remain open – regarding the adoption and implementation of such solutions – whether they refer to service or advanced technology. As pointed out during the discussion involving the research evidences, and with particular reference to those traditional and highly product-centric industrial realities – most of which were interviewed or were asked to compile the survey – different resources and capabilities are necessary in order to adopt the above changes in an efficient and profitable way. However, from the analysis it is evident how the combination of services and digital technologies can really represent a distinctive tool for manufacturing companies, helping them on the tortuous path towards the new normal. The research activity that I carried out as collaborator of DT-Lab, whose results are presented in chapter 3, has certainly highlighted these aspects, with a significant portion of the sample that will move through digital services and technologies making concrete investments in this direction. Moreover, the codification of the interviews carried out in the previous months, further confirms the extent to which the most digitized companies have been able to quickly adopt certain measures. In my mind, these should not only be seen as an end in itself, with respect to the current pandemic, but also as a real indicator of industrial resilience capable of satisfying various needs, starting with factory operations, moving on to the safety of employees and their training on digital channels, moving on to the relationship with suppliers and partners, ensuring proximity to the customer. Considering the extent and breadth of the current health emergency, taking into account also the tremendous impacts suffered in each sector, digitally ready

companies, i.e. those who over time have made investments aimed at technological modernization, have certainly reacted better and faster. Such latter aspects appeared clear since the beginning of this research, where I started performing the first interviews with managers whose aim was, at first, that of understanding what was actually happening and then react. Combining the qualitative and quantitative bodies of my research, the general perception that emerges is that of an industrial context that is finally aware of change. Whether it is understood as an offer with a more serviced component and in which digital technologies finally find a wider use, leading to concrete and proven results from those who, through such solutions, have managed to mitigate the impacts of a phenomenon never seen before. For these reasons, the Covid-19 could really act as a watershed, thus enabling a wider number of manufacturing companies to adopt and then implement digital solutions, based on industry 4.0 technologies, both in terms of production and service. However, it is important to note that, in addition to the various challenges, resources and skills that need to be addressed, the willingness and involvement of the so-called business leaders is crucial. It must be able to manifest itself concretely, thus embracing real medium-long term strategies, aimed at the implementation of existing technologies and the development of new offers based on real product and service packages, capable of satisfying the demands of a wider portion of the market. Only the combination of these ingredients can ensure that this change is adopted by a considerable number of manufacturing companies. It is however undeniable, from my own perspective, how much governments are pushing, through appropriate incentives, the digitization of the different sectors that make up the socio-economic fabric of one country rather than another. Considering the empirical data obtained through a multi-monthly research, taking into account what information collects and disseminates in terms of digital and service, including the series of analyses carried out by large consulting firms, I believe that this pandemic has all the requirements to mark a turning point towards a real digital transformation in manufacturing, in which services will certainly play a greater role in the offer to the customer. Such a personal interpretation finds confirms in the directions that automotive and printing industries are undertaking in terms of service-led growth strategies. The former, although not yet able to develop result-oriented solutions, is strongly moving towards business models based on pay-per-use solutions, with the aim of developing real platforms for the provision of services. In this sense, as highlighted in the previous sections, major manufacturers are planning to develop digital platforms, thus allowing the customer to choose how to move along a given route, enabling him/her to define the choice of a bike, a car, a scooter, a train or anything else, to travel a certain number of kilometers and arrive at the desired destination. Just think how important all of this could be, especially in the days that we are living in, where it is strongly recommended

to avoid crowds even in the transport of people, thus allowing any person in planning how many kilometers to do with a specific vehicle, also according to the flow of people present on that particular route and utilizing a particular mean of transport. Likewise is the direction taken by the printing industry, where OEMs will no longer be considered as mere press or copier manufacturers, but as providers of multi-service platforms capable of taking care of the entire process of modification, archiving and storage of the electronic document in office environments. Overall sentiments are pushing myself to consider the change – towards services and digital technologies – as something already begun and whose effects are, somehow, already visible. Especially, considering the directions that the companies, participating in my analysis, are undertaking. Conclusively, I believe that the thesis work carried out – whose primarily aim was that of demonstrating how digital servitization can help manufacturers to mitigate the Covid-19 effects – embodies the necessary elements (qualitative and quantitative data, literature review) to provide some managerial insights, in line with the topic covered and discussed previously. Provided that there are still limits characterizing my analysis, as those envisaged in chapter 3, a further contribution to the issue has been provided. Indeed, the latter interviews performed in October 2020 – whose aim was that of filling a gap envisaged in the reference literature, involving the automotive and printing sectors and the degree of servitization characterizing them – further accomplish my aim of giving a complete overview on the issue, thus extending the precious evidences collected as collaborator of the DT-Lab.

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